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Attitudes and Trust in Leveraging Integrated Sociotechnical Systems for Enhancing Community Adaptive Capacity: Project Phase I

Prepared for **Teaching Old Models New Tricks (TOMNET) Transportation Center**

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The overarching goal of the project is to understand and model ways in which we can leverage unique – and interconnected – physical and social characteristics of place to enhance community adaptive capacity in response to disruptions. This first phase (one-year) sets the stage for that line of inquiry by exploring and assessing the state of the field and best practices regarding attitudinal surveys in the areas of both resilience and transportation planning. The review explores the role of networked sociotechnical systems as they contribute to adaptive capacity, a concept rooted in social-ecological resilience theory, at the community level. Relevant applications of social network analytical methods are explored as a means of guiding methodological development for the next project phase.</td></tr>
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EXECUTIVE SUMMARY

The overarching goal of the longer-term project is to understand, model and develop ways in which communities can leverage unique – and interconnected –social and technical resources of place to enhance their own adaptive capacity. Phase I focuses on an extensive review of the literature in community adaptive capacity, socio-technical systems and social trust and social networks.

Adaptive capacity is a latent community attribute (Brown & Westaway 2011) that enables reactive and/or anticipatory response to change (Folke et al. 2010). The concept of adaptive capacity is widely applied within socio-ecological resilience theory, which offers rich conceptual models for describing the nature and dynamics of complex adaptive systems. Although rooted in the field of conservation ecology, resilience concepts have been adopted in urban planning research to help describe the functioning of cities and communities as complex social and socio-ecological systems. In particular, the socio-ecological resilience concepts of traps and imbricated systems are relevant to addressing challenges posed by community reliance on brittle sociotechnical systems.

Sociotechnical systems comprise the technological artifacts, human participants, and organizational frameworks and procedures that produce products or services (Little 2004b). Humans and technology are becoming more deeply interdependent, intertwined in brittle sociotechnical systems that provide many essential and useful services (Townsend 2013a, Giddens 1990). Growing disparities between urban and rural/remote areas present both challenges and opportunities for the development of sociotechnical systems that can help to bridge the widening gap in community well-being and enhance community adaptive capacity.

Social capital, an important resource for supporting community adaptive capacity (Freitag et al. 2014) is often measured using SNA (Prell 2012). SNA methods help to describe the characteristics and relative strength of connections among community members and/or institutions, and they provide a methodological approach for better understanding how community social networks can help to enhance community adaptive capacity. Changes in technology have altered the structure and function of communities, the ways in which they form, and their interactions with the systems that sustain them, leading to an increasingly networked society (Rainie & Wellman 2012) in which human and technical contributions to community adaptive capacity are interdependent.

INTRODUCTION

The increasing reliance of cities and urban-rural regions on complex and interdependent infrastructures has increased vulnerability to all scales of natural and man-made threats. In both urban and rural areas, new smart cities systems have created a reality in which society has become increasingly reliant on the brittle infrastructure of cell phones, cloud computing and GPS-reliant devices – technologies that are susceptible to system-wide failure (Townsend 2013b). Communities depend on these infrastructures for myriad everyday tasks and activities, not to mention critical services such as health care. Despite the risk and uncertainty associated with new technologies, people often trust them (Li et al. 2008) even though they often fail (Townsend 2013b). At the same time, disruptions caused by natural and man-made hazards are increasing in both frequency and severity, exacerbating the impacts resulting from physical infrastructure system failure, which are felt most by societal groups dealing with pre-existing vulnerabilities and social inequalities (Elliott & Howell 2017, Klinenberg 2015). Disruptions are inherently geographical, as affected communities often become reliant on local resources when municipalities and agencies become overwhelmed. Meanwhile, standard approaches to resilience planning tend to uphold a status quo that shifts the responsibility for recovery from disruptions onto those least able to afford it (Davoudi et al. 2012).

Despite the continued widespread adoption of – and growing societal dependence upon – digital technology, adults in rural and remote areas are still less likely than their urban counterparts to own digital devices or go online (Perrin 2017). This disparity occurs partially due to differences in age, race and income but is also influenced by geography, including the relative lack of infrastructure for high-speed internet and slower connection speeds in rural areas, which limits the ways in which rural residents can access distant resources. Digitally supported transportation services (e.g., emerging ride-sourcing services such as Uber and Lyft) are also significantly sparser in rural areas, giving rural residents fewer options for accessing critical services like health care, the provision of which has become increasingly sparse in rural America. On an everyday basis, rural residents therefore must spend more time and money to access these services; in the case of a disaster, they may lose access altogether. The ubiquity of networks that provide opportunities for urban dwellers place the "have-nots" at a social network disadvantage (Hampton 2007), threatening to leave poor, unconnected communities behind (Urry 2012, Townsend 2013a).

Finally, the decline of social infrastructure – "the public places and organizations that shape the way people interact" (Klinenberg 2018) – is occurring at the same time that society is turning away from place-based community activities and towards aspatial communities of interest facilitated by new technology (Putnam 1995, Rainie and Wellman 2012, Webber 1963). Public spaces continue to be important for community health, safety, well-being, economic development, relationship formation and the practice of civic behaviors, and the decline in the availability and quality of social infrastructure has resulted decreased social participation and trust (Klinenberg 2018), critical ingredients for community well-being and adaptive capacity. Social infrastructure also serves as the "backup" for physical infrastructure when it fails (Freitag et al. 2014).

In this context, this review seeks to understand, from both urban and rural perspectives, how place-based (community) resources, both social and technical, can bridge the divide between rural and urban communities and overcome the deficiencies in the physical infrastructures. It is believed that as a result, community adaptive capacity will be enhanced in response to both disasters and long-term challenges (e.g., climate change and long-term economic declines). Social resources are given broad meanings in this study, encompassing concepts such as place attachment, social capital, social trust and social networks, and attitudes toward using new and alternative

services (e.g., ridesharing, intranet and FM radios). Technical resources include both physical resources (e.g., disaster preparedness kit) and systems (e.g., transportation) and cyber and information (e.g., communication) systems.

LITERATURE REVIEW

1. Community Adaptive Capacity

The first section of the review draws upon socio-ecological resilience theory, with a focus on adaptive capacity, which is emerging as a subfield within urban planning. Adaptive capacity is the ability of a system (such as a community) to absorb shocks or reconfigure and transform in response to or in anticipation of change (Folke et al. 2010). Adaptive capacity is a latent characteristic of communities that can be activated through social networks (Adger & Vincent 2005). While the term "resilience" tends to be used in connection with disaster planning (Davoudi et al. 2012), the concept of adaptive capacity relates to questions of everyday community well-being (Freitag et al. 2014), which originates from socio-ecology theories on resilience. Socio-ecological resilience theory offers rich conceptual models for describing the nature and dynamics of complex adaptive systems. Widely used in the field of conservation ecology, these models have also been adopted to describe the functioning of communities as complex social and socio-ecological systems. In the rest of this section on community adaptive capacity, we review the conceptual development of adaptive capacity within the socio-ecological resilience literature. our review also includes a collection of empirical studies that represent both qualitative and quantitative approaches to the measurement of adaptive capacity at the community scale.

1.1 Socio-ecological Resilience, Complex Systems Theory and Adaptive Capacity

Panarchy (Gunderson and Holling 2001), one of the seminal texts within the socio-ecological resilience literature, develops a theory that describes the ability of natural systems to evolve via recurring cycles of change. *Panarchy* identifies three key features of ecosystem structure and function based on a model of system evolution and adaptive change: potential, connectedness and resilience. *Potential* describes the limits of what is possible for the system; *connectedness* describes the extent to which a system can control future change; and *resilience* describes how vulnerable the system is to unexpected change (Ibid, 51). The relationship between sustainability and scale is conceptualized as a set of nested adaptive cycles (the "panarchy").

The direction and development of the overall system can be influenced by instances of "remember" and "revolt" between the levels at key points in the adaptive cycle where learning is combined with continuity. The "remember" instances occur when a change or disruption that occurs in one level of the panarchy is influenced by the organizational structure of the level above it, incorporating elements of systemic memory into the resulting adaptation. "Revolt" occurs when a change that occurs in one level of the Panarchy is transmitted to a higher level when the higher level's resilience is low – by this mechanism, it is possible for small events to overwhelm larger ones in the system hierarchy when the timing is right.

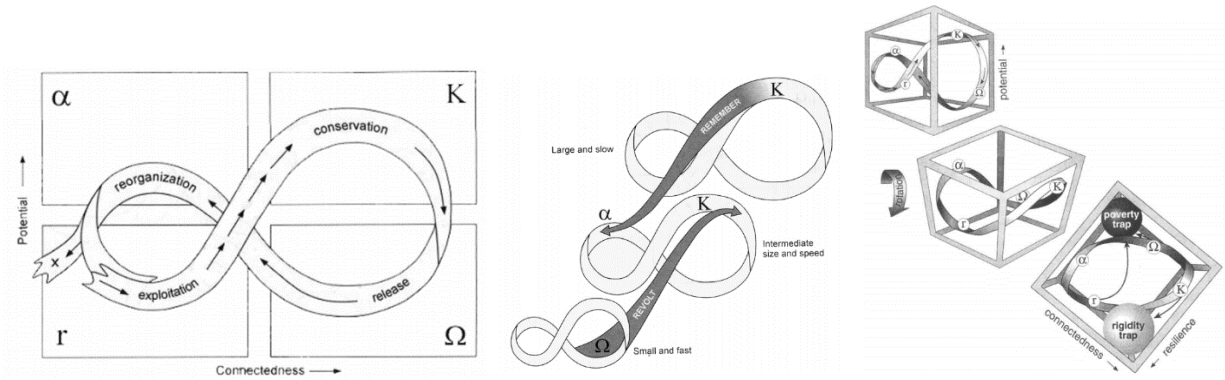

FIGURE 1. Graphic depictions of the four stages of the adaptive cycle (left, Allen and Holling 2010), the nested hierarchy of the Panarchy (center, Allen and Holling 2010) and the occurrence of poverty and rigidity traps in maladaptive systems (right, Holling 2001).

The authors of *Panarchy* identify key differences between social and ecological systems, including the ability of social systems to transcend geographic boundaries using abstract symbolism – for example, the monetary system is a symbolic system that enables human institutions to exist separate from specific geographic locations. Other characteristics of social systems include their ability to be reflexive; to exhibit forward-looking behavior; and to exploit a variety of scales through the development and use of technology. In this context, social system structure, social capital and social networks (including horizontal and vertical ties)[1] play a key role in the transformation of socio-ecological systems. Reciprocity, or the mutual exchange of resources, is highlighted as an important factor in achieving transformation while navigating conflicts in social systems, such as reaching a compromise between differing objectives of social groups involved in a process of change.

A particularly relevant concept from *Panarchy* is the practice of incorporating flexibility, novelty and adaptive learning into the management of complex systems – to the point of intentionally introducing disturbances – in order to remain resilient by avoiding the development of brittle systems that could fail and endanger critical resources. Brittle systems are those that have become maladaptive; they have a kind of perverse resilience, representing what Holling (2001) calls a "rigidity trap." Systems stuck in this kind of trap have lost the ability to adapt or foster novelty and "carry the seeds of their own destruction" in their potential for system-wide failure (Ibid, 401).

Allen & Holling (2010) argue that novelty and innovation are necessary for system adaptation and evolution; without these things, systems can lose their resilience, falling into rigidity traps from which they are unable to share stored capital. In social systems, the ability to shape change and avoid traps is supported by a range of adaptive characteristics, including local knowledge and social practices supported by institutional memory (Folke & Berkes 2002). However, social systems tend to rely on brittle systems lacking the imbricated structures that support adaptive capacity in natural systems (Gunderson and Holling 2001).

Unlike resilience, which can have negative attributes and consequences as demonstrated in the discussion of traps above, adaptive capacity is universally regarded as a positive

[1] In a community context, ties within communities – for example, between different community organizations – are considered horizontal ties, while ties from groups inside the community to organizations outside the community are vertical ties. See Berke, P. R., Kartez, J., & Wenger, D. (1993). Recovery after disaster: achieving sustainable development, mitigation and equity. *Disasters*, 17(2), 93-109.

characteristic of complex systems (Engle 2011). Adaptive capacity is understood as an important contributor to positive community resilience (Berkes & Ross 2013) and as a primarily social construct involving human agents and collective action (Adger & Vincent 2005, Adger 2003, Berkes & Ross 2013) that is manifested by way of social networks and interpersonal connectivity (Brown & Westaway 2011).

In a community context, adaptive capacity is a latent quality of social groups that is represented by available resources that support the potential for change (Adger & Vincent 2005). Enabling adaptive capacity requires looking backward (remembering); looking forward (visioning); and the willingness and ability to act (resources and agency). Although influenced by interdependent factors at multiple scales, adaptation is manifested at the community level through bottom-up processes (Smit and Wandel 2006, Adger 2003).

Sometimes extreme circumstances of change may not allow for adaptation, instead requiring a system to transform. Transformability is defined as "the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable" (Folke et al. 2010, 4). Transformability involves comprehensive, systemic change as well as knowing when to transform to avoid traps and building the capacity to do so (Walker et al. 2004). Transformation typically involves a greater magnitude of impact, a longer time scale and a greater spatial scale than does adaptation. Drawing upon case studies of socio-ecological systems, Folke et al. (2010) find that transformations involve three phases: preparation, making use of a crisis as an opportunity for change, and building resilience of the transformed system.

Some resilience scholars suggest that society has now entered an era of transformation in which it must work to build and maintain ecological resilience as well as the social flexibility needed for coping, innovation and adaptation (Holling 2001, Wolfram 2016). This may require changes in patterns of interaction among community actors as well as shifts in organizational and institutional configurations (Folke et al. 2010). Marshall et al. (2012) observe that some of the characteristics that might enhance adaptive capacity (e.g., place attachment) could potentially diminish transformative capacity due to the difference in the magnitude of change – and the nature of the change – required.

1.2 Adaptive Capacity: Empirical Studies and Approaches to Measurement

The concept of adaptive capacity, which is rooted in socio-ecological resilience theory (Carpenter and Brock 2008, Folke et al. 2010) has been widely adopted in the literatures on climate change adaptation (Adger 2003, Adger & Vincent 2005) and disaster preparedness (Brown & Westaway 2011). Adaptive capacity has been identified as a bridging concept between and among disparate fields, including the resilience and vulnerability literatures (Engle 2011); the human development, well-being and disaster resilience literatures (Brown and Westaway 2011); and ecological (systems) resilience and developmental psychology (Berkes and Ross 2013). However, few studies in the urban planning literature even mention adaptive capacity. A search of four mainstream planning journals – *Journal of Planning Literature, Journal of the American Planning Association*; *Planning Theory and Practice*; and *Journal of Planning Education and Research* return only 23 papers that mention the phrase "adaptive capacity." Of these, only one, Frietag et al. (2014), uses the phrase in the title of the paper. In this paper, the authors demonstrate the utility of taking a community participatory, asset-based approach to planning for "whole community" disaster mitigation. They find that social capital is a critical

factor in enhancing community adaptive capacity, as it enables local self-organization and serves as a backup when vulnerable institutional and physical infrastructures fail (Ibid).
As a latent feature of communities that is typically manifested only reactively, adaptive capacity has proven to be difficult to measure (Engle 2011). Some scholars argue that it cannot be measured directly (Jones et al. 2010) while others claim that it can indeed be measured (albeit "in theory") at various scales, although multiple sources of uncertainty make such measurement challenging in practice (Adger & Vincent 2005). Despite this disagreement, a wide variety of research approaches for assessing adaptive capacity have been suggested and attempted. Measurement approaches often use strengths-based models (Brown & Westaway 2011), and although indicator approaches are popular, their reliance on aggregated data has been recognized as inappropriate for assessing adaptive capacity, which is both socially and spatially heterogeneous (Adger & Vincent 2005). Other approaches include case study analysis (Adger et al. 2005, Connon 2017, Harrison et al. 2016, Fischer & McKee 2017, Goldstein 2008, May 2019), social network analysis (Ingold et al. 2010, Janssen et al. 2006) and OLS (Ordinary Least Squares) regression (Carpenter 2015).

The widespread use of qualitative, case study approaches to examine community adaptive capacity reflects a focus on the place-specific nature of CAC (Community Adaptive Capacity), but such approaches do not lend themselves to generalization or direct comparison. On the other hand, while quantitative approaches do enable concrete measurement and generalizability of CAC research, they tend to rely on proxy variables or indicators (such as Emery & Flora 2006; see also Carpenter 2015) that might not accurately represent the process of interest or account for the heterogeneity of the study context. Smit & Wandel (2006) suggest addressing this issue by using bottom-up research approaches that are derived from community knowledge.

A common theme in the empirical studies reviewed is the call for approaches to better understand the dynamics and mechanisms through which adaptive capacity operates. Berkes and Ross (2013) suggest the need for research on the processes that activate latent adaptive capacity (such as the process indicator approach used in Harrison et al. 2016). Alternative approaches include the use of power frameworks (May 2019) or community dynamics analysis (Fischer and McKee 2017). Although there are many examples of research that assess adaptive capacity following large hazard events, these are relatively rare occurrences. Attempting to better understand community reactions to smaller, less stressful (but more frequent) events could potentially provide insights into the process of community adaptation. A research approach could be developed for looking specifically at the ways in which services are provided via social and/or technological systems in both "normal" and disaster circumstances, noting flexibility, substitutability, imbrication.

The use of social capital and the structure of social ties as a basis for understanding the dynamics of adaptive capacity is another recurrent theme, suggesting that expanding the use of SNA (Social Network Analysis) approaches in the study of CAC would be appropriate. Both horizontal and vertical connections (Ingold et al. 2010), which are articulated by Connon (2017) and Harrison et al. (2016) as bonding (horizontal, within-group), bridging (horizontal, between-group) – as well as linking (vertical, hierarchical) – social capital are understood to contribute to community adaptive capacity in the face of change. Adger et al. (2005) suggest that bonding social networks support social learning while bridging social networks enable the development of integrative strategies for adaptation.

2. Sociotechnical Systems

Little defines socio-technological systems (STS) as "the assemblage of technological artifacts, human participants, and organizational frameworks and procedures that have the objective of producing a product or service" (2004b, 4047). This definition is adopted for this project, changing it slightly to "socio-technical systems," which is more widely used across multiple literatures and which embraces technical knowledge as well as technological artifacts.

Increasingly, integrated social and technological systems are embedded within a network of "communication and computing infrastructures whose dynamics and evolution are defined and driven by human behavior" (Vespignani 2009, 425). Infrastructures that provide critical services to society (e.g., transportation and communication networks) are examples of socio-technological systems. Klinenberg (2018) suggests that infrastructure reflects the societal goals and aspirations of its time. In the U.S., reliance on interdependent infrastructure systems has increased while the redundancy and extra capacity of those systems has eroded due to deregulation, desire for efficiency and the growth of competition (Little 2004b). As physical infrastructures become increasingly interlinked with information technology, they become more vulnerable simply due to the inherent complexity of the socio-technological systems in which they are embedded (Little 2004a). Townsend, for example, points out the brittleness of smart city communication infrastructure and its susceptibility to bugs, calling attention to the fact that new technologies often generate unintended consequences that have greater impact than the technology's originally-intended purpose (2013a).

2.1 Social Infrastructure

Community social infrastructure, comprising physical and organizational structures that shape the way people interact (Klinenberg 2018), provides a framework within individuals can interact to build trust and reciprocity (Rogers & Jarema 2015), two important components of social capital. Public buildings such as community centers, recreational facilities and schools are critical to the development of communities because they facilitate the creation of formal and informal networks by providing a place for social gathering and interaction (Green & Haines 2012). Leyden and Goldberg (2015) argue that people's level of community involvement is to some extent dependent on the qualities of the built environment; Green and Haines (2012) also claim that the physical design of communities influences social relationships.

Hampton et al. (2011) note that interaction in public spaces is important for building social network diversity, which in turn provides people with access to more diverse resources and serves as a precursor to participation in more traditional (place-based) public activities. However, in contemporary communities, social gatherings are increasingly moving from public spaces to private homes (Wellman 1999), which provides less opportunity within communities for the kind of continual, face-to-face interaction that builds social networks (Rogers & Jarema 2015, Whitham 2018, Urry 2012, Audirac 2002). The specific role of the built environment in building and maintaining social capital remains under-researched (Leyden & Goldberg 2015), and planners need to pay attention to the consequences that contemporary social networks have on the use of public space (Wellman 1999).

Social infrastructure plays a role in enhancing the adaptive capacity of potentially brittle sociotechnical systems. When hard infrastructure fails, "it's the softer, social infrastructure that determines our fate" (Klinenberg 2018, 15). Immediately after Mexico City's 2017 earthquake, people spilled into the parks and public spaces, which were adaptable and multifunctional; they also served to support social familiarity before the earthquake even happened, facilitating the

construction of social ties that would help to deal with the consequences of the disaster (de Jong 2017). Social infrastructure also plays an important role in supporting inclusion and equity in urban spaces by providing spaces in which anyone is welcome to participate. Although the quality and availability of social infrastructure affects everyone, it is particularly important for children, the elderly and other with limited mobility or lack of autonomy that keeps them bound to place (Klinenberg 2018).

2.2 Trust, Social Networks and Social Capital

Trust also plays an important role in socio-technological systems. In *The Consequences of Modernity,* Anthony Giddens asserts that due to the complexities and uncertainties that pervade modern life, people are required to place trust in expert (technical) systems as part of everyday existence in a kind of "bargain with modernity" (1990, 90). These same systems have enabled what Giddens refers to as "time-space distanciation," resulting in the separation of social relations from place (1990), a concept that aligns with the move toward a networked and less place-dependent society (Webber 1963, Rainie and Wellman 2012). Time-space distanciation refers to the ability of social systems to interact in ways that are not limited by space and time; this has been made possible by advances in transportation and communications technology that do not require people to be in the same place at the same time in order to engage in social interaction. Time space distanciation requires trust in both persons and abstract systems. Social networks create opportunities for building trust, and our reliance on technology (and expert systems) has modified the function of social networks in contemporary society: while we now rely more on expert systems, we rely less on one another, at least on an everyday basis, resulting in fewer opportunities for the face-to-face interactions and transactions that build social capital.

2.3 Communication and Transportation Infrastructure in Rural Communities

Community is defined in multiple ways, often by location, identity, or organizational membership. Improvements in transportation and communication networks have reduced rural isolation while simultaneously increasing the separation between the location, organizational and identity elements of community (Flora 2016). The cost of transportation and access to modern communication infrastructure like broadband have been strong influences on urban to rural migration, and an increase in highway infrastructure coupled with a decline in public transportation services has contributed to a pattern of long commutes for rural residents (Brown & Schafft 2011). Lack of transportation is a major barrier to health care access in rural areas. Although transportation infrastructure has historically been a public service, IT and telecommunications infrastructures are provided by private companies and tend to be biased toward large cities with a concentration of well-off users (Audirac 2002). Yet, information technology is a critical resource for contemporary rural life; internet connectivity provides access to jobs, facilitates social relationships, enables access to public information and delivers educational and health services (Brown & Schafft 2011). While rural communities are most in need of improved digital connectivity to compensate for their remoteness, they are least connected (Salemink et al. 2017).

Although telecommunications technology has acted as somewhat of a leveling force between urban and rural areas, the digital divide between urban and rural (as well as rich and poor) is growing. In a review of 157 papers on digital developments and rural development in advanced countries, Salemink et al. (2017) found evidence of persistent and growing differences

in data infrastructure quality between urban and rural areas, which is exacerbated by the inability of public policies improve data infrastructure apace with market developments.

The continued integration of digital technologies into new aspects of daily life creates distinctive rural forms of digital disadvantage and vulnerability which result in a variety of different forms of social, economic and cultural disadvantage (Roberts et al. 2017). Although rural communities could benefit from technological innovation, the market for "smart city" infrastructure does not encompass rural communities. The very networks that provide potential opportunities for grassroots innovation in urban areas also place the "have-nots" at a social network disadvantage (Hampton 2007) and threaten to leave poor, unconnected communities behind (Urry 2012, Townsend 2013a).

2.4 STS Empirical Studies of Transportation and Communication Infrastructure

Transportation studies

Social capital and alternative access to transportation. The empirical studies focused on access to transportation services in sociotechnical systems reveal that social networks and social capital play an important role in access to transportation for groups who may not be able to pay for it, filling mobility gaps for those who may otherwise be excluded from driving (Lovejoy and Hardy 2011). Social capital is also related to dynamics of social exclusion and transport disadvantage (Schwanen et al. 2015). Non-market interactions also occur in the practice of slugging, the success of which depends more on the development of social norms than on social networks or social exchange (Mote and Whitestone 2011).

Using social network data for understanding travel behavior. Carrasco et al. (2008) develop a methodology for inferring social-activity travel patterns from social network connections using data on the spatial distribution of social activities and relationship of activities with ICT use. Chaube et al. 2010 use social network data to understand commuter travel patterns and preferences, revealing that willing to engage in ridesharing depends on trust, convenience and incentives.

Communication studies

The formation and dynamics of online communities. Masden et al. (2014) conduct a study of Nextdoor users to determine the site's ability to build and support social capital and neighborhood ties, finding that some of the tradeoffs in creating a virtual community based on physical community geography include difficulty in dealing with issues that cut across communities, defining meaningful community boundaries and creating a forum that supports sharing of appropriate information. Using Twitter data, Farnham et al. (2015) examine the capability of social media as a kind of "networked third place" with the potential to provide a venue for online social interaction and bottom-up conversation about community issues, finding potential synergies with local businesses. In a study of the effects of online community-building tools on neighborhood interactions, Hampton et al. (2007) find that both lack of internet connectivity and neighborhood instability have negative and additive effects regarding lack of resources available to communities through their social networks. Williamson and Ruming (2016) use social network analysis to visualize the networks of two community groups involved in planning processes and suggest that SNA could also be used to aid planners in better understanding how community groups are organized and how they communicate with one another.

Rural and urban differences in social media use. Gilbert et al. (2008) find differences between the ways people use social networking sites in rural and urban areas; differences include levels of trust as well as network size, average distance of friends and use of privacy settings. *Relationship between behaviors in virtual and physical space.* Beginning from the premise that networks that are high in social capital predict democratic engagement, and that democratic engagement leads to greater well-being, Hampton (2011) examines the ways in which different types of social ties contribute to civic and civil behaviors, finding that overall network diversity – as determined by the presence of bridging ties – is a predictor of civic engagement, more so than network size or diversity of core (bonding) contacts.

3. Social Capital & Social Network Analysis

This section of the review covers the following topics: 1) social capital theory and the role of trust in social networks; 2) measurement of social capital using SNA; 3) SNA applications relevant to urban planning research and understanding CAC; and 4) relevant empirical studies reviewed.

3.1 Social Capital Theory

Many definitions of social capital exist, although most agree that social capital refers to value or assets embedded in a social network that can be accessed and mobilized by individuals to facilitate collective, purposeful action (Lin 2001, Prell 2012, Van der Gaag & Snijders 2005, Hsung et al. 2001). Certain aspects of social structures, such as trust and social norms, are understood to assist in the access and mobilization of social capital (Green & Haines 2012, Rogers & Jarema 2015). Investment in social capital is critical to the development of other forms of community capital, such as human, financial, physical and environmental capital (Borgatti et al. 2009, Flora 2016).

Social capital is often described in terms of its ability to "bond" or "bridge." Bonding social capital describes ties that contribute to community cohesion, while bridging social capital refers to ties that "bridge" disparate elements within a network (e.g., organizations or communities (Rogers & Jarema 2015). Green and Haines (2012) suggest that both kinds of social capital are important for supporting change in place-based communities; bonding ties contribute to a more integrated community while bridging ties build extra-community support networks. The concepts of bonding and bridging are akin to concepts of horizontal and vertical integration in the disaster resilience literature, which aid in community disaster recovery; absence of such integration leads communities into a kind of poverty trap (Carpenter and Brock 2008) from which it is difficult to emerge (Berke et al. 1993, Holling 2001; see also Ingold 2010).

It should be noted that, like the concept of resilience, social capital has a "dark side" (Rogers & Jarema 2015), meaning that connections that are very dense and strong can make a system less flexible or adaptable. Rigidity traps can occur in social network structures, for example, in situations where a particular actor or set of actors holds the power to shape collective action, identity and memory, thereby limiting the contributions of weaker members and decreasing adaptive capacity (Ernstson et al. 2008).

3.2 Social Capital, Social Networks and Trust

Trust

Trust involves risk-taking in situations of interdependency (Buskens 2002); it enables people to create and maintain relationships with strangers by reducing the transaction costs for collaboration in the absence of personal familiarity (Torche & Valenzuela 2011). Trust is a core component of social capital and influences outcomes for actors in a network based on the extent to which it facilitates sharing or exchange (Leyden & Goldberg 2015, Prell 2012). Investment by individuals in social relations can help to build mutually reinforcing patterns of trust and reciprocity within a social network (Green & Haines 2012, Lin 2001) that act to strengthen social capital.

In his book *Social Networks and Trust*, Buskens argues that in modern society, trust serves three functions: facilitating cooperation between individuals, maintaining social order through the development and enforcement of norms (both discussed briefly above), and reducing the complexity of modern life and (2002). This reduction in complexity is increasingly necessary as society becomes more and more dependent on the abstract sociotechnical systems. These abstract systems embody the expertise that lies beyond any one person's individual grasp, but upon which we depend in order to engage in day to day activities (Giddens 1990). As society has become more complex, social trust has become more important (Earle and Cvetkovich 1995). Social trust in institutions can also help to build social capital, thereby enabling flexibility and creating the conditions necessary for the enhancement of adaptive capacity (Adger 2003, Engle 2011).

Earle and Cvetkovich (1995) distinguish between two forms of social trust: pluralistic (within-group) and cosmopolitan (across-group). In their view, pluralistic social trust is associated with acceptance of the status quo while cosmopolitan social trust is associated with community-building and reorganization in response to new ideas and information. In a community context, these two types of social trust could be thought of as corresponding to situations of strong network closure through bonding ties (pluralistic) or an abundance of bridging ties and structural holes (cosmopolitan) (see discussion of network closure vs. structural holes below). Whereas pluralistic social trust tends to reinforce within-group norms and generate across-group social distrust, cosmopolitan social trust, which reaches beyond group boundaries, is necessary for solving complex social problems (Ibid).

Although Earle and Cvetkovich's characterization of the two types of social trust suggest that overly strong networks within communities may lead to negative outcomes in certain situations, the value and usefulness of different network structures generally depends on the outcome of interest (Torche & Valenzuela 2011). Networks with high closure may be better for preserving resources and enforcing group norms, while more networks with a variety of bridging ties can be useful for identifying new opportunities and gaining new skills or information (Ibid).

Reciprocity and generalized exchange

Whereas trust is an expression of social capital that facilitates relationship-building between strangers (as noted above), reciprocity –measured in SNA as the mutual exchange of ties between nodes (Hanneman & Riddle 2011) – occurs in networks where personal relations have already been established (Torche & Valenzuela 2011). Direct reciprocity generally excludes any kind of obligation toward strangers; in fact, the occurrence of reciprocal behavior is a sign that social ties have been strengthened and that relations between strangers have been transformed into personal relationships (Ibid).

Transactions in which a person gives something of value without direct reciprocation (but with an expectation of being paid back in the future in some way) can be characterized as generalized exchange (Whitham 2018). Generalized exchange occurs when people place trust in a social system and its associated norms rather than on any particular individual. It enhances social capital and reinforces prosocial behavior at both the individual and collective levels. While the indirect reciprocity that occurs as part of generalized exchange does not require a personal relationship between the provider and the recipient, it is often reinforced by shared social identity (Ibid).

3.3 Measuring Social Capital Using Social Network Analysis (SNA)

Social networks provide access to social capital, those resources that allow people to achieve goals of personal well-being while also supporting collective action for change (Rainie & Wellman 2012). Nan Lin, a prominent social capital scholar, argues that the measurement of social capital must be based on its embeddedness in social networks (2001). Accordingly, social network analysis (SNA) research methods, which focus on the characteristics, dynamics and effects of social structure, have played an important role in the measurement of social capital, and social capital is one of the most common theories explored in SNA (Prell 2012).

Social networks consist of a set of social relations (or ties links) among a set of network members (or nodes, actors) (Rainie & Wellman 2012). Nodes can be people, organizations, or other types of entities. Ties represent connections between nodes and can be based on shared attributes, social relations, interactions or flows between the members of the network.

Social network research is based on the premise that the characteristics of a social network structure, and a node's position within that structure, determine the opportunities and constraints that node will face, thereby influencing its outcomes (Borgatti et al. 2009, Prell 2012). SNA techniques focus on discovering, describing and analyzing the patterns of relationships between and among social entities and the implications of those patterns (Wellman 1999, Wasserman & Faust 1994). Van der Gaag and Snijders note that while much research is focused on the characteristics of social networks themselves and the resources embedded within them, less attention has been paid to the specific processes by which resources are accessed (2005), highlighting a potential direction for the expansion of social network research.

SNA concepts

Tie strength and the strength of weak ties. Ties in a network can be characterized in many different ways, such as quality, quantity, multiplexity (variety of connections) or symmetry (bidirectionality) (Rainie & Wellman 2012). One quality that is often used to understand ties in social capital analysis is the relative strength of a tie, which can be measured in terms of relationship type. Family and close friends typically constitute strong ties, while acquaintances are connected by weaker ties. One of the most well-known theories in social network analysis is Granovetter's argument about the strength of weak ties (1977). Granovetter posits that an ego's strong ties will tend to interact with one another, forming a closely bound group that is not likely to receive information from or be socially connected to outsiders. Weak ties, on the other hand, have the potential to form "bridges" to more distant parts of the social network and to connect egos to novel opportunities, information or resources. At the level of the network, this suggests that systems with few weak ties will be fragmented and less able to mobilize effectively for collective action (Granovetter 1977).

Network structure: closure vs. structural holes. Another network theory that has been widely applied to social capital research is Burt's comparison of network closure and structural holes (2001). Network closure means that nodes within a network tend to be interconnected. Networks with high closure have the potential to build social capital because they are so tightly linked together, suggesting a situation in which there is trust, obligation, dependency and sharing of information among the nodes. Structural holes are places in the network where ties are not formed, creating "bridges" between tightly knit groups. Burt argues that those actors located in a position to bridge between groups have an advantage because of their ability to broker connections between otherwise disconnected parts of the network (measured as "network betweenness"), thereby gaining access to novel information or opportunity (2001). Burt finds that denser networks tend to be better for preserving and maintaining resources within the group while networks with many structural holes (and therefore many bridges) have greater ability to search for and obtain resources from the outside (see also Lin 2001).

Homophily. In their seminal paper, *Birds of a Feather: Homophily in Social Networks*, McPherson et al. (2001) describe principle of homophily, which states that individual similarities tend to lead to connectivity within a network. Homophily has a great deal of influence on a wide variety of social structures and network ties, from personal relationships to employment to interest group membership. Personal networks tend to be homogeneous with regard to many personal characteristics, which shapes the kinds of information people receive and how they interact with others; ties between like individuals also tend to last longer than ties between individuals with fewer similarities. Geographic propinquity is noted as playing a role in the formation of homophilous relations.

SNA measurement approaches

There are two primary approaches to measurement in SNA. The first involves looking at the whole network and measuring its structure by gathering data on the resources within the network and on the links between the nodes. The second approach considers personal (egocentric) communities and measures the relationships in which an actor, or "ego," participates as well as those between the actor's connections, or "alters." Whole networks comprise multiple personal networks.

Whole network approaches. For whole-network studies, the target population is defined by the study group of interest, which could be defined by position, participation in an event, reputation, relationship or some combination thereof (Marsden 2011), not by a sampling strategy as in social science surveys. Information is gathered about all members of the target population and about all relationships within that group. Whole-network approaches are best suited to relatively small networks, as gathering data on an entire network becomes more onerous as network size increases. Sampling of nodes or links within a network can be used to estimate some network structural properties (Ibid).

Gathering data about the entire network from individual study participants provides information on that person's perception and understanding of network relationships and structure. The *sociometric test*, which is often administered in a survey or interview format, asks each network member to identify other people within the network with whom they have a specific kind of relationship. The *cognitive social structure* approach asks respondents to provide information on the entire network, not just on those relationships in which they are personally

involved. A simpler version of this approach is *socio-cognitive mapping* or *pile sorting*, in which respondents are asked to arrange a set of cards labeled with network members' names into groups based on the study criteria of interest.

Egocentric approaches. Egocentric studies are often carried out as part of a representative sample survey, in which case the study population and sampling strategy are defined by the requirements of the survey sampling methods. In addition to setting a boundary that defines the target respondents, survey designs for egocentric networks must also determine how alters are chosen. Network data can be gathered using procedures familiar in social science research, such as surveys, interviews, observation, diaries, archives or electronic sources (Prell 2012). Survey instruments are often used to gather egocentric social network data at the community level. Three of the most commonly used survey techniques for eliciting network information from respondents are described below. Although similar in structure, each survey technique collects a different type of information.

- The *name generator* asks respondents to provide names of persons with whom they have a specific type of relation that meets the criteria of interest for the network study.
- The *position generator* asks respondents to indicate whether they have social connections to people in specific social positions, often occupations. The social positions listed typically represent a collection of social resources based on a hierarchy (Hsung et al. 2001).
- The *resource generator* asks survey respondents to indicate whether they have access to a list of concrete resources representing a specific measure of social capital.

As an alternative to the multi-item generator instruments, single-question survey items can be used to ask respondents to provide a summary assessment of a network property of interest (Marsden 2011). Although this type of approach does not gather data on specific ties between actors, single-item measures are simple and efficient. Examples of single-item network questions include, "How many close friends do you have?" or, "how many people do you have contact with in a typical day?"

SNA data analysis: relevant node- and network-level indices

Although social network data can be analyzed in myriad ways, there are specific node- and network-level measurements that are likely most applicable for use in the study of community adaptive capacity based on the empirical studies reviewed (see Appendix 1 for more detail).

Node-level indices

- *Betweenness centrality* indicates the extent to which an actor lies between other actors on the shortest path that connects them. Actors with high betweenness centrality act as brokers in the network and have the ability to control the flow of resources or information between groups (Wasserman & Faust 1994).
- *Degree centrality* is the count of a node's links. Degree centrality can indicate a node's level of activity in the network (Wasserman & Faust 1994).

Network-level indices

- *Clustering* occurs when nodes tend to interact with a relatively small set of other nodes within a network, forming a tight grouping. Clustering can reflect patterns that occur in

everyday life, such as common place of residence or similar behaviors depending on how ties are defined (Hanneman & Riddle 2011).

- *Connectivity* is a count of the number of nodes that would need to be removed to sever all connections (direct or indirect) between two nodes. Low connectivity suggests a vulnerable linkage, while high connectivity indicates robust linkage (Hanneman & Riddle 2011).
- *Network density* is measured as the proportion of all possible ties that are actually present. Density influences levels of individual social capital (and/or social constraint) and can affect the speed at which information moves through a network (Hanneman & Riddle 2011).
- *Multiplexity* refers to the tendency for two nodes to share multiple types of connections. Multiplexity can be used as an indicator of relationship strength (Carrington et al. 2005).
- *Reachability* refers to the presence of a path of connections whereby one actor in a network can "reach" another. Lack of reachability signals divisions in the network or presence of subpopulations (Hanneman & Riddle 2011).
- *Reciprocity* is the extent to which directed ties in a network are mutually exchanged between nodes. A high degree of reciprocity in a network may indicate a highly cohesive population. Reciprocity is helpful in building social capital (Hanneman & Riddle 2011).

SNA empirical studies

Relevant studies that illustrate the use of social network analytical methods are assembled on two specific topics: understanding mechanisms for enhancing collaborative capacity and methods for integrating social and spatial data. Those of the selected studies that present an in-depth description of empirical research methods are included in Table 1 (see Appendix 1) which provides details about the network measures used, research methods employed, type of data gathered and the scale of the study.

Understanding collaborative practices and building collaborative capacity through SNA

- *Assessing capacity for self-organization.* Afzalan and Evans-Cowley (2013) explore the self-organizing capacity of three communities by analyzing network data from neighborhood Facebook pages. By associating network interaction density with trust and assessing the ability of the forum to reach non-members, the authors show how groups use online forums to self-organize by sharing information and arranging face-to-face interactions.
- *Measuring formation of social capital.* Mandarano (2009) uses SNA to assess the effectiveness of collaborative planning process and the extent to which social capital is formed through those processes. Quantitative measures of network structure were gathered using a survey instrument and supplemented by interviews focused on the mechanisms behind the structure. The author suggests that network analysis could also inform the early stages of collaborative processes by elucidating existing network structures and identifying gaps.
- *Evaluating effectiveness of capacity-building interventions.* Williams et al. (2018) employ a longitudinal approach to SNA measure changes in resilience capacities among

disaster preparedness coalitions before and after partnership training activity interventions. Metrics used for evaluation include number and characteristics of organizations; time spent on coalition activities; and partnership measures of trust, perceived value, density and coordination. Findings provided a basis for the development of capacity building activities.

- *Leveraging SNA to build organizational capacity.* Based on extensive partnership with community organizations, Provan et al. (2005) propose that social network analysis can be used both as a research method and as a tool for helping community organizations improve coordination and build capacity. They argue that network data can and should be used to assist organizations in enhancing collaboration and improving community well-being.

Integrating social and spatial data using SNA

- *Integrating network data into GIS.* Andris (2016) explores how social networks can be included as layers in a GIS for improved understanding of social relation formation and social exchange across the spatial landscape. The paper outlines best practices for analyzing social networks in GISystems illustrated with case studies exploring a variety of SNA concepts.
- *Understanding built environment influences on the formation of social ties.* Boessen et al. (2018) use SNA methods to explore relationships between built environment features (density, land use and design) and different types of social connections (core ties, friends, and kin). Results indicate that the number of social ties is related to built environment characteristics and that these relationships vary between rural and urban areas as well as at different scales.
- *Creating spatial weights for survey data.* Makse et al. (2014) introduce a methodology that involves integrating social network survey data with observation-based spatial weights to measure variation in small-scale political environments. The authors demonstrate that the inclusion of micro-level information improves model fit. Furthermore, they find evidence of the influence of spatial context on study participant perception and behavior.

SUMMARY

This report presents a literature review examining and synthesizing state-of-the-field research in the research areas described above and constitutes the work product completed during Phase I of the project. Phase II will build upon the Phase I findings to implement a pilot survey focused on issues of social trust, place attachment[2], and disaster preparedness and response as relevant to different modes of transportation and communication services. Understanding the interactions among these three aspects of community (social trust, place attachment, and disaster preparedness and response) will provide us with data to inform strategies for enhancing adaptive capacity in future phases.

The interdependency of physical and social infrastructures plays an important role in the ability of communities to be resilient in the face of change, contributing in many ways to their adaptive capacity to deal with disasters. The urban-rural disparity in infrastructure availability and connectivity results in very different disaster preparedness needs for communities of different character and location. Communities of different socioeconomic makeup also experience these disparities differently and are disproportionately negatively affected by disaster. The brittle nature of physical and communications infrastructure calls into question whether there exists untapped potential for social networks and social infrastructures to provide connectivity to needed resources when physical (including communications) infrastructures are compromised or unavailable. This review suggests a gap in the literature regarding both research on adaptive capacity at the community scale and on the potential of the social aspects of sociotechnical networks to more effectively leverage social networks in disaster scenarios.

Furthermore, attitudinal variables like social participation, trust, and willingness to share, which are linked to community well-being and adaptive capacity, have not been integrated into large-scale disaster preparedness efforts. This review reveals an opportunity for better understanding, at the community scale, how attitudinal and behavioral factors contribute to adaptive capacity. Disaster preparedness efforts are often focused on the accumulation of material resources, such as food, backup power, and emergency medical supplies. This review suggests that broadening that effort to improve social connectivity could help to improve the effectiveness and efficiency with which resources are shared in disaster scenarios. The next phase of this project involves the development of a survey instrument that gathers information on both traditional preparedness measures as well as behaviors and attitudes related to community connectivity. This data will be used in subsequent phases of the project to better understand the potential for resource matching between community needs and social infrastructure providers as well as the mechanisms and motivations behind willingness to share disaster preparedness resources.

[2] The emotional and cognitive experience linking people to places.

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Williamson, W., & Ruming, K. (2016). Using social network analysis to visualize the social-media networks of community groups: Two case studies from Sydney. *Journal of Urban Technology*, 23(3), 69-89.
Wolfram, M. (2016). Conceptualizing urban transformative capacity: A framework for research and policy. *Cities*, 51, 121-130.
Zhou, Y., Huang, Y., McGlynn, J., & Han, A. (2017). Who Will You Share a Ride With: Factors that Influence Trust of Potential Rideshare Partners. arXiv preprint arXiv:1707.04284.

APPENDIX 1: SNA EMPIRICAL STUDIES CITED

Case study	*SN measures*	*Methods*	*Data*	*Scale*
Afzalan & Evans-Cowley 2013 **-----** The role of online neighborhood forums in creating self-organized and resilient communities	Degree: number of ties (friends, posts) Density: ratio of number of friends/posts to the probable number of friends/posts Modularity: structure of online forums, including number of communities	Survey (web-based) Facebook data scraping (Netvizz) Network visualization & analysis (Gephi) Comparison of network analytical findings & descriptive data from survey	Frequency of interaction Trust in others for help in need Use of online forum to arrange in-person meetings Belief in information-sharing capacity of forum Social contact with people outside forum	Whole-network: comparison of three forums
Boessen et al. 2018 **-----** The built environment, spatial scale, and social networks: Do land uses matter for personal network structure?	Degree: number of ties Tie characteristic: type of relationship (kin, core ties, socializing)	Survey Network analysis Negative binomial regression	Population density Urban/rural distinction (based on U.S. Census) Land use Street connectivity Single-family housing location	Ego-centric, evaluated at three scales across the Western U.S.: micro neighborhood, meso city, macro
Ingold et al. 2010 **----------** how governance structures can foster or undermine adaptive capacity	Degree Betweenness centrality Embeddedness Direction and frequency of communication flow	Survey Interviews Network analysis	Frequency and nature of relations with other actors in the network	Whole network
Jacobs and Cramer 2017	Normalized degree centrality	Survey Network analysis	Opinions about conversation strategies and global warming Trust in government News sources	Ego-centric, community scale
Janssen et al. 2006 **-----** Toward a network perspective of the study of resilience in social-ecological systems	Density: number of links divided by the maximum possible number of links Reachability: the extent to which all the nodes in the network are accessible to each other Centrality: distribution of links among the nodes, structural importance	Survey Interviews Network analysis	Varies by system (four case studies presented) Examples: Node type (patch, user, organization) Tie type (character of relationship, active/"sleeping," distance between patches, ecological processes, water infrastructure	Whole-network: comparison of socio-ecological systems

Case study	*SN measures*	*Methods*	*Data*	*Scale*
Lienert et al. 2013 **-----** Stakeholder analysis combined with social network analysis provides fine-grained insights into water infrastructure planning processes	Centrality: actor importance/access to information (degree centrality), Power: (betweenness centrality) Core/periphery analysis: relative fragmentation of cooperation networks	Stakeholder analysis (interviews) Socio-cognitive network mapping Network analysis (UCINET)	Actors influenced and affected, actor interests and affiliation Interaction patterns; planning barriers & opportunities Relational type (cooperation, financial exchange, pressure, conflict)	Whole network: stakeholders in water infrastructure planning group
Mandarano 2009 **-----** Social network analysis of social capital in collaborative planning	Density: community-level social capital Centrality: actor-level social capital Similarities:* relative proximity of actors based on their similarities Hierarchical clustering:* group partitions based on similar behaviors Change in communication ties	Survey "Elite" interviews Network analysis & visualization (UCINET) **UCINET-specific applications*	Node attributes (demographics) and interests (organizational participation) Interorganizational relationships (pairwise exchange of information, resources, funds) Direction of communication, change in links (communication patterns)	Whole network: organizations involved in the NY-NJ Harbor Estuary Program's Habitat Workgroup
Makse et al. 2012 **-----** Networks, context, and the use of spatially weighted survey metrics	Spatially proximate network heterogeneity Spatially proximate network heatedness Spatially proximate discussion stimulation	Neighborhood observation Survey (political name generator, neighbor name generator) Spatial analysis (GIS ArcMap Spatial Weights Matrix) Ordered logistic regression	Presence of political yard signs Precinct-level voting data Geospatial data (home location) Local contacts with whom respondents discuss politics (frequency and character of discussion)	Egocentric within a neighborhood
Provan et al. 2005 **-----** The use of network analysis to strengthen community partnerships	Density: overall level of connectedness Centrality: relative involvement of organizations Multiplexity: strength of partnerships based on types of links Fragmentation: network structure	Survey Interviews Agency records Network analysis & visualization (UCINET)	Network bounding Link content Link frequency Level of interaction Trust	Whole network: public and nonprofit community health agencies in two communities

Case study	*SN measures*	*Methods*	*Data*	*Scale*
Williams et al. 2018 **-----** Evaluating community partnerships addressing community resilience in Los Angeles, California	Density: number of connections reported between organizations as a function of all possible connections Multiplexity: number of ways in which organizations interact	Longitudinal descriptive analysis (one-year gap): comparison of mean differences using t-statistic ($p<0.05$) Network survey & analysis (PARTNER)	Trust Perceived value of partners to mission Contacts between organizations Activity coordination Hours spent on coalition activities by partner organization staff	Whole network: members of community coalitions

APPENDIX 2: STS EMPIRICAL STUDIES CITED

Citation	Keywords	Methods	Notes
Carrasco, J. A., Hogan, B., Wellman, B., & Miller, E. J. (2008). Collecting social network data to study social activity-travel behavior: an egocentric approach. Environment and Planning B: Planning and Design, 35(6), 961-980.	NA	Network survey, interview	Relationship of social networks to social activities/travel behavior
Chaube, V., Kavanaugh, A. L., & Perez-Quinones, M. A. (2010, January). Leveraging social networks to embed trust in rideshare programs. In 2010 43rd Hawaii International Conference on System Sciences (pp. 1-8). IEEE.	NA	rideshare needs assessment survey	understand commuter travel patterns, their needs and to identify their preferences for private vehicles and public transit for a variety of travel needs; users are willing to increase participation in ridesharing programs if three core issues are addressed – trust, convenience and incentives
Farnham, S. D., Lahav, M., Monroy-Hernandez, A., & Spiro, E. (2015). Neighborhood community well-being and social media. environments, 40, 49.	Twitter; social media; community well-being; hyper-local; third place; networked publics; neighborhoods	Surveys, interviews, analysis of Twitter data	Multi-scaled, comparative study; how does social media use affect neighborhood well-being, look at communication patterns, King County cases
Gilbert, E., Karahalios, K., & Sandvig, C. (2008, April). The network in the garden: an empirical analysis of social media in rural life. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1603-1612). ACM.	Social media, rural, digital divide, social network sites	MySpace analysis, non-parametric statistical tests reporting medians as measures of central tendency	Urban-rural comparison; building trust online; uses data from UW rural research center
Hampton, K. N. (2007). Neighborhoods in the Network Society the e-Neighbors study. Information, Communication & Society, 10(5), 714-748.	Community, social networks, weak ties, computer mediated communication, political communication, Internet,	Longitudinal social network surveys, hierarchical linear modeling	What role does the internet play in community communication, and how does it help form social ties? Bridging online and parochial divide

	neighborhood effects, social ecology, e-government, local media, community network, informatics		
Hampton, K. N. (2011). Comparing bonding and bridging ties for democratic engagement: Everyday use of communication technologies within social networks for civic and civil behaviors. Information, Communication & Society, 14(4), 510-528.	cross-cutting; political participation; deliberation; neighborhood; social networks; social capital	Telephone survey with name generators, logistic regression	Bonding/bridging social capital; civic activities/behaviors, frequency of interaction – does the Internet promote democratic engagement?
Hampton, K. N., Lee, C. J., & Her, E. J. (2011). How new media affords network diversity: Direct and mediated access to social capital through participation in local social settings. New media & society, 13(7), 1031-1049.	civic engagement, community, echo chamber, pervasive awareness, social isolation, social support	Phone survey, OLS regression	Relationship between communication technologies and diversity of personal social networks; role of place in organization of personal networks
Masden, C. A., Grevet, C., Grinter, R. E., Gilbert, E., & Edwards, W. K. (2014, April). Tensions in scaling-up community social media: a multi-neighborhood study of Nextdoor. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (pp. 3239-3248).	Social media; Nextdoor; local social media; civic engagement	Questionnaires, interview, inductive thematic analysis	Intended vs. actual use of neighborhood-based social networking sites; privacy issues; physical vs. virtual neighborhood boundaries
Lovejoy, K., & Handy, S. (2011). Social networks as a source of private-vehicle transportation: The practice of getting rides and borrowing vehicles among Mexican immigrants in California.	Ridesharing		Lovejoy, K., & Handy, S. (2011). Social networks as a source of private-vehicle transportation: The practice of getting rides and borrowing vehicles among Mexican immigrants in California. Transportation research part A: policy and practice, 45(4), 248-257.

Transportation research part A: policy and practice, 45(4), 248-257.			
Mote, J. E., & Whitestone, Y. (2011). The social context of informal commuting: Slugs, strangers and structuration. Transportation Research Part A: Policy and Practice, 45(4), 258-268.	Social context Social interaction Transportation policy Qualitative research Informal commuting Slugging	Interviews, coded analysis	Social interaction influencing transportation systems
Schwanen, T., Lucas, K., Akyelken, N., Solsona, D. C., Carrasco, J. A., & Neutens, T. (2015). Rethinking the links between social exclusion and transport disadvantage through the lens of social capital. Transportation Research Part A: Policy and Practice, 74, 123-135.	Social exclusion Transport disadvantage Social capital Literature review Social network	Literature review	Links between social exclusion and transport disadvantage
Williamson, W., & Ruming, K. (2016). Using social network analysis to visualize the social-media networks of community groups: Two case studies from Sydney. Journal of Urban Technology, 23(3), 69-89.	community groups; social media; social network analysis; participation; Australia	SNA - degree (number of network connections), tie strength, and community detection methods	Social media and community participation in planning
Zhou, Y., Huang, Y., McGlynn, J., & Han, A. (2017). Who Will You Share a Ride With: Factors that Influence Trust of Potential Rideshare Partners. arXiv preprint arXiv:1707.04284.	Ridesharing, social network, Instagram, Exploratory Factor Analysis, logistic regression	Exploratory Factor Analysis, logistic regression	Factors influencing trust-based decisions; focus on social media