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Social Ties, Space, and Resilience:

Literature Review of Community Resilience to Disasters and Constituent Social and Built Environment Factors

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Abstract: Communities have faced a variety of crises in recent decades, including more frequent and severe natural disasters. As applied to disasters, resilience entails the ability of a community to rebound following a hurricane, earthquake, or other disturbance. Given the importance of resilience in promoting an effective recovery, the factors that contribute to community resilience are of great interest to scholars and practitioners in many fields. Recent work has examined, for example, socioeconomic indicators that contribute to greater social vulnerability and organizational structures that contribute to a more effective recovery. The importance of strong social networks in resilience is among the most oft-repeated lessons learned in recent scholarship. This paper examines the intersection of three connected threads in the literature to understand one particular aspect of resilience: how the built environment contributes to greater resilience by supporting and encouraging strong social networks. Given that social networks positively influence resilience and that the built environment exerts influence on social networks, this literature review examines evidence linking strong social networks, a varied and integrated built environment, and greater resilience.

JEL Classification: Q54
Key words: disaster resilience, hazards, social networks, built environment

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Introduction

In the wake of incredibly destructive events such as Hurricane Katrina, the Joplin, Missouri tornado, and Hurricane Sandy, the importance of community resilience to natural disasters has been underscored repeatedly. Resilience is defined as a ‘‘…measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables” (Holling, 1973). When applied to disasters, resilience connotes an affected area’s ability to rebound after a catastrophic event. Resilience in this context entails that a community returns to its previous state or, alternately, that a community stabilizes into a new organizational regime. Although the relative resilience of a community is only fully known after disaster strikes, there are community characteristics that are known to contribute to resilience. Understanding the contributing factors to resilience can save lives and reduce the costs to communities facing disasters. Therefore, given the increasing shocks of natural disasters, a greater understanding of resilience is important for creating safer, more sustainable communities.

One factor that is widely believed to impact resilience is the presence of strong social networks. Urban planners recognize the importance of social networks in creating more resilient communities and in informing the planning process in general (Healey, 1998), but it remains a fuzzy concept in some ways, as networks can be difficult to identify and measure. However, particularly when telephone and electricity services are interrupted, as after Katrina, geographically based social ties are crucial for household- and community-level disaster resilience.

While social networks build resilience, the built environment of communities has been shown to influence and support many important social networks (Entwisle, 2007; Fischer et al., 1977; Rutten, Westlund, & Boekema, 2010). The built environment also matters for resilience in general, as it is a physical, social, and symbolic anchor to everyday habits, a familiar framework of orientation, and a support system for social networks. In short, the built environment connects residents to a place and can serve as a benchmark for recovery. Therefore, it is possible that the domain of urban planning can be harnessed to foster greater resilience by facilitating stronger social networks.

Below is a review of research concerning resilience, natural disasters, social networks, and the built environment found in a number of disciplines. The following literature review defines and reviews relevant work related to each concept as well as connections that have been made between the concepts.

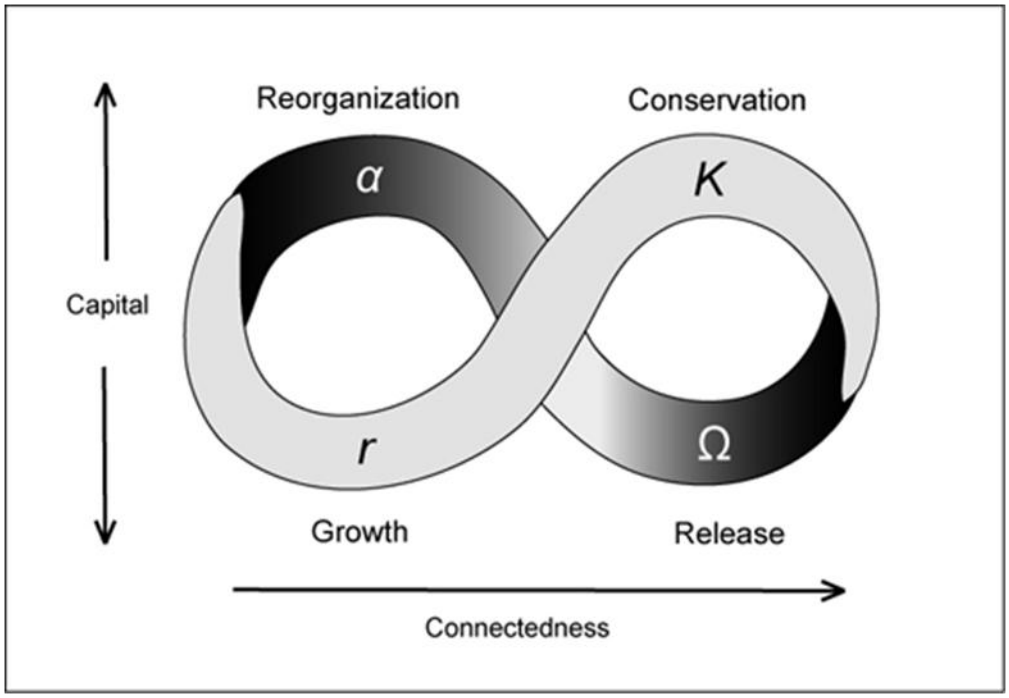
1. Resilience

When applied to disasters, resilience is an affected area’s ability to rebound after a catastrophic event. For most communities, this would mean the return of lifeline infrastructures such as utilities, food and water, and shelter in the short-term. In the long-term, this would mean the return of households and businesses and a return to self-sufficiency and effective governance. Most sources argue that resilience is best achieved when resources and capabilities are drawn from within the community to bring these systems back online (Paton, 2000). A community’s adaptability to change or adaptive capacity is strongly related to resilience; collectively, individuals can influence resilience by affecting and responding to change in the system (Walker, Holling, Carpenter, & Kinzig, 2004). Reliance on one method or system can lead to instability, whereas flexibility and redundancies in a community allow for contingencies in

case of a catastrophe, which is particularly evident in interdependent infrastructure systems such as the information technology and energy sectors (Cutter et al., 2008).

Cycles of change in social and ecological systems can be illustrated through the adaptive cycle (Peeples, Barton, & Schmich, 2006) (Figure 1). Within the cycle, there are four stages of rapid growth, conservation, release (or crisis), and reorganization. The rapid growth stage is characterized by weak connections and regulation; during the conservation stage connectivity is improved and resources are accumulated (specialization and economies of scale begin to appear), and vulnerability increases due to changing conditions; the release stage occurs when major events or crises are sufficiently intense to upend the system (this includes the breaking of connections and weakening of control); and reorganization is the rebuilding stage that is experimental, inventive, and includes the creation of new connections. Rapid growth and conservation are often called the fore loop of the adaptive cycle and reorganization and release are termed the back loop. Fore loop processes are stable and predictable and allow the accumulation of capital, back loop processes are characterized by uncertainty and loss of capital. Although back loop reorganization can throw a system into disarray, it can also have positive results for a system lodged in a conservative fore loop phase. Different stages of the cycle can be experienced at different scales in a system (this phenomenon is called a panarchy, or a hierarchy encompassing all possible levels of systems) (Gunderson & Holling, 2002). Though social-ecological systems are affected by many variables, a few important often slow-moving variables drive change in the system. The adaptive cycle and panarchy concepts can be applied to urban systems in general and social systems in particular and inform our understanding of how disturbances affect communities. Identifying the stages of the adaptive cycle as they relate to a particular community may be useful both before and after a disaster.

Figure 1. Adaptive cycle



Source: (Peeples et al., 2006)

From a hazards planning perspective, a conceptual framework has been developed, consisting of interrelated technical, organizational, social, and economic ("TOSE") dimensions that contribute to and affect resilience (Bruneau et al., 2003). Technical and organizational factors relate to infrastructure and local agencies and governance and social and economic factors are entrenched in the community at large. All four TOSE dimensions describe contributions to a community's capacity for resilience. In addition, there are four resilience dimensions (the "four R's") by which resilience can be measured, including robustness, redundancy, resourcefulness, and rapidity (Bruneau et al., 2003). Robustness refers to the overall strength of a system, or its ability to withstand a stressor without failing. Redundancy is the existence of substitutable elements in the system, allowing continuation of necessary services even when some elements fail. Resourcefulness includes the ability to plan and implement disaster recovery based on established priorities and goals. Rapidity is simply the ability to carry out these activities quickly. The TOSE dimensions and community-level disaster resilience in general can be evaluated along each of the four R's.

2. Disaster and Hazards

Although disaster and natural hazards research has originated from scholars in a wide array of fields, this literature review focuses on the fields of urban planning and sociology, which are most relevant for understanding the links between social networks, the built environment, and resilience. Although the work in other fields is important for forecasting disaster risk, a compelling argument has been made that disasters should be conceived of as not strictly external forces that cause upheaval, but rather socially constructed events, which informs our understanding of and approach to disaster response (Mileti, 1999). In fact, disasters should be viewed in terms of social vulnerability, as various social and economic consequences arise from not only the physical damage incurred, but the various short- and long-term effects to housing, health, the economy, and social structures and cohesion (French, Lee, & Anderson, 2010). The broad field of disaster research has expanded accordingly to take into account social, cultural, and economic factors along with technical solutions.

Relevant past work in the areas of urban planning and sociology can be divided into two distinct categories—those that examined strategies for pre-disaster mitigation and those that focused on post-mortem analysis of events. In terms of pre-disaster work, there are several approaches that have been taken to exploring the effectiveness of mitigation and other pre-disaster planning activities. Perhaps the earliest views on interactions between natural disasters and human systems focused on flood plain development and the protection of property (White, 1936, 1937). Land use planning and zoning were early tools employed by planners to prevent encroachment in waterways in order to protect human property from flood damage. This work also recognized the need to evaluate flood stages based on land use changes in floodplains and drainage areas and engineering interventions such as levees and reservoirs, rather than on past flooding trends alone. Although the impacts of flooding on social stability and prosperity of communities were acknowledged decades before, measuring these impacts was not addressed in earnest until the early 1950s (Tierney, 1989).

More recently, the role of planning in effective disaster mitigation has been advanced. For example, including mitigation in either standalone hazard plans or comprehensive plans has been shown to be a potential strategy for encouraging safer development and garnering public support for mitigation (Burby et al., 1999). Currently, federal programs focused on insuring at-risk property and providing aid after a disaster tend to discourage or even undermine local government planning efforts,

as there are few incentives for municipalities to be proactive. Unfortunately, development continues unabated by local government in many high risk areas. For example, despite state and local efforts to limit residential exposure and regardless of plan conformity and quality, there has been no significant effect on growth in vulnerable coastal areas in Florida (Deyle, Chapin, & Baker, 2008). It has also been shown that although land use management in flood plains has great potential in mitigating risk, communities that adopt this strategy tend to have already created a problem with previous flood plain development (Burby & French, 1981).

Pre-disaster planning in general is necessary and is most effective when combined with strong public involvement. High-quality plans informed by local interest groups were found to have the greatest impact on environmental problems, and natural hazards in particular, and to increase levels of commitment in elected officials (Burby & May, 1998). Based on these findings, it was recommended that constituencies be created for the solution of environmental problems to include a broader cross section of the population in the planning process and facilitate adoption of household-level mitigation practices through the dissemination of information about risk. In effect, strong, politically oriented social networks improve the commitment of public servants and the capacity of a community.

Building on the importance of commitment and capacity, scholars have advocated incorporating disaster mitigation in sustainability strategies, adding disaster resilience to the existing list of economic, environmental, and social goals of sustainability (Godschalk et al., 1999). Sustainability already incorporates techniques that protect the environment while increasing the effectiveness of human systems, for example by recommending the construction of bioswales, which mimic natural vegetated waterways, for drainage. A resilient development approach adds complexity to sustainability, taking into account potential natural hazards, with the intent of creating an appropriately strong and flexible built environment. The commitment to disaster mitigation should be driven by community leaders and combined with increased capacity to plan and implement mitigation programs. This demands a proactive and context-specific approach justified by sustainability's doctrine of meeting the needs of future generations.

In addition to land use planning, building codes, and other structural or engineering solutions, local communities have also used policy-based mitigation measures to stem property damage risk and minimize casualties caused by localized flooding (Brody, Zahran, Highfield, Bernhardt, & Vedlitz, 2009). This includes adaptive or flexible strategies for land and water management, public outreach, preparedness, and other approaches. Based on an examination of less adaptive, more prescriptive policy levers under FEMA's Community Rating System (CRS), localities were most likely to choose "low-hanging fruit" or the least expensive strategies rather than choosing strategies according to effectiveness. However, locally driven policies adapted over time were shown to be effective in mitigating property loss (Brody et al., 2009).

Individual households bear a considerable amount of financial burden after a disaster; however, there often appears to be a general lack of interest in household-level mitigation such as voluntary insurance programs, despite the potentially large financial losses from a low-probability, high-impact event such as a major hurricane (Kunreuther, 2006). Households have limited resources and fail to consider disaster risk in long-term financial planning. They may also be following a local trend, not wishing to be the lone residence undertaking dramatic structural protection measures while others rely on government aid. This is an argument for supplementing voluntary preventative measures with local

planning and policies, including building codes, tax incentives, and required hazard insurance similar to requirements under the FEMA National Flood Insurance Program (NFIP).

In the second category of disaster research, post-disaster analysis has generally concentrated on case studies or other accounts of particular disasters, often comparing and drawing conclusions from patterns across time. For example, a recent case study tracked the rebuilding process in New Orleans, Louisiana after Hurricane Katrina from the perspective of urban planning professionals (Olshansky & Johnson, 2010). This work recognized the tensions between a swift recovery and a careful assessment of the situation to ensure decisions are most beneficial. Ensuring public participation and building consensus tended to be more difficult during the conflict, when past frictions were often amplified; therefore effective leadership and a clear message to the public was essential. According to Olshansky and Johnson, public meetings that informed the post-Katrina Unified New Orleans Plan were well attended and citizens were savvy enough to follow the planning discussions, but the messages of various public and private entities leading the rebuilding process were not consistent or clear.

Several studies have examined the impacts on social systems as well as the responses by formal and informal networks. For example, work has been done to examine the post-effects of disasters on social systems, including social networks (Tierney, 1989). Again, disasters are defined by Tierney as the damage and disruption to both physical and social structures. According to observations by Tierney, after a crisis, community organizations reform along two dimensions. The first is the dimension of tasks, which are either routine or nonroutine compared with pre-disaster activities (day-to-day versus disaster-specific tasks), and the second is the dimension of structure, which can either remain constant or expand when compared with pre-disaster organizational structure. Reforms along these dimensions allow organizations to respond accordingly to household recovery needs, conflicts, and community mental health needs. As an example, the Red Cross conducts tasks that are outside of its everyday operations and also expands in structure to absorb additional volunteers after a disaster. Pre-disaster working relationships between organizations are also important post-disaster and can affect coordination of disaster response activities.

In terms of local government and other formal municipal networks, in a case study of the Northridge, California earthquake of 1994, major disaster losses were suffered due to individual, organizational, and governmental decisions regarding planning and mitigation techniques, in addition to structural issues resulting from development patterns and building code standards and enforcement (Tierney, 1995). Post-disaster, local governments frequently find it difficult to make use of disaster aid resources due to a lack of organizational capacity (Berke, Kartez, & Wenger, 1993). In a meta study of past disasters, a high degree of horizontal integration, or many connections between local networks, produced open communication and collaboration on local problem solving, increasing local capacity for disaster recovery and resilience (Berke, 1993). In addition, vertical integration, or ties between local and external or higher-order organizations, was also important for expanding available resources and communicating needs more broadly. These two networking forces are most effective when operating simultaneously toward a common goal of recovery.

Such formal organizations are clearly important after a disaster. Sociologists have also examined the role of community social capital in recovery, specifically the informal networks and resources brought to bear through connections among residents. These connections have been shown to influence recovery at least as effectively as material resources, if not more (Aldrich, 2012). The mechanisms

through which this is made possible include the creation of a kind of informal insurance or pool of financial aid, the ability to collectively solve common problems that interfere with recovery, and a deepening of the social fabric, which in turn increases the potency of the local voice. Further discussion of the specific role of social networks on resilience is discussed in a later section of this literature review.

Planning's post-disaster role in restoring the torn social fabric of a community as well as the built environment has also been explored. In response to the questionable effectiveness of some existing federal policies and programs like CRS, the argument has been made to reform and strengthen the state and federal regulatory roles in order to provide guidance and shore up local pre- and post-disaster efforts, which can suffer from the aforementioned lack of commitment (Berke & Campanella, 2006). This includes explicitly requiring land use management for risk reduction and infrastructure insurance at the local level. In addition to federal interventions, strong, local grassroots networks that empower citizens with lasting skills combined with greater ties to local formal networks are believed to improve recovery. These efforts can mend the torn social fabric.

Research regarding post-disaster recovery in the built environment has shown that among the various types of structures impacted by a disaster, residential damage typically constitutes the majority of total damage after a disaster and therefore housing is a major planning-related factor in post-disaster recovery. The U.S. system for rebuilding housing is largely designed to aid single-family, owner-occupied units. For the most vulnerable low-income households, short- to midterm housing is only available through Red Cross shelters. Over the long-term, large proportions of the affordable multifamily housing stock are not replaced (Comerio, 1997). The lack of rental housing is a recurring problem in many other case studies.

In fact, entire neighborhoods can be at risk. After the Mexico City earthquake in 1995, the government planned to clear a devastated inner-city slum and move residents outside of the city. Residents successfully organized to protest this decision. In that instance, social mobilization successfully challenged and reversed forced relocation and gentrification of the area; however, this is not always the case. Data from Hurricane Andrew in 1992 showed that long-term single-family home recovery was weaker among ethnic or racial minority neighborhoods and renter-occupied households (Zhang & Peacock, 2009). Abandonment of property and long-term volatility in the market were also persistent problems in recovery after Andrew.

Recovery of nonresidential sectors often experience greater delays post disaster. After the Coalinga, California earthquake of 1983, housing recovery was relatively rapid, demonstrated by a spike in building permits following the earthquake, but the central business district and other businesses were slower to recover (French, Ewing, & Isaacson, 1984). Local residents were strongly committed to rebuilding the community, and the local development authority was instrumental in assisting the commercial sector. Overall, the impacts to the social and political fabric were less severe than they might have been due to prompt, effective rebuilding efforts. Indeed, the prompt recovery of housing as well as infrastructure is important in facilitating the return of the business sector (Olshansky, Johnson, & Topping, 2006).

Given the challenges in providing affordable housing post-disaster, it is not surprising that the dimensions of social vulnerability have been well documented in post-disaster assessments. Wealth and age have been found to be the most significant factors and other social vulnerability factors commonly cited include race, ethnicity, gender, family structure, and tenure (Cutter, Boruff, & Shirley, 2003). As an

example, following a 1982 Paris, Texas tornado, African American residents in the community were privy to fewer economic aid resources such as Small Business Administration (SBA) loans and were more dependent on family and kin networks of support in emotional (but not financial) recovery (Bolin, 1986). Women are also known to be particularly vulnerable to disasters. Work in developing countries has demonstrated effects such as more pronounced and prolonged emotional distress and fewer financial resources in single-parent, female-headed households (Bolin, Jackson, & Crist, 1998). Despite these differences, disaster research continues to focus on families in recovery to the detriment of single-parent female or other female head of household situations.

Socioeconomic factors have also been shown to contribute to post-disaster conflicts (Bolin & Stanford, 1991). To protect vulnerable populations, adequate and representative citizen participation should be included in recovery activities. The likelihood that casualties are encountered by flooding, for example, increases with population density, and the presence of socially vulnerable populations, in addition to obvious factors such as precipitation rates, flood duration, and property damage (Zahran, Brody, Peacock, Vedlitz, & Grover, 2008). Social vulnerability, in particular among minorities, lower-income groups, and the aged, is associated with delayed evacuation, greater incurred damage, fewer resources, and slower rates of rebuilding (VanZandt et al., 2012). Furthermore, as a result of these phenomena, disasters cause neighborhood change including increased socioeconomic disparity as populations relocate (Lee, 2012).

Overall, disaster research has advanced tremendously in past decades, in part due to several events causing large-scale damage to urban areas in the United States in the 1980s and 1990s, when that magnitude of destruction was thought to be unique to developing countries (Comerio, 1997). However, the growing reach, complexity, and interdependencies in the built environment have made determining appropriate mitigation techniques increasingly difficult.

3. Social Networks

Social networks are assemblages of individuals or groups related to one another through connections such as familial ties, friendship, similar interests, similar beliefs, or other types of common circumstances. Although theories related to social networking date back at least to Durkheim at the turn of the last century, the body of knowledge has become increasingly sophisticated, spurred by an infusion of ideas from the fields of physics and graph theory and a rich laboratory of web environments (Facebook, Twitter, Second Life, etc.). A social network can be conceptualized as a web of nodes (individuals or groups) and ties (links between nodes). Within a network, nodes can be described by degree centrality (number of node connections), betweenness (how many connections include a certain node within a network), and closeness (on average, how close a node is to all other nodes). These values can be used to characterize the strength and topology of an entire network or the importance or influence of a single node (Freeman, 1978). Other methods of measuring networks include elasticity, sociometrics, and graphing.

Social network analysis and other social network approaches can be included in many aspects of planning, including forging an understanding of power structures, fostering cooperation, and improving the flow of information (Dempwolf & Lyles, 2012). Perhaps the most applicable with respect to community-level networks is in understanding relationships involving multiple layers of government as well as informal networks in planning. Recent studies have examined the spatial impacts of networks,

generally finding that community exists independent of space. However, social networks impact the planning of space in that they can be drawn upon in public participation and economic development activities.

Social networks may exist independent of physical space; however, networks are often organized or biased geographically. Particularly in times of need, ad hoc networks may form locally to mobilize resources. It should be noted that although a social network may provide economic benefits, this is not the primary motivation for joining a network (Lin, Cook, & Burt, 2001). Robust social networks are associated with many benefits to individuals, households, and organizations: physical, psychological, and social well-being (Aday, 1994; Berkman, Glass, Brissette, & Seeman, 2000); employment opportunities (Granovetter, 1973; Montgomery, 1991); access to financial resources (Ben-Porath, 1980); information seeking and utilization of social services (Birkel & Reppucci, 1983); and community mobilization (Snow, Zurcher, & Ekland-Olson, 1980). Isolation or lack of social network support is associated with the inverse of these conditions, and yet a significant population remains on the margins, unable or unwilling to associate with these supportive networks.

Social networks are considered a conduit for social capital, defined as "investment in social relations with expected returns" (Lin et al., 2001). In connecting individuals, social networks allow social capital to be transferred and accumulated in a community. Social capital has two constituent facets, which are strongly correlated: social trust and civic engagement (Putnam, 2000). Therefore, participation in formal social networking organizations, or associational membership, promotes more trusting citizens and greater social capital. The percentage of the population participating in formal networks such as church groups, unions, parent teacher associations, has been declining for years (Putnam, 2000), creating a society with fewer formal ties through organizations, if not through other social interactions. Putnam's work outlines the benefits of association activity and the problems connected with weakening community engagements, a macro trend that does not appear to be subsiding.

Critics of Putnam and the wave of interest his work generated in social capital argue that social capital is improperly defined, misinterpreted, and conflated with other concepts such as Tocqueville's notion of civil society and that many findings lack empirical rigor (DeFilippis, 2001). However, this argument applies chiefly to work that focuses on capital or economic growth and neglects dense social networks that lack access to resources but provide other benefits.

a. Social Networks and Resilience

In addition to the general advantages that membership in social networks confers regarding social and economic position, networks are also instrumental in helping people cope with and recover from disasters. With respect to disaster resilience, social networks have been shown to be important for reducing vulnerability in preparing for and responding to a disaster (Cutter et al., 2003), for facilitating response and mitigation tactics such as evacuations from the bottom-up (Aguirre, 2006), and for improving household-level disaster preparedness by increasing the perception of the availability of resources (Paton, 2003). In terms of associational membership, there has been excellent research demonstrating the positive impacts of community groups in recovery efforts (Patterson, Weil, & Patel, 2010). However, disasters impact social networks by straining the support network and limiting the effectiveness of individuals who would have otherwise provided support to the more vulnerable.

Although surges in support through social networks occur after a disaster (so-called new "synthetic communities"), these support networks fall prey to pre-existing conflicts and tend to dissolve even while recovery is underway (Tobin, 1999).

During a disaster, various types of social networks are utilized or formed including familial, religious, political, economic, medical, educational, scientific, legal, risk management (insurance and first responders, etc.), mass media, communications, transportation, energy, food, water, leisure, entertainment, construction, rebuilding, land use, and environmental regulation and protection (Aguirre, 2006). Many such networks, such as faith-based organizations or citizen volunteer groups, operate in response to a disaster or emergency but are not part of formal disaster planning and management. Other networks may not have been part of original disaster planning and management plans, but may become formalized and incorporated into plans and preparations for future emergencies. These types of networks are vital to surviving and recovering from disasters and either are or may become a trusted foundation for future resilience.

According to psychologists (Kaniasty & Norris, 1995), "[r]esearch strongly documents this role of social support as a provider of emotional comfort, material goods, self-esteem, or information" (p. 396). The authors outline two modes of social network support: the stress buffer and main effects models. Stress buffering encompasses how individuals in crisis are protected from resultant stress by the presence of social networks. According to this model, the benefit occurs when the stressor is applied. In contrast, main effects encompass how social support inherently benefits physical and psychological health, regardless of the situation. The benefits for community resilience therefore are more apparent when stress is applied; however, the authors believe the inherent benefits also protect the community from physical and mental health vulnerabilities ahead of a disaster. Furthermore, the authors showed that stress-inducing events act as triggers for mobilizing social support.

Another study operationalized "sense of community" as one of several "social cognitive variables" that can be used to predict preparedness and resilience to a natural hazard (Paton, 2003). Feelings of belonging related to social justice, trust, participation, and empowerment within the system were measured. People with strong feelings of belonging to a place were shown to be more likely to convert intentions of preparedness into actual household preparations. An earlier piece by the same author (Paton & Johnston, 2001) examined resilience more broadly and found that involvement in community activities increases the ability to resist and recover from natural hazards and that consensus building in decision making is a significant opportunity for empowering residents and promoting resilience.

The uneven topography of networks across socioeconomic status may impact resilience. As social and employment structures evolved in past century and economic conditions have deteriorated in inner-city poor neighborhoods, the working-class social network composition and some forms of organizational participation have been affected by neighborhood poverty (Rankin & Quane, 2000). These communities tend to lack the social network ties that may help alleviate poverty through better employment or access to resources. Areas of concentrated poverty tend to have lower participation rates in institutional resources such as businesses, schools, social clubs, and other organizations (Rankin & Quane, 2000). Furthermore, poor communities are plagued by lower levels of trust and lowered expectations of reciprocal behavior (Stack, 1979). Therefore, there is a diminished chance that neighborhoods will aid one another and limited social support is available in the face of a disaster or

other crisis. Not all impoverished communities lack strong social ties—others have found that the inner-city poor and other disenfranchised groups are as well-networked as anyone else (Gans, 1962). However, they are less likely to have financial reserves in these networks to recover from a disaster.

An example of the recovery inequality faced by those without access to social networks occurred following Hurricane Andrew. In one analysis of the disaster (Peacock, Morrow, & Gladwin, 1997), communities were compared to ecological systems given the complex, interacting social ties. Community elements were seen as connected through nonhierarchical, dynamic contingency linkages through which information, resources, and even individual members flowed. All nodes in the network were dependent on others although interdependencies were not purely reciprocal. Given the socioeconomic conditions in Miami, recovery from the storm was greatly impacted by its pre-existing social ecology, including its pervasive inequalities. For example, the Cuban community benefitted from greater access to resources than other minority groups and was thus able to recover more quickly than similarly situated networks. Recovery was impacted by levels of economic development, divisions of labor, the political system, and the size of network sub-populations.

Environmental scientists have also used a social-ecological model to explain disaster recovery in coastal areas, similar to the ecological systems model used in the Hurricane Andrew analysis (Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005). The social-ecological model draws upon the recovery and resilience functions of natural ecosystems in framing the parallel role of social support networks after a disaster. For example, after a catastrophic event, ecosystems are equipped with a "memory" of biological legacies that allow diverse but intertwined organisms to reorganize as before. Similarly, social memory comes from a diverse group of individuals and institutions combining their practices, knowledge, values, and worldviews. This pooled learning creates a more resilient system, able to withstand disasters and other major disturbances. These processes could be observed after the 2004 Asian tsunami, as fishing communities on Simelue Island near Sumatra used inherited social memory as well as local institutional preparedness to survive despite being close to the earthquake's epicenter. Formal and informal institutions with deep social and environmental knowledge, and accordingly, the networks inherent in these institutions, are vital for mitigating the effects of disasters.

A recent study examined earthquake recovery in two incidents in Japan and India with a focus on the strength of social networks in recovery and rebuilding (Nakagawa & Shaw, 2004). Similar neighborhoods in Kobe, Japan (affected by a 1995 earthquake) and Gujarat, India (affected by a 2001 earthquake) were studied. Victims were surveyed using the "Integrated Questionnaires for the Measurement of Social Capital" developed by the United Nations. Based on the results of the survey, the communities with the highest levels of social capital (including external and internal networks), displayed the fastest recovery despite lower income levels. The Kobe earthquake shifted Japan's national focus of disaster management from an engineering issue to a social and technical issue.

Social networks are consistently upheld as an important factor in resilience. However, criticisms generally focus on the difficulty in defining both of these terms. Resilience is difficult to measure or even recognize in certain situations. The time necessary for a community to recover may vary by the scale of the disaster and size of the community, therefore, a community may spend many years in the reorganization stage of the adaptive cycle before returning to a stage of growth. Similarly, social networks are difficult to identify and measure. Despite this, many studies have attempted to operationalize these concepts and their practical usage has not waned.

4. The Built Environment

The term built environment literally refers to all types of developed land such as cities, suburbs, and rural towns, or any other element constructed by humans. Thus, this includes structures from huts to high-rises, streets and sidewalks, lighting, signage, public art, and parkscapes. Naturally, the built environment also includes contents of those types of features such as walls, furniture, and other objects. There are many theories about the connection between people and place and the types of phenomena and behaviors that are influenced by the built environment.

Creating an ideal built environment has been central to planning and architecture for millennia. The past hundred years or so are particularly rich in various planning movements. Ebenezer Howard introduced "Garden Cities" in 1898, which promoted freedom from the city, including ample green space, with a mix of agriculture, industry, and housing and overall self-sufficiency in carefully planned and controlled towns (Howard, 1965). Only a few such towns were realized in England, but the concept was influential in the United States. For example, Clarence Perry developed the idea for an idealized neighborhood unit in 1929, meant to encourage community and strengthen family life through neighborhood anchors such as schools and parks (Lawhon, 2009). Perry's sometime-collaborator Clarence Stein, seeking to replicate Garden Cities in the United States, later introduced hierarchical circulation patterns separating pedestrians, local, and through traffic at Radburn, New Jersey (Stein, 1949). Although they were once planning outsiders, the radical ideas of Frank Lloyd Wright's "Broadacre City" and Le Corbusier's "Radiant City" also attempted to revolutionize urban design for modern society (Fishman, 2003). More recently, Kevin Lynch went to great lengths to systematically understand how humans perceive their environments and navigate in a complex urban area (Lynch, 1960). Perhaps the most influential planning movements in recent decades has been New Urbanism, which has promoted a return to traditional patterns of development, including walkable, mixed-use neighborhoods (Katz, Scully, & Bressi, 1994).

Scholars have extensively analyzed the purported outcomes of planning movements and other built environment techniques. Common research topics included the impacts of the built environment on travel, particularly trip length and mode choice (Ewing & Cervero, 2001); the effects of factors such as housing, isolation, and transportation infrastructure on public health and mental health (Srinivasan, O'Fallon, & Dearry, 2003); and building-level up to community-level impacts of the built environment on the natural environment (Forsberg & VonMalmborg, 2004). Studies also have examined the impact of catastrophic events on the built environment, such as climate change (Wilby, 2007).

Research on the built environment extends well beyond the planning and architecture domains. A December 2012 Google Scholar search on the term "built environment" (in quotes) returned 17,200 works in 2012 alone.

a. The Built Environment and Social Networks

The influence of the built environment on social networking opportunities and the ultimate structures of social networks is a common topic among scholars of various disciplines. The spatial configuration of a region impacts the social networking opportunities, particularly within and between residents and businesses. Social networks with the most potential for resiliency are rooted in the built environment, with the nature, strength, and quantity of social ties influenced by development patterns.

Building on the work of Jane Jacobs, urban planning research has shown that walkable, mixed-use neighborhoods can encourage the development of social capital and place attachment through an increase in interactions and a higher likelihood of neighborhood amenities, including characteristics of the built environment that influence social networks, such as varied land uses and pedestrian-oriented design (Leyden, 2003). New Urbanism claims that factors that influence social capital include density, street connectivity, design, and land uses. However, physical design actually increases the probability of community building through interaction rather than creating sense of community *prima facie* (Talen, 1999).

A study of Diggs Town (Norfolk, Virginia) (Bothwell, Gindroz, & Lang, 1998) demonstrated the ability of neighborhood design to directly improve social interaction by surveying residents of a housing project after its redesign from modernist bunkers to New Urbanism-style units with front porches and defined lawns. Residents found the new layout safer in terms of traffic control and crime and led to a greater sense of community and self-esteem. Planners have long desired to create a sense of community through urban design and have more recently sought to measure and define the relationship between the social and physical realms.

Problems with the social doctrine of New Urbanism and related trends have been presented. The lack of direct evidence and role of nonenvironmental factors, for example, weaken the argument that neotraditional design can encourage social mixing and social capital (Talen, 1999). Although studies have validated certain claims of New Urbanism, such as increases in pedestrian travel (Lund, 2003) and property values (Tu & Eppli, 1999), its espoused sense of community has been questioned.

Anthropologists and sociologists have also examined how the built environment reflects and influences our social connections and communications. However, in contrast to most planners and architects, the focus is on the built environment and its constituent elements as experienced by cognitive schemata and therefore spaces need not be physically defined. Spaces exist in individuals' cognitive maps of their surroundings, defined by the activities that take place there (Rapoport, 1994). Development patterns are influenced by politics, codes, and ideologies, and many elements of the built environment remain fixed over time (with new generations utilizing them). Spaces therefore transmit cultural meaning and identity over time and correspond to and promulgate social structures.

Social space can also be broken into objective and subjective components (Wilson, 1980). Objective components include the nature of people's interaction in space, which is a critical variable contributing to how individuals experience space. Activity patterns can therefore be predicted from the type of space in question. The subjective component includes the "city of the mind," or cognitive maps. These fields provide a basis for understanding how the built environment, even after catastrophic damage, exists in human and collective memory and is assigned greater value than the bricks and mortar from which it is crafted. Differences in theories behind physical design and social interaction are common among social ecologists, but the field has a unified intellectual tradition that space and physical design influences social structure (Bothwell et al., 1998).

Place attachment is also a significant topic in discussions of human interaction with the built environment. Place attachment is based on our past interactions and the potential for future interactions between ourselves and our physical surroundings (Milligan, 1998). Geographic space is the stage to which we assign meaning and in which social interactions are set. The bonding of people to place occurs through personal, group, or cultural processes, notably those related to social networks.

Studies of destruction of place, through natural disasters or slum clearance, have been used to illustrate the strong connection between a society or community and the specific place in which it resides. Recent work in Louisiana (Burley, Jenkins, Laska, & Davis, 2007) found that cross-generational social and economic ties inspired residents of bayou communities to fight for wetland protection. Residents correctly believed that coastal land losses caused by government and industrial activities such as canalization and pollution exacerbated naturally occurring erosion and limited coastal protection from hurricanes. In spite of and because of the growing fragility of their community, residents of coastal Louisiana towns continued to experience strong attachment to the unique landscape and culture in which they lived. This attachment varies by community, in that it may be tied to specific sites such as unique ecosystems, cafés or parks, architectural styles, or historic development patterns.

Rooted in the field of architecture, space syntax argues that the functions of society follow form, or that various social phenomenon are likely to occur because of physical structures (Hillier, 2008). These theories are also influenced by sociology, geography, and anthropology and provide a method for measuring and analyzing the impact of space on behavior. Space syntax literature focuses on the organizing structures that dictate human behavior, such as connectivity and sight lines that influence choice and movement in space. Specific measures include metric reach and angular reach, which quantify the connectivity of streets by identifying the length of street network accessible within a given distance or number of direction changes (Peponis, Bafna, & Zhang, 2008). Specific to space syntax, previous studies have shown that the spatial configuration of spaces affects social behavior. For example, retail and other land uses that benefit from increased pedestrian and vehicle traffic gravitate toward higher movement locations, which are statistically more likely to be well integrated with the urban grid (Hillier, 1999a). Additionally, it has been shown that the level of development of a neighborhood is contingent upon its embeddedness in the circulation system of a city, either preventing or encouraging economic activity and social capital (Hillier, 1999b). Finally, many factors that relate to resilience have been associated with integration, reach, and other syntax measures. These include urban poverty, economic activity, social interactions, and the distribution of land uses, among others.

The relationship between space and poverty (which is correlated with fewer networking opportunities) has been investigated and defined by recent space syntax research (Carpenter & Peponis, 2010; Vaughan, 2007; Vaughan, Chatford Clark, Sahbaz, & Haklay, 2005). Generally, access to economic and social opportunities through well-integrated spaces has been associated with a higher incidence of wealth at the smallest levels of analysis (parcels and block faces). According to Vaughan (2007), the relationship between space and poverty has been discounted by researchers and decision-makers. However, Vaughan showed that space at least partially explains the causes and persistence of poverty (Vaughan et al., 2005). Street integration was shown to greatly affect the distribution of social classes in London. There, higher-class streets tended to be significantly longer with much more direct accessibility (in terms of directional reach) than lower-class streets (Vaughan, 2005). The concentration of poverty in urban areas and increased isolation from the wealthy has been well documented (Massey, 1996). Since the formation of the earliest settlements, the density of impoverished households has been increasing in cities, with the greatest extremes seen in the current post-industrial era.

There are differences in levels of social networking among impoverished and isolated communities, however. In addition to the inherent differences in networking based on the built environment, there may be cultural or historical conditions that lead to atypical networking behavior. In fact, certain groups form local solidarity networks with positive benefits. As early as 1925, research from

the Chicago School identified "natural areas" or neighborhoods formed by proximity and social contact (VanKempen, 1994). These units are analogous to and informed by thinking on ghettos and slums and other sub-ecologies of poverty found in cities. Social isolation has been shown to be a contributing factor to persistent poverty and is most prevalent where real estate in undesirable and impervious to gentrification. These spaces are found clustered in cheap, dilapidated, and inaccessible areas, such as inner-ring suburbs in the United States. Despite the limitations of exclusion, homogeneity (of income, ethnicity, or similar) may also strengthen social support ties through solidarity (Bolt, Burgers, & VanKempen, 1998). Social and geographical similarities provide necessary resources such as employment, entrepreneurial support, informal economies, and family services like child care.

Overall, the built environment is shown to impact social systems and social networks through a variety of mechanisms. Critics have questioned methodological approaches and theoretical models, as nonenvironmental factors may also be at play. However, increased sophistication in the field and greater mainstream interest has ensured its continuation.

b. The Built Environment, Social Networks, and Disaster Resilience

Although the link between a built environment that supports social networks and disaster resilience has not been expressly connected, a few studies have identified physical manifestations of the link between social networks and disaster resilience, or artifacts of the built environment that can predict resilience. For example, physical structures that facilitate social networks were found to contribute significantly to day-to-day recovery activities in a case study of five flood-impacted communities in the Midwest (Sherraden & Fox, 1997). In this instance, networks were most effective in recovery when they had an organizational base, or a physical address in which activities could be centralized and staged.

A second example of the influence of the built environment on social networks and the impact of this relationship on disaster resilience is the Chicago heat wave of 1995. Prolonged temperatures above 100 degrees Fahrenheit, scattered power outages, loss of fire hydrant pressure, and surges in emergency room and hospital demand taxed the city's resources. Overall, 485 people died due to heat-related causes over the course of one week, far exceeding the 222-bay holding capacity of the city's morgue. A social and geographical analysis of the event (Klinenberg, 2002) illustrated the grim patterns of vulnerability in Chicago, a city notoriously divided, with distinct borders separating regions and groups that touched but did not interpenetrate. The losses of life were disproportionately felt in both socially and spatially disenfranchised communities. Victims tended to be social outcasts, including the elderly, the poor, and ethnic or racial minorities, who were also physically isolated. Geographically, these deaths were concentrated in low-income, minority, and violent regions of Chicago. Further, many elderly victims, who comprised 73 percent of the casualties, were concentrated in public and for-profit single-room occupancy dwellings in poor neighborhoods. Chicago's social problems were reflected in and reinforced by the spatial distribution of disenfranchised populations and un-networked households, reducing the area's overall resilience to the heat wave crisis.

In another study of the Chicago heat wave of 1995, The U.S. Centers for Disease Control (CDC) and Prevention conducted 339 matched-pair surveys of victims and survivors and included social network and living condition variables in their data collection (Semenza et al., 1996). Data collected in interviews and a statistical analysis showed that living alone and not leaving the home increased the risk of death, while participation in group activities, having friends in the Chicago area, and having a pet in

the home all reduced the risk of death. The empirical evidence offered by the CDC illustrates the impact of living arrangements and social networks on the loss of lives in a disaster.

5. Conclusion

Kevin Lynch argued that "A city is hard to kill, in part because of its strategic geographic location, its concentrated, persisting stock of physical capital, and even more because of the memories, motives, and skills of its inhabitants" (Vale & Campanella, 2005). The desire to rebuild rather than retreat has been imprinted on our society, at least in part through the social structures that transmit the emotional and cultural meanings of a place. Overall, the literature supports the notions that social networks promote resilience, that the built environment impacts social networks (and social networks influence the built environment), and that elements of the built environment are therefore beneficial to disaster resilience. A number of theories exist as to how aspects of the social and built environments impact disaster recovery and overall community resilience. Although many conceptual models of these relationships are offered, there is consensus that socially engaged communities are most resilient and that an underlying urban design that includes well-connected streets and diverse spaces encourages social engagement.

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