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The Role of Social Capital in Resiliency: Disaster Recovery in Puerto Rico

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The disasters that occurred during the 2017 Atlantic hurricane season not only became an economic burden for federal and local governments but also for those who had their houses damaged and lived without electricity, water, and related necessities 1 year after. In the case of Hurricane María in Puerto Rico, ineffective oversight of the large-scale humanitarian crisis also contributed to long-term delays in recovery efforts. This paper explores how barrios (small legal divisions) can use social capital to recover and potentially increase resilience before after a disaster. By looking at two rural barrios in Puerto Rico, the study presents how the communities' actions pre-and-post-Hurricane María assisted the residents in coping and reducing vulnerability. The study conducted semi-structured interviews with community leaders to assess the communities' capacities in their organizations, emergency management, collaborations, and ongoing efforts to mitigate future shocks. A thematic analysis for each site described three key dimensions of social capital (bonding, bridging, and linking) that these communities leveraged to enhance resiliency. Findings show that social capital facilitated recovery efforts and enhanced resiliency through shared values, network expansion, new partnerships, and a desire to make their communities more robust and less vulnerable to upcoming environmental disturbances.

KEY WORDS: disaster recovery, social vulnerability and vulnerable populations, emergency management and response

摘要

2017 年大西洋飓风季出现的灾害不仅成为了联邦和地方政府的经济负担, 还对那些房屋被毁、一年后生活在没有供电、供水和相关必要设施环境里的人造成了经济负担。在波多黎各遭遇飓风玛丽亚这一案例中, 对大规模人道主义危机的无效监管也导致了灾后恢复工作的长期拖延。本文探究了 *barrios* (小型立法部门)如何使用社会资本恢复并可能增强灾害后的韧性。通过审视波多黎各的两个乡村 *barrios*, 本研究展示了飓风玛丽亚前后时期的社群行动如何协助居民应对并减少脆弱性。本研究对社群领导者进行了半结构化访谈, 以评估社群在其组织工作中的能力、应急管理、协作、和持续努力, 以期缓解未来灾害冲击。对每个 *barrios* 进行的主题分析描述了社群用于增强韧性而使用的三个关键社会资本维度(整合型、桥接型、连结型)。研究发现表明, 社会资本通过共享价值观、网络扩展、新伙伴关系、和希望将社群变得更为强健、减少面对未来环境干扰时的脆弱性, 从而促进了恢复工作、增强了韧性。

关键词: 灾害恢复, 社会脆弱性与脆弱人口, 应急管理与响应

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Resumen

Los desastres que ocurrieron durante la temporada de huracanes en el Atlántico durante el año 2017 no solo se convirtieron en una carga económica para los gobiernos federales y locales, sino también para aquellos que tuvieron sus casas dañadas y vivieron sin electricidad, agua y necesidades relacionadas un año después. En el caso del huracán María en Puerto Rico, la ineficaz supervisión de la crisis humanitaria a gran escala también contribuyó a retrasos a largo plazo en los esfuerzos de recuperación. Este documento explora cómo los barrios (pequeñas divisiones legales) pueden usar el capital social para recuperarse y potencialmente aumentar la resiliencia antes de un desastre. Al observar dos barrios rurales en Puerto Rico, el estudio presenta cómo las acciones de las comunidades antes y después del huracán María ayudaron a los residentes a sobrellevar y reducir la vulnerabilidad. El estudio realizó entrevistas semiestructuradas con líderes de la comunidad para evaluar las capacidades de las comunidades en sus organizaciones, gestión de emergencias, colaboraciones y esfuerzos continuos para mitigar las crisis futuras. Un análisis temático para cada barrio describió tres dimensiones clave del capital social (bonding, bridging y linking) que estas comunidades aprovecharon para incrementar la resiliencia. Los resultados muestran que el capital social facilitó los esfuerzos de recuperación y mejoró la capacidad de recuperación a través de valores compartidos, la expansión de sus redes, nuevas asociaciones y el deseo de hacer que sus comunidades sean más robustas y menos vulnerables a las próximas perturbaciones ambientales.

PALABRAS CLAVE: Recuperación ante desastres, vulnerabilidad social y poblaciones vulnerables, gestión y respuesta ante emergencias

Introduction

The commonwealth of Puerto Rico became an unincorporated territory of the United States in 1898. It is located in the northeast Caribbean Sea between the Dominican Republic and the British Virgin Islands (Lewis, 2017). It consists of 78 municipalities including Vieques and Culebras, two smaller islands on the east of Puerto Rico. Similar to other islands in the Caribbean, high levels of urbanization and population densities (mostly in coastal areas) and external economic processes have added to Puerto Rico's vulnerability to natural hazards (Barker, 2012; Méheux, Dominey-Howes, & Lloyd, 2007; Mimura et al., 2007). Within the socioeconomic context, the archipelago has confronted an economic and fiscal crisis, which has resulted in 45 percent of the population living below poverty levels, high levels of welfare dependency, and a population decrease of 500,000 over the past 10 years primarily due to limited employment opportunities (COR3, 2018). When Hurricane María made landfall in Puerto Rico on September 20, 2017, the catastrophic event, aside from the physical impacts, demonstrated the larger economic, political and social crisis that the island had been experiencing for the past 30 years. These conditions served to exacerbate and limit the recovery efforts and can be viewed both as a basis for a lower than expected resilience, as well as a more extensive and seriously enhanced level of vulnerability.

Hurricane María, with sustained winds of 155 miles per hour is considered the strongest disaster to hit Puerto Rico since Hurricane San Felipe II in 1928. (Fritz, 2017). Yet, the lack of state government resources due to the decades of disinvestment and economic hardship served to diminish preparedness efforts and increased the level and extent of vulnerability especially in infrastructure such as the energy system (Eakin, Muñoz-Erickson, & Lemos, 2018; Lluveras, 2018). In the aftermath, the slow and inadequate early responses from the government, logistical stumbles (the delayed opening of ports), slow delivery of supplies to municipalities, and other response factors resulted in slow recovery efforts (Clement, Zezima, & Guskin, 2018). Similarly, laws such as the Jones Act (1917), the lack of Congressional representation, and geographical separation of more than 1,000 miles from the U.S. mainland also influenced the delay of shipping goods to the island when most needed (COR3, 2018; Rodriguez-Díaz, 2018; Yglesias, 2018).

Despite the allocation of Federal funds to the island through Federal Emergency Management Agency (FEMA) and other agencies, the situation continued to be critical for those displaced from their homes and rural communities that still lacked essential services almost 1 year after the hurricane. In 2018, the Governor of Puerto Rico had to request more funds and support from FEMA (R. Rossello, Letter to Mr. President Trump. 30 Aug. 2018). Due to the lack of support and serious levels and types of vulnerability, the emergency and recovery efforts stretched out longer than many other disasters (See Kates & Pijawka, 1977). Almost 2 years after the disaster, the mostly governmental inaction to reduce vulnerability across the archipelago continues to be well documented through media reports and scholarly articles (Acevedo, 2019; Caro, 2019; García-López, 2018; Mazzei, 2019; Ross, 2018).

As presented in Puerto Rico's governor federal request for disaster recovery *Build Back Better Puerto Rico* (2018), the trajectory of Hurricane María (from east-to-west) collapsed Puerto Rico's Electric Power Authority (PREPA) consequently affecting the communication system, airport, hospitals, supermarkets, water systems, and streetlights, to mention a few. For municipalities, physical damage to their town hall and fiscal difficulties created additional challenges in the emergency management and recovery process (Pares & Caro, 2018). Within this context, this research looks at smaller legal divisions within municipality boundaries called *barrios* that have self-organized and created community-based nonprofit organization before the hurricane and how social capital—in terms of the shared values, collaboration capacity and community organization—facilitated resource gathering to create a buffer and reduce vulnerability in the aftermath of Hurricane María (Delgado, 2018; Echenique, 2017). The focus on the role of social capital in enhancing resilience in this study reinforces the work found in Nakagawa and Shaw (2004) as well as Aldrich (2012).

Although social capital implies the development and application of internal community resources, the idea of "linkage" stresses the importance of establishing connections between these communities and external resources including

governmental agencies, other communities, nonprofit organizations and diaspora relationships (Aldrich, 2012; Esnar & Sapart, 2016; Zhang, 2016). What is less documented is how residents of a community through community-based organization can reduce their vulnerabilities to extreme weather events by nurturing and utilizing their social capital prior to the outset of disasters. Using a case study approach and semi-structured interviews with community leaders in two rural barrios, this study produces evidence of the role of social capital in reducing adverse impacts and mitigating future hazards. These two selected barrios have had community-based organizations for more than thirty years, and they provide a unique perspective that other communities (in both urban and rural settings) can learn from in their ongoing efforts for hurricane recovery and disaster resilience.

Disaster Resilience and Social Capital: Background

Disasters are described as events or situations of significant harm, disruption and/or distress to a community or country (Gilbert, 1998; Quarantelli, 2005). They occur when a hazard such as tropical storms, anthropogenic fires, earthquakes, and landslides interact with social, economic, environmental, and physical spaces to cause disruption to the human environment system (Barasa, 2018; Mayunga, 2007). In traditional disaster literature, the main focus of management and planning have been in disaster preparedness, emergency response, and recovery. However, climate change and its challenges have given significance to the study of resiliency, vulnerability, adaptive capacities and social capital as these concepts assist in understanding how communities, organizations, institutions, and individuals can better cope with disruption, return to stabilization and reduce future vulnerabilities (Aldrich & Meyer, 2015; Mayunga, 2007; Murphy, 2007).

Resiliency

The term resilience was first used by Holling's (1973) work on ecological systems and since then, it has been used in different contexts (e.g., physical systems, socioecological systems, psychology, and disaster management) to outline the ability of a system to return to a steady state after disruption. When defining resilience to hazardous events, Timmerman (1981) expressed resilience as the capability of a system to absorb and recover from hazardous events. Aside from the environmental and physical dimensions that resiliency theory focuses on, the study of social systems around resilience has developed its own criteria. In this sense, social resilience can be described as how a community is able to receive a shock and find alternatives to restore, keep functioning and improve levels of resilience for upcoming events (Adger, 2000; Keck & Sakdapolrak, 2013; Maguire & Hagan, 2007; Pelling, 2003). However, as Masterson et al. (2014) highlights, precaution should be taken when applying this concept to a social system as systems can "bounce back"

to the same form or state as prior to the disaster, which is not necessarily adaptive as it can set the stage for future disasters.

Taking the social approach to resilience and considering the complexities of communities in terms of their social, economic, and natural environments, community resilience can be described as a survival process in a moment of disruption (Imperiale & Vanclay, 2016). However, it also implies the minimization of vulnerabilities and strengthening the community to better cope with future disasters (Coles & Buckle, 2004; Wilson, 2012). From an emergency management perspective, Ross's (2016) work showed that "bouncing back," "self-reliance," and "community" are the main themes in the interpretations of community resilience. Her work also presents adaptive capacity, organizational capacity, emergency manager experience, and past disaster experience as important factors when explaining how emergency managers view resilience. Other elements that characterize community resilience include "factual knowledge base of the community, training, networks, leadership, collective efficacy, and empowerment" (Patel, Rogers, Amlôt, & Rubin, 2017; Sherrieb, Norris, & Galea, 2010). Moreover, community resilience takes into consideration how different units such as grass roots, neighborhoods, and larger geo-political institutions can make decisions under uncertainty and adapt (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). Separated from the differences encountered in resilience literature in terms of economic, social, ecological, and infrastructure approach, it becomes relevant to differentiate between urban and rural resilience (Beekman, Heide, Heijman, & Schouten, 2009; Kapucu, Hawkins, & Rivera, 2013). For example, in contrast to cities, rural communities struggle more with having government relations and have fewer financial resources to promote and support disaster mitigation strategies and reconstruction, which results in greater and longer vulnerabilities to extreme events (Beekman et al., 2009; Kapucu et al., 2013).

Social Capital

In its relationship to resilience, the idea of social capital offers insights into the complexity and dynamics a community faces at times of disruption. Social capital can be conceptualized as a set of social networks that include trust, reciprocity, common rules, norms, and public engagement. Social capital helps us to understand how a community organizes itself to work with rapid change (Cheshire, Esparcia, & Shucksmith, 2015; Masterson et al., 2014; Putnam, 2000; Wilson, 2012). As a collective dimension, through a network, social capital can increase access to information, resources, capital, and expertize to promote development. Scholars have argued that in terms of its cost-effectiveness, developing relations can require significant time and resources (Kapucu, 2011). Nevertheless, at the community level, social capital can function as a gap filler when governments and markets fall short mitigating disaster risks (Aldrich, Sothea, & Yasuyuki, 2015). Social capital nurtures community connectedness, provides informal "safety nets," and assists people in accessing resources, which can increase the likelihood that the community will be

able to adequately address their disaster concerns (Lindell & Prater, 2003; Masterson et al., 2014). Recent growth in the literature on social capital offers insights on disaster response and recovery as it acknowledges the role of local social networks and community engagement in planning the reduction of hazard vulnerability and getting the system to recover (Aldrich, 2012; Aldrich & Meyer, 2015; Minamoto, 2010; Nakagawa & Shaw, 2004).

Different types of social capital have been recognized in the disaster research field. To illustrate, bonding, bridging and linking all have influence in resiliency outcomes (Aldrich, Meyer, & Page-Tan, 2018). *Bonding social capital* is characterized by building strong ties and assistance between members of a group and can be driven by culture, religion, ethnicity, and identity (Hutanuwatr et al., 2013; Pretty, 2003; Putnam, 1993). It describes the connections between family members, friends and close allies resulting in tight bonds in a group (Adler & Kwon, 2002; Aldrich & Meyer, 2015). In post-disaster situations, for example, bonding capital can be observed most clearly in the emergency assistance (food, shelter, and temporarily migration options) given by the relationships with immediate family members and relatives as occurred with Cyclone Sidr in the case of Bangladesh (Islam & Walkerden, 2014). Another example by Hawkins and Maurer (2010) looked at how different forms of social capital were present among 40 families in the aftermath of Hurricane Katrina. Their analysis showed that bonding social capital was important for immediate support, especially for those with low incomes.

When it comes to accessing outside resources and creating connections between groups, *bridging social* capital becomes beneficial. This type of social capital is driven by the needs of new information, connecting different groups with a common goal. It is characterized by people who are like each other through community ties or organizations in different locations making the network diverse (Nakagawa & Shaw, 2004). In a disaster context, these connections assist in community revitalization and resilience as people can exchange knowledge, experience, and capital (Beekman et al., 2009). For example, after Hurricane Katrina, neighborhoods that connected with outside neighborhoods accelerated their recovery in contrast to communities that stayed within their neighborhood (Aldrich et al., 2018).

Linking social capital brings a community access to resources that are not local such as funding by government, humanitarian aid institutions, and non-local donations. Linking social capital becomes important as Nakagawa and Shaw (2004) highlight in their comparative case study using the post-earthquake cases of Kobe, Japan and Gujarat, India as it connects disaster survivors with governmental officials for response and recovery efforts such as providing financial and physical resources. Likewise, reaching out to decision makers in the central government, private sector, supra local entities, foreign NGO's and civil society organizations have also been proven to accelerate recovery processes (Aldrich, 2018; Hawkins & Maurer, 2009; Hutanuwatr et al., 2013; Tierney, 2013). Additionally, research has shown that in disaster aftermaths, the internet and social media provide a linkage

for support as was exhibited in the case of hurricane Katrina in disaster response (Aldrich, 2018; Kim & Hastak, 2018).

Social capital reflects the quantity and quality of social cooperation at times of uncertainty. For example, it helps resolve collective problems easier as the community works together towards a common goal. Social capital in the form of activities of local organizations can include resilience into their projects in support of recovery processes (Barone & Mocetti, 2014). In the case of communities that have weak social ties, resource dependency, and low human capital (knowledge, social attributes, and capability), the community's capacity to withstand a disaster becomes harder (Beekman et al., 2009). Similarly, low levels of solidarity among community members and poorly developed social networks can contribute to erosion of social capital (Beekman et al., 2009; López-Marrero, 2008). As an example, López-Marrero's (2008) case studies on adaptive capacities in flood prone areas in Puerto Rico highlight how weak social capital (low solidarity, poor social networks, and lack of personal security) influenced adaptive capacities to be of limited value to flood prone areas. Thus, the number of nonprofit organizations, religious organizations, recreational clubs, and involvement in public programs are valuable for measuring social capital as a source of community cooperation (Mayunga, 2007).

The case study of Mary Queen of Vietnam Catholic Church after hurricane Katrina (2005), is an example of the important role faith-based organizations can play in disaster recovery using social capital. As Rivera and Nickels (2014) demonstrated, social capital in this case was used for disaster recovery through community members' formal and informal networks to pursue recovery and redevelopment goals. Within this context, the church became a physical and spiritual center for this community to have access to shelter, food and related necessities. Moreover, a cases study by Hutanuwatr et al. (2013) on the 2004 Indian Ocean tsunami's impact on coastal Thailand highlights how the grass roots response in recovery efforts assisted in coping with vulnerabilities through their collaborative networks. This case study used a mixed methods approach to show how locally based, collaborative recovery programs and multiscale social networks can reduce vulnerability and increase resiliency. In the Thailand case, new banks were established by communities throughout ties with faraway places that became linked.

Vulnerability

A system's capacity to respond to a hazard relates to its ability to adjust to a disturbance, moderate the effects, take advantage of any available opportunities and cope with the consequences of any system transformation (Cutter, 1996; Hutanuwatr et al., 2013; Thomas et al., 2019). From a disaster perspective, vulnerability can be defined as the characteristics of a person, group or a community and how they influence the ability to anticipate, cope with, and recover from the hazard impact (Donner & Rodriguez, 2011; Wisner, 2003, 2016). In this sense, vulnerability "implies a measure of risk associated

with the physical, social and economic aspects so the system can cope from a disturbing event" (Masterson et al., 2014, p. 79). However, the level of vulnerability is viewed as the relationship between risk and preparedness or risk and resilience with the risk being the probability of an adverse outcome and its impacts or effects (Wisner, 2003).

Vulnerabilities to disasters can be evaluated by "determining three pre-impact conditions: hazard exposure, physical vulnerability, and social vulnerability" (Lindell, Prater, & Perry, 2007) as cited in Kapucu et al. (2013, p. 217). The hazard exposure is determined by the capacity of the natural hazard to affect the geography (Masterson et al., 2014). The physical vulnerability relates to the location of the population and its built environment. In this sense, it is a combination of how resistant structures are, such as homes or businesses, roads, water, and sewer systems and the natural environment (which can protect/isolate the community). Social vulnerability, relates to how social factors influence the ability of communities and their populations (individuals and households) to anticipate, respond, resist, and recover from disasters (Masterson et al., 2014). A social vulnerability perspective focuses attention on the characteristics and diversity of the population in terms of broader social, cultural, and economic factors, which can include race and ethnicity, gender, household composition, education, poverty, social isolation, political marginalization, age, housing tenure, and employment status (Masterson et al., 2014; Pelling, 2003). In other words, natural hazards can become disasters when they interact with populated areas that have sensitive infrastructure and social weaknesses.

Adaptation (in the form of robustness, redundancy, rapidity, and resourcefulness) is a key quality of a resilient system (Kapucu et al., 2013). The concept has received wide attention, as it can be reactive (response to a stress that has already occurred) or proactive (anticipating future stress) (Brooks, 2003; Buckman & Rakohimova, 2017). In a disaster context, such approaches are drawn from previous state conditions and emergent processes that put communities at risk and envision future outcomes. Applied to social systems, adaptation calls on the skills employed by social and political institutions to think and act towards anticipated events and reduce vulnerability (Buckman & Rakohimova, 2017).

The degree of social and physical vulnerability a community has depends on its pre-disaster context. Figure 1 takes into consideration Aldrich's (2012) framework on social capital to present how social capital is situated as an important variable in disaster recovery because of its ability to support community resilience. In this sense, the multiple networks that a community has prior to the disaster can assist in their capacity to cope, achieve goals within a time period that can avoid losses, and recover by establishing new or enhancing existing networks to utilize different types of resources.

On the basis of the previously discussed literature, this research addresses the following question: How did the two barrios use social capital to reduce vulnerability prior and in the recovery process of Hurricane María?

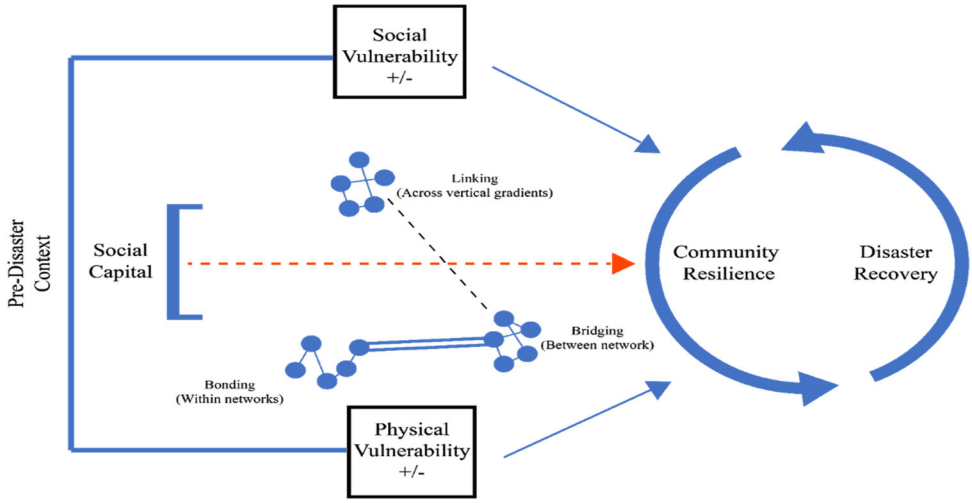


Figure 1. Social Capital in Disaster Recovery Framework (With Aldrich, 2012).

Methodology

Study Design

This study utilized a qualitative research design, specifically focused on two cases of successful use of social capital in post-disaster response. This design is appropriate for exploratory analyses as it meant to understand the meaning and dynamics of social or human problems (Creswell & Creswell, 2018). Although this exploratory design cannot explain when or why social capital fails, it can identify possible social capital dynamics that may contribute to successful post-disaster response. We used two barrios to assess the importance of social capital, but these cases focus on what social capital can do from a successful perspective (Figure 2).

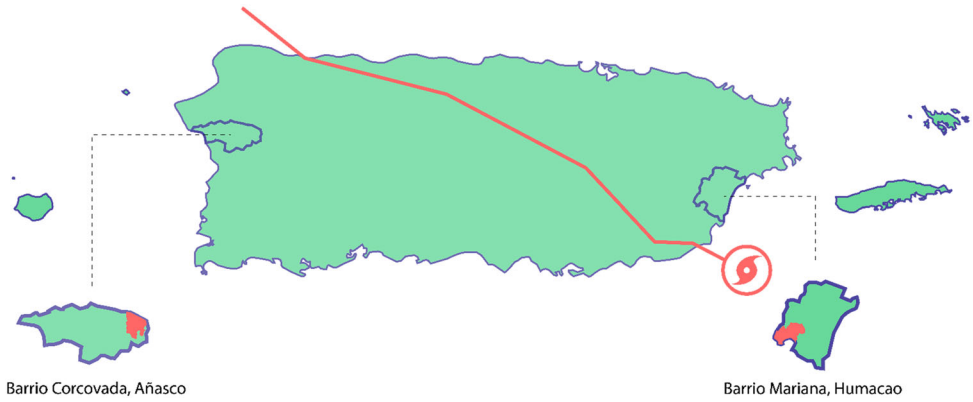


Figure 2. Puerto Rico With Hurricane María Trajectory and the Two Study Areas.
Source: National Weather (2017) & Google Maps (2019a,b). Sketch by: Jan Cordero.

Site Selection

The two barrios selected for this study were Corcovada in the municipality of Añasco, Puerto Rico, and Mariana in the municipality of Humacao. Corcovada is a rural barrio located in the mountains of the municipality of Añasco in the western side of Puerto Rico. According to the 2010 U.S. Census, Corcovada has 627 residents (U.S. Census Bureau 2010 Census of Population and Housing, 2012). In 1990, Corcovada residents created the *Comité Communal de Corcovada Inc*. (Corcovada Communal Committee, Inc.) a community-based nonprofit organization to address community needs such as the management of their community owned water system as well as to provide cultural activities and capacity building for its members (Primera, 2008). Mariana is a rural barrio in the municipality of Humacao, Puerto Rico which is located in the east side of the island and it has 3,230 residents (U.S. Census Bureau 2010 Census of Population and Housing, 2012). In 1982, the residents officialized their community-based organization *Asociación Recreativa y Educativa Comunal del Barrio Mariana, Inc*. (Recreational and Educational Community Association of el Barrio Mariana de Humacao, Inc.) with the mission to serve as a catalytic agent that promotes collaborations and active participation to address challenges in the community and provide well-being (Diaz, 2013). Both barrios have experienced challenges such as water insecurity, critical infrastructure during "normal times" with earlier hurricanes that have impacted the island. Nonetheless, these barrios were selected because they were highlighted by the media as communities with high levels of community resilience in the aftermath of Hurricane María such as front line leadership, community networks, and effective communication (Delgado, 2018; Patel et al., 2017; 80 Grados, 2018). Additionally, as the literature and media highlighted major challenges for rural settlements in post-disaster recovery, having an understanding on how their organizations used social capital in the recovery process can inform both rural and urban areas in recovery and future events.

Sample and Data Collection

The primary data for this research were collected through face-to-face, semi-structured interviews of 13 identified community leaders. We used a purposive qualitative sampling technique to select individuals, who could convey the information from firsthand evidence about community hazard vulnerability and recovery dynamics (Creswell & Plano Clark, 2011; Patton, 2002). Although our sample is small (due to the small number of community leaders in each site), our sample size in each site meets the minimum size of required for theme identification in qualitative research (Guest, Bunce, & Johnson, 2006).

In the barrios of Corcovada and Mariana, community leaders knew the reasons for their community-based organization, how their networks have

expanded throughout the years, their community values, objectives, and how resources were brought into the community after Hurricane María. In the case of Corcovada, 12 community leaders make up the board of directors and in Mariana 9 community leaders make up their board of directors. After contacting all the community leaders in each site through social media and by phone, 7 community leaders in Corcovada and 6 community leaders in Mariana agreed to be interviewed for a 60 percent response rate of total community leadership. Table 1 provides an overview of the leadership roles in the organization.

Interviews lasted from 25 up to 60 minutes depending on the comfort level and the details the participant wanted to share. We used a semi-structure interview protocol for this study to collect information concerning the challenges the community faced in the aftermath of Hurricane María and facts that explain success. At the same time, we addressed the communities' capacities in their organization, emergency management, collaborations, and ongoing efforts to mitigate future shocks. The interview protocol focuses on the role of "bonding, bridging, and linking" social capital played in the disaster recovery and how they contributed to their community resilience.

Data Analysis

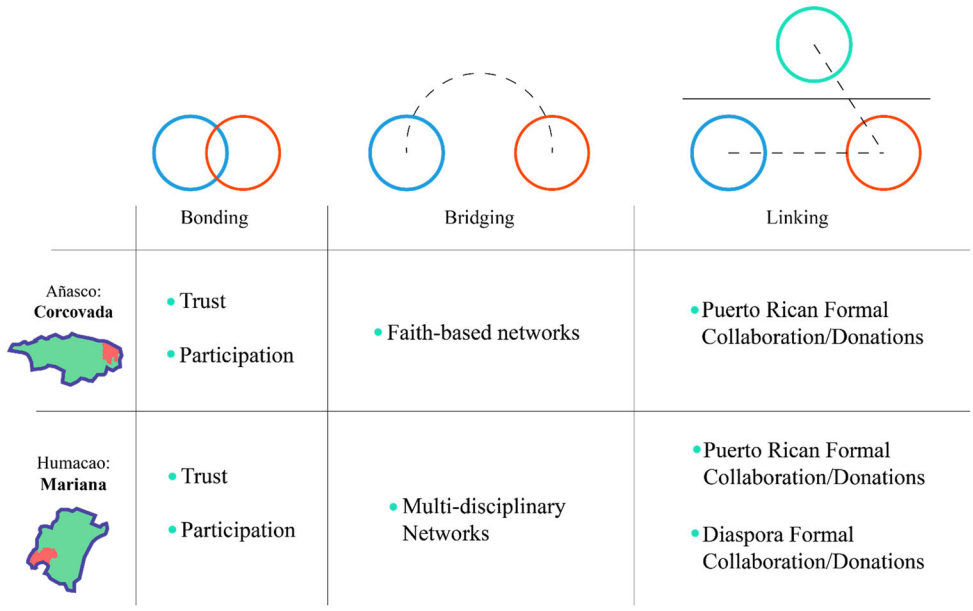
For the qualitative data analysis, the first step involved transcribing the interviews verbatim in Spanish and organizing the field notes from the interviews. MAXQDA 2018 was used for the data analysis (VERBI Software, 2017). Using the information and ideas generated by the participants, a theme identification was conducted in the three domains of social capital highlighted by the literature: bonding, bridging, and linking social capital. After coding the three domains in the interviews, subthemes for each type of social capital such as trust, active participation, multidisciplinary networks, and diaspora formal collaborations/donations were identified. We used established techniques for thematic analysis drawing from the work of Ryan and Bernard (2003) and Bernard, Wutich, and Ryan (2016). With such thematic analysis, we were able to show how each site used social capital in the aftermath of the disaster.

As our sample size was small, we were careful to use two other data sources for the purposes of triangulation and validating the results of our primary analysis: archival data and participant-observation (Yin, 1989). The archival cross-check drew from public documents volunteered by the community leaders. These documents were examined to provide a background on the community organization efforts and the different infrastructures used to reduce vulnerability post Hurricane María. The participant-observation cross-check drew from the first author's observations, photos in each field site as well as informal interactions with other members of the community.

Table 1. Participants in the Study

Key Informant Code	Gender	Position in Community Organization	Years in the Organization	Profession
PCI	Male	Community Aqueduct Manager	30	Electrical technician
PC2	Female	Secretary of Community Organization	10	Retired
PC3	Female	Coordinator of Community Engagement activities	5	Retired
PC4	Male	Operator of Community Aqueduct	25	Retired agronomist
PC5	Male	Board Member	6	Retired
PC6	Female	President	30	Business
PC7	Male	Board Member	20	Retired
PM1	Male	Board Member	30	Retired
PM2	Female	Community Organization Events Coordinator	4	Student
PM3	Male	Administrator of Community Organization	28	Retired teacher
PM4	Female	President	30	Retired teacher
PM5	Male	Coordinator in ARECMA Center for Community Transformation	2	Graduate student
PM6	Female	Secretary of Community Organization	25	Housewife

Table 2. Main Social Capital Themes Across Sites



Findings

In terms of preparation, participants in both neighborhoods recall that for Hurricane María they prepared individually for up to 2 weeks and some participants talked of personally not preparing for such an event. Reasons for not preparing included that they already had the needed supplies from Hurricane Irma (2 weeks before on September 6, 2017) and that they never expected María to have the impact that it did. However, as will be further detailed, the fostering of social capital during "normal times" throughout their organization and collaborations assisted in coping with eventual vulnerability in the recovery process.

As part of the thematic analysis, the three forms of social capital highlighted by the literature (bonding, bridging, and linking social capital) and the analyses of emerging subthemes capture how two community-based nonprofit organizations and their networks were valuable for disaster recovery in their rural communities. Concepts from Nakagawa and Shaw (2004) work on social capital at the Mano community in Kobe, Japan and Gujarat, India were used and modified for this thematic analysis. Table 2 summarizes the main themes across the two data groups.

Bonding Social Capital

For Corcovada, Añasco, the main challenges in the aftermath of the storm in terms of physical vulnerabilities were accessibility to enter the community (broken

trees, poles, and landslide) with three houses destroyed, baseball field and basketball court severely damaged, lack of electricity for 127 days and the community water aqueducts in need of a battery system or constant diesel to continue its operation. Social vulnerability was mainly expressed as food insecurity and needing medical supplies (specifically for those over 45 years). Such vulnerabilities were presented within the context of the Municipality of Añasco, where supermarkets, pharmacies, and banks closed or had limited supply the first week's post-disaster due to the power outages or damages to their infrastructure. The main themes that describe the role of individuals assisting their neighbors and community (bonding social capital) in the days following Hurricane María were trust and active participation. Referencing Nakagawa and Shaw (2004) work, trust is viewed as "sustained trust in the leader and among community members" and participation as "high level of participation of people in community activities and collective decision making through frequent community meetings" (p. 19).

In Corcovada, community leaders expressed bonding social capital in the aftermath of Hurricane María in the various ways the neighbors united to work on community needs. In terms of the physical infrastructure damage, community leaders interviewed in Corcovada explained how their members tackled some of these challenges. First, they gathered and used resources within the community such as diggers, bulldozers, and related machinery from the neighbors that work in agricultural and construction industries to create access to outside the community and for residents whose houses became isolated by landslides. In the process, members of the community including youth worked to take the trees and other obstructions out of the road. An example of this was presented by the following participants:

> "Quickly these people were all organized. They began with "machetes" (bowie knife) and different machines to remove everything from the streets. Adults and kids were assisting by taking out the pieces of wood, removing rocks and helping in anything that the machines couldn't reach". PC3

Even though most of the houses in Corcovada were built of cement, three houses made of wood collapsed. Community leaders gathered more than 20 residents and assisted in the reconstruction of two houses:

> "In one day, we reconstructed the house because they had children, one had three and the other had two and, in a day, we built 2 houses. I looked for 22 people, all carpenters to help in this process". PC1

As these examples show, the community understood the needs of such families that lost everything and actively participated in the reconstruction process. In addition, the Secretary of *the Communal Center of Corcovada* mentioned how their community-based organization gathered donations from the community and provided food and other necessities to such families to assist them in their recovery. She also expressed that there were high levels of participation and unity among the

residents and the community-based organization before Hurricane María. This can be attributed to their high-level organization as the community leaders meet at least once every month and they hold resident assemblies every six months. Moreover, as participants expressed, residents have been actively involved in community development projects such as in the re-design of a closed school in the barrio to have a gym, doctors office, computer room and the space for reunions and other community needs. In this sense, their civic engagement and active participation in the aftermath continued to be strong as every member in the household in one way or another actively engaged in the aftermath by either cleaning, gathering food for neighbors, doing lines at the gas station for their community aqueduct and giving emotional support when needed.

Similar to Corcovada, in Mariana, the community leaders presented elements of bonding social capital with examples by the ways in which the community members gathered to create access to the main roads and donated to residents of the barrio and nearby neighborhoods. In terms of physical infrastructure, the community leaders expressed physical isolation (as the roads were covered by trees and electrical poles), several houses with roofs blown away, community children's park destroyed, water insecurity, broken communication systems and power outages for 8 months as their main challenges. Regarding social vulnerabilities, food insecurity, access to medical supplies and mental health related situations were highlighted as main challenges.

Before María struck, community leaders reported that residents on average prepared individually for up to two weeks. Despite this, many community member's basic needs were not being met. Community leaders gathered in *la loma* (the hill) and decided to use the *Recreational and Educational Community Association of Barrio Mariana de Humacao* (ARECMA) cooking facilities and make a house by house announcement to make meals for the community and nearby neighborhoods for 3 months:

> "…30 people came to ARECMA cooking facility saying, "I am willing to cook". They arrived because they were in their homes without water, without light and alone. Single women, widows, women over 70 years saying, "I am, here willing to do something for my community". They arrived and started cooking. They were cooking for three consecutive months, from Monday sometimes until Saturday and Sunday. When we said to them "take a break" they said "no, because what am I going to do at home? There is no electricity at home, there is no water"". PM4

As this example shows, community members were very willing to assist in the cooking process as soon as they heard about the plan. Even though this dynamic was primarily aimed to provide food for the residents and nearby neighborhoods, it created an emotional support space for the people that wanted to talk, decompress and reflect about their post-Hurricane María realities.

In this effort, a group of women who became the main cooks for the community were key:

> "They were the ones who did everything. They were the ones who roamed around the space recovering people from the psychological, physical scourge that had happened here, because really, the devastation here was big. There was no water, in nine months we got the electricity back and in six months we got the water. That was a lot, a long critical period, but those women were there giving that solidarity hug, that strength and that energy that was necessary for the early recovery of this community". PM4

Trust in the community organization was demonstrated by respondents in their statements about the vital role that ARECMA played in the aftermath of the hurricane because of the island-wide humanitarian crisis. As expressed by one of the board members interviewed, ARECMA served as a platform to make decisions on issues that were affecting all the residents of the Mariana such as food insecurity and water scarcity. Likewise, the organization had the collaborative capacity to extend their resources to adjoining neighborhoods that shared vulnerabilities. These collaborative capacities from ARECMA community leaders were rooted in their work with residents in the areas of community empowerment and education. They had worked in community recreational projects (e.g., children playground) and had developed different facilities in the barrio such as a kitchen facility (which is used for cultural events), office space for reunions and a communal garden to mention a few.

> "The fight was strong and let me tell you that if Mariana had not been organized, many people from this neighborhood and people from Humacao neighborhoods would have suffer from starvation after the hurricane. What happened in Humacao was that even if people had money, especially those who had their food stamps, they could not use them either. There was no electricity, there was no ATM and if you do not have the foundation, as ARECMA had, it could not have helped the community". PM3

As this example demonstrates, ARECMA's organization in the aftermath was very important and necessary because it became the place to organize and tackle community-wide needs and even though people that had money in their banks could not access it because of the island-wide power outage. In this sense, their pre hurricane social and physical infrastructures allowed them to adapt and cope with the impact from María.

Bridging Social Capital

When describing the access to resources outside the community and creating linkages between groups, the two identified were "multidisciplinary networks" and "faith-based networks". Multidisciplinary networks are defined as "interaction with various stakeholders such as town-planning, consultants, academicians, other

community activity groups, other neighbors' associations, etc." (Nakagawa & Shaw, 2004, p. 11). Faith-based networks are defined as individual interactions and community member interactions with nearby churches and religious organizations for hurricane related assistance.

For Corcovada, the church played a vital role in gathering donations and other resources for the community. As explained by one of the board members interviewed, Corcovada's organization has its seeds in 1967, when a priest came to the community and started gathering residents under a mango tree. At the time, 35 families collaborated with him to construct a road for the community and a community water system to address their water insecurity. This history with faith-based entities (e.g., Catholic, Presbyterian, and Adventist) played an important role for residents to cope with Hurricane María. As an example, the Presbyterian and Catholic church assisted in bringing large water purifiers to the community and used their facilities as food collection center for further distribution throughout Corcovada. Also, in terms of preventing the community from water insecurity the Presbyterian church donated money to the communal committee for their water system to have a power plant as a back-up plan. Moreover, in terms of donations from adjoining neighborhoods, members of a fraternity association from a nearby community coordinated with the community-based organization committee and visited Corcovada to bring food and clothing donations for those in need.

> "The challenges were big, but the community took the street, cleared the roads, cut trees and they were working constantly in the community aqueduct. The church helped us a lot in this process. The Presbyterian church, the Catholic and other churches nearby brought food, water, and other provisions. The Presbyterian church at one point became a center for food and aid distribution". PC4

For Mariana, the church was also an entity that assisted the community in food provisions. As ARECMA made the announcement of bringing food donations to be cooked in their facilities for the community, a nearby church donated food to ARECMA. These donations and others from adjoining neighborhoods helped to feed over 400 people for three consecutive months. Moreover, as Mariana's community leaders had been collaborating with social worker students from the University of Puerto Rico at Humacao, community leaders got in contact with students from the nursing school as well to assist residents in need of health and social services. In this sense, community leaders spoke about the importance of their community-based organization as governmental institutions were incapable to assist in their immediate needs. In regards of the collaboration between the social worker students and ARECMA leaders, a participant expressed:

> "Students from the School of Social Work have helped us in an incredible way. They come to the facilities of ARECMA and we have conversations about the research they will do based on the needs we have. After María they helped use greatly doing household surveys of the needs in the

community. Also, they provided information to residents in areas of physical and mental health issues. We have a very good and close collaboration with then and the Social Work department". PM5

Linking Social Capital

Linking social capital is described as the relationship the community has with political institutions, private businesses and nonprofit organizations outside of the community that can bring resources into the community. Before Hurricane María, these two community-based organizations had established shared values and visions around renewable energy, self-management and the search for a better quality of life for their members, which served as the foundation for the extension of their network with institutions such as municipalities, universities and nonprofit organizations on community projects. However, in the aftermath of the hurricane, some of these networks were extended based on their established connections and the mobility of community leaders. For the two barrios, the main sub-themes were "Diaspora formal collaborations/donations" and "Puerto Rican formal collaborations/donations". Such definitions were modified from Nakagawa and Shaw (2004) definition of formal collaborations which are those "interactions with government officials through community development activities" (p. 19). Diaspora formal collaborations/donations is defined as United States or international nonprofit organization or businesses that assisted in the recovery process by sending resources such as donations or materials for a resilient recovery. Puerto Rican formal collaborations/donations are defined as partnerships with local, national or federal government, NGO's and private institutions partnerships or donations to assist in the recovery process.

In Corcovada, "linking" social capital was shown throughout formal collaborations with agencies such as the FEMA, the municipality of Añasco and Puerto Rican nonprofit organizations. Moreover, volunteers and donations from nonprofit organizations and mainland U.S. citizens going to the community as volunteers were also hidden by the participants. In terms of the formal collaboration's examples, the interviews talked about their necessity of diesel for their community water system power plant and a collaboration with FEMA and the municipality of Añasco was made to provide them gasoline and continue to give water service to the residents:

"FEMA also visited us after María, and we received diesel for the power plant that allowed the community aqueduct to keep functioning. We were 127 days without electricity services so in this process FEMA filled out our documents and through the municipality of Añasco we got diesel for the power plant. That way we could stop doing the long lines in the gas stations where sometimes there was no gasoline when we got to the front of the line after waiting for hours". PC6

Furthermore, nonprofit organizations such as "Fundación Comunitaria de Puerto Rico", "Somos Solar," and church volunteers from the continental U.S. assisted in the recovery process throughout formal collaborations or bringing donations. In Corcovada, the community had been trying for 3 years prior to Hurricane María to have alternative energy systems for their community aqueduct and got it installed two months prior to the hurricane. However, they lacked a battery backup system when María and they could not use the solar panels to operate the aqueduct.

> "… the system was installed two months prior to the hurricane and when María arrived [laughs out loud] we were left without anything, because we did not have the batteries. That project cost $ 89,000 without the battery system but at that time, we did not know the importance of having the battery. María was the one who woke us up and made us see that there are other things that are thought as not important, but you don't see their value until you have stumbled on that problem. Once the hurricane passed, we said "and the solar panels?" If they do not have a battery how are we going to manage the aqueduct". PC6

The formal collaboration for diesel between the Municipality and FEMA helped avoid water outage. One participant explained that after a FEMA agent became aware of their situation and multiple calls were made, an alliance between the Puerto Rican renewable energy company "Máximo Solar", nonprofit promoter of renewable energy "Somos Solar" and "Fundación Comunitaria de Puerto Rico" a nonprofit dedicated to advance sustainable development in the island came to the community and agreed to finance the battery system the aqueduct needed to be made more resilient. In this alliance, an important element denoted by participants was the need to write a proposal. However, because some community leaders have taken workshops related to proposal writing, this allowed them to successfully present a proposal that would allowed their water system to be robust. In terms of international collaborations for the community, only the presence of the Mormon Church was highlighted as a group of volunteers assisted to re-construct one of the houses that was damaged by the hurricane.

In Mariana, most of their formal collaborations came from continental U.S. networks, businesses and international organizations that viewed what was occurring in the community (as the members used social media for their donation requests) and traveled to the community to serve as volunteers. However, they did create partnerships and received donations from Puerto Rican nonprofit organizations such as "La Maraña" and "Fundación Comunitaria de Puerto Rico". In this case, community leaders highlighted the role of the diaspora as important to coping with vulnerability in the aftermath of the disaster rather than the Municipality of Humacao or the FEMA, the community leaders denied the role of the municipality of Humacao and the FEMA and highlighted the role of the diaspora as important to cope with vulnerability in the aftermath of the disaster:

> "Well, the diaspora played a very important role. They had a concern for the families they had here and for the country. The diaspora mobilized

> resources and that helped us to have contacts for the needs of the community. Also, the organizations and individuals that visited brought food, water filters, first aid kits and related. Yes, although you would not believe it, the diaspora played a very important role because it helped us meet the needs we face here in Puerto Rico because we did not even have the basic services that one is supposed to have". PM2

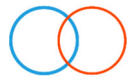
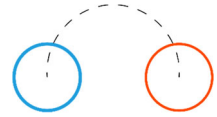
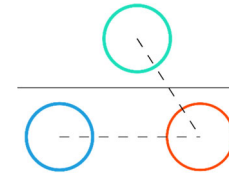
In Mariana, as the previous quote highlights, formal collaborations with external institutions assisted greatly in their recovery efforts. Examples included nonprofit organizations such as "Unlimited Possibilities" which sent 12 volunteers to the community to assist in repairing infrastructure in the community. In terms of a formal collaboration within Puerto Rico, community leaders talked about their ongoing work with the nonprofit organization "La Maraña". This collaboration assisted the community in the redevelopment of their community children's park and the creation of an emergency plan for any upcoming environmental disturbances. Regarding their community developed emergency plan:

> "We put all the houses of the barrio on a giant map with the help of the nonprofit organization "La Maraña". We went house by house and we have brought residents to identify where their house is. Also, we have filled out a form of how many people live in the house, how many are over 60 years of age, if there are children and or family members with disabilities. This to be able to identify the needs of the community and to find alternatives to assist residents in a quicker and effective way if another hurricane or related event happens". PM6

Along with formal collaborations for community development projects, Mariana received different types of donations mainly from nonprofit organizations from both U.S. continental and internationally. Examples of this include: WI-FI system for community members to contact their family in PR and outside of the island, water filters, solar lamps, solar system for the community center and monetary donations to buy food for the community kitchen among others. Additionally, one of the formal collaborations brought job opportunities for three members of the community so they could have employees working on some of their new proposals for the barrio. This was highlighted by the community leaders as vital in advancing their projects as they required documentation on the objective for the project, community impact and financial administration.

As noted previously, before Hurricane María, the community had rescued the elementary school Juan de Dios elementary school (which was closed by the Department of Education) before Hurricane María to create a center for community necessities. After the hurricane, the community and it has received various donations to also enable the community to use the center as a post-disaster space to attend for meeting community needs such as a shelter. This repurposed school now will have a library, hostel, solar solar-operated laundry facilities, tools storage (mechanics/street cleaning tools), an art gallery, and a health clinic with nurses and

Table 3. Summary of Social Capital Actions in Both Communities

	 Bonding	 Bridging	 Linking
Añasco: **Corcovada** 	Use of community organization facility to take decisions and act on problems affects all the residents including access to community and food provision. Resources gathering within community to cope with the events.	Support through donation from faith-based organizations (e.g., Prebsterian church), the University (e.g., UPR-Mayaguez) and donations from entities such as Unniversity fraternity groups.	Use of pre-exixting neyworks (i.e., Municipality of Añasco) and new relations with government organization (i.e., Federal Emergency Management Agency [FEMA]), nonprofit and profit organizations from Puerto Rico to address community resilience.
Humacao: **Mariana** 	Use of community organization facility to take decisions and act on problems affects all the residents including access to community and food provision. Re-sources gathering within community to cope with the events.	Support through donation from adjoin neighborfood and the University (e.g., UPR-Humacao) to aid in identified resident needs.	New relations with Puerto Rican nonprofit organization. Network expansion to profit and nonprofit organizations ouside of Puerto Rico to address community resilience.

social workers from the University of Puerto Rico, Humacao to assist the community. Donations and formal collaborations were highlighted by the participants to be very important in accelerating the remodeling of the school to be used by the public. Moreover, to present an overview of the findings Table 3 provides a summary of how Corcovada and Mariana used social capital in the aftermath of María.

Discussion

Hurricane María transformed the daily routine of 3.2 million people as they had to visit designated areas for water collection, families were displaced, and people had to wait in long lines for gasoline among other challenges. In the broader context of the deficiencies of the government and the dynamics island-wide in the aftermath of this event, the primary objective of this study was to evaluate the role of social capital in enhancing post-disaster community resilience. Although they have not been able to address all their vulnerabilities due to challenges associated to financial

constraints, community leaders in Corcovada and Mariana have reflected and acted on community projects to increase resilience.

For Corcovada, community leaders expressed that their partnership for the batteries for their community water system solar panels has already increased their community resilience for future events as it provides water security for their residents and adjoining barrios. They are currently in communication with engineering professors at the University of Puerto Rico, Mayaguez Campus (UPRM) and nonprofit organizations to have renewable energy systems installed for all the residents of the barrio as they acknowledged the cascading effects of energy outage as one of the biggest challenges for any future event. Similarly, they have partnered with UPRM Community Development Institute for students to do community-based participatory research in the barrio and provide data that can reduce their vulnerability. In the case of Mariana, the hurricane provided the opportunity to advance their community project *Centro de Transformación* (Center for Transformation) in the repurposed school with essentials for disaster scenarios such as solar-powered laundries, health clinic, shelter space, agricultural garden, and water filters. Additionally, finalizing an emergency plan for the barrio which will show the location of each household with information about elderly populations and, critical health situations (e.g., disabilities) to better know where those at most risk are, and how to proceed during environmental disturbance.

Theoretical and Practical Contributions

The literature on social capital and community resilience has shown that in the aftermath of a disaster when government and markets fail, social capital can fill the gap for resource allocation (Aldrich et al., 2015). Social capital alone, however, is not sufficient to achieve disaster recovery and resilience (Jovita, Nashir, Mutiarin, Moner, & Nurmandi, 2019; Nakagawa & Shaw, 2004; Williamson, 2013). In this context, we need to know more about the role of community-based nonprofit organizations in the aftermath of a disaster as it is poorly documented but can be potentially powerful for understanding how social capital can advance community resilience-oriented projects. The findings provide a better understanding of these organizations' role from a community leadership perspective and advance the literature on social capital for disaster resilient communities. The study denotes community-based organizations as institutions where social capital is fostered and strengthened in times of stress. The implications from this study shows that pre-disaster social organization, community planning, and interactions add significant resiliency after a disaster, especially in organizing communities to take action. For communities with economic limitations, the study also found that the community-based organizations provide credibility for substantial donations and other resources to advance community projects while expanding their connections to obtain new financial support.

Pre-planning for resiliency as part of a social organization's mission or vision enhances the actualization of plans for making resilience happen. In this

sense, social capital can be viewed as a means for resiliency if the community identifies it as a goal and can use a catastrophic event such as Hurricane María as a window of opportunity to receive economic and social support for their community agenda. Additionally, the combination of maintenance of the social organization, long-term leadership, and adaptation to new ideas through active participation of the members allowed these two communities to reduce vulnerability in the aftermath of the extreme event. The community leaders have built capacity for planning and community involvement through enhancement of lessons learned from previous shocks and adapted their social capital to address present and future needs.

On the basis of the experiences of Corcovada and Mariana, social capital can become a powerful tool for barrios to obtain resources for their wellbeing using a bottom-up approach. To foster social capital, there is a need to prepare communities with participatory processes and activities such as community visioning exercises. These exercises allow community members to reflect and generate ideas of their desired future state and what is needed to achieve it. They also provide the space for self-identity, integration, and acknowledging their potential for cooperatives and advancing goals. Community-based or similar organizations can provide the foundation for social capital to constantly flourish. Having a community organization with a unified vision and mission allows other types of capacity building to take place and advance the community's objectives. An example of this are workshops that support community members in writing proposals. These workshops enable the community to articulate their desires as well as communicate how they will manage community development projects. Moreover, the community needs to nurture ties and personal relations with external networks to build partnerships across scales (local, national, and international). This is important as these partnerships will attract financial aid and educational resources for community knowledge and development.

Practical implications of this research also point to the need for institutions such as the municipality to seed social capital in their barrios. Municipalities can facilitate the gathering of residents and open the space for conversations on community well-being, trust, cooperation, networks, emergency management, vulnerabilities, and disaster risk reduction. This could provide the opportunity to start creating relationships with the local government and understanding the different capacities both groups have when a disaster strikes, while reflecting on their weaknesses and networks to reach in such difficult times. The government can also be a liaison for public–private partnerships that would mitigate vulnerabilities and flourish social, physical, and economic projects for community well-being. Although the Puerto Rican government has created a reform proposal for a socioeconomic transformation in Puerto Rico, there are no specifics on how such processes would be done at the municipality level nor how to advance community resilience. Hence, also being aware of Puerto Rico's financial crisis, community leaders, and the local government should focus on nurturing policy that can allow budget allocation from public and private

organizations that can address community disaster preparedness, disaster recovery, community resilience, and sustainability efforts. Generating such a funding mechanism will aid communities with scare financial resources to better carry out responsibilities when government fails to do so and address resiliency in the recovery process.

Limitations and Future Research

In terms of limitations of this study, time and the availability to interview more community leaders were the main constraints. Similarly, the findings of this work cannot be generalized to the experiences of other barrios in these two municipalities. Another limitation was that this was not a comparative case study as the research design did not have any "failure" cases. This is a limitation in terms of supporting the fact that social capital ensures and enhances disaster resilience. Given these limitations, the importance of these findings relies in presenting how two rural barrios used social capital to cope with the effects of Hurricane María during the recovery process and after the disasters to enhance community resilience. Future research should examine challenges and opportunities for the development of community-based organizations to address community resilience. Research should also explore what role, if any, governmental institutions, universities, private and nonprofit organizations can play in supporting the creation of community-based organizations that nurture social capital and advance community resilience.

Conclusions

Scholars have discussed the benefits of social capital in disaster recovery using case study approaches (Aldrich, 2012; Barone & Mocetti, 2014; Hawkins & Maurer, 2010; Islam & Walkerden, 2014; Nakagawa & Shaw, 2004). In Puerto Rico, scholars such as López-Marrero (2010) and Rivas (2018) have highlighted the need to study the operationalization of social capital for community well-being, adaptive capacity, and disaster recovery. The case studies in two rural barrios of Puerto Rico presented here highlight that social capital has the potential to support residents of a neighborhood in gathering, reflecting on, and accessing information. Likewise, mobilizing resources throughout their networks and acting upon their most pressing issues for community resilience. In terms of disaster response and recovery, community-based organizations provide a foundation for members of a group to congregate with the common objective of evaluating their main challenges in terms of hazards exposure and use their social capital and social organization to look for alternatives and reduce vulnerabilities.

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References

80 Grados. 2018. *Comunidad ilumina "su imaginación" en Mariana, Humacao* (May 25). http://www.80grados.net/comunidad-ilumina-su-imaginacion-en-mariana-humacao/

Acevedo, Nicole. 2019. "Housing is Key to Puerto Rico's Recovery. Will 2019 See Promised Funding, Solutions?" *NBC News* (February 4). https://www.nbcnews.com/news/latino/housing-key-puerto-rico-s-recovery-will-2019-see-promised-n959776

Adger, W. Neil. 2000. "Social and Ecological Resilience: Are They Related?" *In: Progress in Human Geography* 24 (3): 347–64, https://ezproxy1.lib.asu.edu/10.1191/03091320070154

Adler, Paul S., and Seok-Woo Kwon. 2002. "Social Capital: Prospects for a New Concept." *Academy of Management Review* 27 (1): 17–40.

Aldrich, Daniel P., Michelle A. Meyer, and Courtney Page-Tan. 2018. "Social Capital and Natural Hazards Governance—Oxford Research Encyclopedia of Natural Hazard Science." *ORE Natural Hazards* https://works.bepress.com/daniel_aldrich/43/

Aldrich, Daniel P. 2012. "Building Resilience: Social Capital in Post-Disaster Recovery, University of Chicago Press, 2012." *Japanese Journal of Political Science* 15 (1): 153–58.

Aldrich, Daniel P., and Michelle A. Meyer. 2015. "Social Capital and Community Resilience." *American Behavioral Scientist* 59 (2): 254–69, https://ezproxy1.lib.asu.edu/10.1177/0002764214550299

Aldrich, Daniel P., Oum Sothea, and Sawada Yasuyuki. 2015. *Resilience and Recovery in Asian Disasters: Community Ties, Market Mechanisms, and Governance*. Tokyo: Springer Japan.

Barasa, Beatrice. 2018. "Increased Incidences, Intensity and Scope of Disasters: Manifestation of Unsustainable Development Practices." *Environment Pollution and Climate Change* 2 (2): 154, https://ezproxy1.lib.asu.edu/10.4172/2573-458X.1000154

Barker, David. 2012. "Caribbean Agriculture in a Period of Global Change: Vulnerabilities and Opportunities." *Caribbean Studies* 40 (2): 41–61.

Barone, Guglielmo, and Sauro Mocetti. 2014. "Natural Disasters, Growth, and Institutions: A Tale of Two Earthquakes." *Journal of Urban Economics* 84: 52–66.

Beekman, Gonne, C. Martijn van der Heide, Wim J. M. Heijman, and Marleen A. H. Schouten. 2009. "Social Capital and Resilience in Rural Areas: Responses to Change." Working Paper Mansholt Graduate School of Social Sciences.

Bernard, H. Russell, Amber Wutich, and Gery W. Ryan. 2016. *Analyzing Qualitative Data: Systematic Approaches*. Thousand Oaks, CA: Sage Publications.

Buckman, Stephen, and Nelya Rakohimova. 2017. "Resilience: An Innovative Approach to Social, Environmental, and Economic Urban Uncertainty." In *Sustainability for the 21st Century: Pathways, Programs, and Policies*, 2nd ed., David Pijawka. Dubuque, IA: Kendall Hunt Publishing. 78–124.

Caro, Leysa. 2019. "Las vidas que aún habitan bajo el toldo de FEMA." *El Nuevo Día* (September 20). https://www.elnuevodia.com/noticias/locales/nota/lasvidasqueaunhabitanbajoeltoldodefema-2494479/

Cheshire, Lynda, Javier Esparcia, and Mark Shucksmith. 2015. "Community Resilience, Social Capital and Territorial Governance." *Ager: Revista De Estudios Sobre Despoblacion Y Desarrollo Rural* 18: 7.

Clement, Scott, Zezima, Katie, and Guskin, Emily. 2018. "PUERTO RICO AFTER MARIA: Residents See a Failure at All Levels of Government." *The Washington Post* (September 12). https://www.washingtonpost.com/news/national/wp/2018/09/12/feature/residents-see-a-failure-at-all-levels-of-government/?utm_term=.4d7c83fee61c

Coles, Eve, and Philip Buckle. 2004. "Developing Community Resilience as a Foundation for Effective Disaster Recovery." *The Australian Journal of Emergency Management* 19 (4): 6–15.

COR3. 2018. "Puerto Rico's Government Reform Program: A New Path Forward." *Government of Puerto Rico*. https://cor3.pr/assets/documents/PPPR-PlanParaPuertoRico(EnglishVersion)-2016.pdf

Creswell, John W., and John D. Creswell. 2018. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks, CA: Sage Publications.

Creswell, John W., and Vicki L. Plano Clark. 2011. *Designing and Conducting Mixed Method Research*, 2nd ed. Thousand Oaks, CA: Sage Publications.

Cutter, Susan L. 1996. "Vulnerability to environmental hazards." *Progress in Human Geography* 20 (4): 1529–39, https://ezproxy1.lib.asu.edu/10.1177/030913259602000407

Delgado, José. 2018. Buscan establecer la "autogobernanza comunitaria" en un barrio de Humacao: La comunidad de Mariana forma una poderosa alianza que surgió luego del huracán María. *El Nuevo Día*. https://www.elnuevodia.com/videos/buscanestablecerlaautogobernanzacomunitariaenunbarriodehumacao-video-245646

Donner, William, and Rodriguez, Havidan. 2011. Disaster Risk and Vulnerability: The Role and Impact of Population and Society (January 8). https://www.prb.org/disaster-risk/

Diaz, Ricardo. 2013. "Barrio Mariana: Una historia de panas y la posibilidad de otro Puerto Rico." *Noticel* (January 20). https://www.noticel.com/la-calle/barrio-mariana-una-historia-de-panas-y-la-posibilidad-de-otro-puerto-rico/607775631

Eakin, Hallie, Tischa Muñoz-Erickson, and Maria Lemos. 2018. "Critical Lines of Action for Vulnerability and Resilience Research and Practice: Lessons from the 2017 Hurricane Season." *Journal of Extreme Events* 05 (02n03): 1850015, https://10.1002/10.1142/S234573761850015X

Echenique, Martín. 2017. "The Power of Puerto Rico's Mayors." *City Lab* (October 03). https://www.citylab.com/environment/2017/10/power-of-puerto-rican-mayors/541800/

Fritz, Angela. 2017. *Puerto Rico Has a Long History With Tropical Storms. None of Them Were Like Hurricane Maria*. https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/09/19/puerto-rico-has-a-long-history-with-tropical-storms-none-of-them-were-like-hurricane-maria/?noredirect=on&utm_term=.1dba853282eb

García-López, Gustavo. 2018. "The Multiple Layers of Environmental Injustice in Contexts of (Un) natural Disasters: The Case of Puerto Rico Post Hurricane Maria." *Environmental Justice* 11 (3). https://doi.org.10.1002/10.1089/env.2017.0045

Gilbert, Claude. 1998. "Studying Disaster." In *What is a Disaster: Perspectives on the Question*, ed. E. L. Quarantelli. London: Routledge. 11–8.

Guest, Greg, Arwen Bunce, and Laura Johnson. 2006. "How Many Interviews Are Enough? An Experiment With Data Saturation And Variability." *Field Methods* 18 (1): 59–82.

Hawkins, Robert L., and Katherine Maurer. 2010. "Bonding, Bridging and Linking: How Social Capital Operated in New Orleans Following Hurricane Katrina." *British Journal of Social Work* 40 (6): 1777–93.

Holling, Crawford S. 1973. "Resilience and Stability of Ecological Systems." *Annual Review of Ecology and Systematics* 4 (1): 1–23.

Hutanuwatr, Khanin, Bob Bolin, and David Pijawka. 2013. Chapter 5: Vulnerability and Disaster in Thailand: Scale, Power, and Collaboration in Post-Tsunami Recovery, *Forces of Nature and Cultural Response*. Netherlands: Springer. 69–92, ISBN: 9789400750005.

Imperiale, Angelo J., and Frank Vanclay. 2016. "Experiencing Local Community Resilience in Action: Learning from Post-Disaster communities." *Journal of Rural Studies* 47: 204–19.

Islam, Rabiul, and Greg Walkerden. 2014. "How Bonding and Bridging Networks Contribute to Disaster Resilience and Recovery on the Bangladeshi Coast." *International Journal of Disaster Risk Reduction* 10: 281–91, https://10.1002/10.1016/j.ijdrr.2014.09.016

Jovita, Hazel D., Haedar Nashir, Dyah Mutiarin, Yasmira Moner, and Achmad Nurmandi. 2019. "Social Capital and Disasters: How Does Social Capital Shape Post-Disaster Conditions in the Philippines?" *Journal of Human Behavior in the Social Environment* 29 (4): 519–34, https://10.1002/10.1080/10911359.2018.1556143

Kapucu, Naim. 2011. "Social Capital and Civic Engagement." *International Journal of Social Inquiry* 4 (1): 23–43. http://dergipark.gov.tr/download/article-file/164113

Kapucu, Naim, Christopher Hawkins, and Fernando Rivera. 2013. "Disaster Preparedness and Resilience for Rural Communities." *Risk, Hazards & Crisis in Public Policy* 4 (4): 215–33. https://onlinelibrary.wiley.com/doi/epdf/10.1002/rhc3.12043

Kates, Robert W., and David Pijawka. 1977. "Chapter 1: From Rubble to Monument: The Pace of Recovery." In *Reconstruction Following Disaster*, eds. J. E. Haas, R. W. Kates, and M. J. Bowden. Cambridge, MA: US The Massachusetts Institute of Technology. 1–23.

Keck, Markus, and Patrick Sakdapolrak. 2013. "What Is Social Resilience? Lessons Learned and Ways Forward." *Erdkunde* 67 (1): 5–19, https://10.1002/10.3112/erdkunde.2013.01.02

Kim, Jooho, and Makarand Hastak. 2018. "Social Network Analysis: Characteristics of Online Social Networks After a Disaster." *International Journal of Information Management* 38 (1): 86–96.

Lewis, Rachel. 2017. "Is Puerto Rico Part of the U.S? Here's What to Know." *Times* (September 26). http://time.com/4957011/is-puerto-rico-part-of-us/

Lindell, Michael K., Carla S. Prater, and Ronald W. Perry. 2007. *Introduction to Emergency Management*. Hoboken, NJ: Wiley.

Lluveras, L. 2018. "One Year Later, Puerto Rico Still Hasn't Recovered From Hurricane Maria." *Global Citizen* (September 20). https://www.globalcitizen.org/en/content/puerto-rico-slow-recovery-hurricane-maria/

López-Marrero, Tania del Mar. 2008. "Adaptive Capacity and Resilience to Floods in the Caribbean: A Case Study of Two Flood-Prone Communities in Puerto Rico."

Maguire, B., and P. Hagan. 2007. "Disasters and Communities: Understanding Social Resilience." *Australian Journal of Emergency Management* 22 (2): 16–20. https://search.informit.com.au/documentSummary;dn=839750155412061;res=IELHSS

Map of Barrio Corcovada de Añasco, Puerto Rico. 2019a. *Google maps*. https://goo.gl/maps/e6yk5526LSsrZS5W7

Map of Barrio Mariana de Humacao, Puerto Rico. 2019b. *Google maps*. https://goo.gl/maps/pRbGy7nqQgFuLPv3A

Masterson, Jaimie H., Walter G. Peacock, Shannon S. Van Zandt, H. Grover, Lori F. Schwarz, and John T. Cooper. 2014. Planning for Community Resilience: A Handbook for Reducing Vulnerability to Disasters, 3rd ed. Washington, DC: Island Press.

Mayunga, Joseph. 2007. "Understanding and Applying the Concept of Community Disaster Resilience: A Capital-Based Approach (Summer Academy for Social Vulnerability and Resilience Building)." *Landscape Architecture* 7:22–28.

Mazzei, Patricia. 2019. "Hunger and an 'Abandoned' Hospital: Puerto Rico Waits as Washington Bickers." *The New York Times* (April 7). https://www.nytimes.com/2019/04/07/us/puerto-rico-trump-vieques.html

Mimura, Nubuo, Leonard Nurse, Roger McLean, John Agard, Lino Briguglio, Penehuro Lefale, and Rolph Payet et al. 2007. Small Islands. Climate Change 2007: Impacts, Adaptation and Vulnerability, *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press. 687–716.

Minamoto, Yuriko. 2010. "Social Capital and Livelihood Recovery: Post-tsunami Sri Lanka as a Case." *Disaster Prevention and Management: An International Journal* 19 (5): 548–64. https://10.1002/10.1108/09653561011091887

Murphy, Brenda L. 2007. "Locating Social Capital in Resilient Community-Level Emergency Management." *Natural Hazards* 41 (2): 297–315.

Méheux, Kirstie, Dale Dominey-Howes, and Kate Lloyd. 2007. "Natural Hazard Impacts in Small Islands Developing States: A Review of Current Knowledge and Future Research Needs." *Natural Hazards* 40: 429–46.

Nakagawa, Yuko, and Rajib Shaw. 2004. "Social Capital: A Missing Link to Disaster Recovery." *International Journal of Mass Emergencies and Disasters* 22 (1): 5–34.

National Weather Services. 2017. *Major Hurricane Maria* (September 20). https://www.weather.gov/sju/maria2017

Norris, Fran H., Susan P. Stevens, Betty Pfefferbaum, Karen Wyche, and Rose L. Pfefferbaum. 2008. "Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness." *American Journal of Community Psychology* 41 (1–2): 127–50.

Pares, Marga, and Caro, Leysa. 2018. "Los municipios luchan para levantarse tras el paso de María." *EL Nuevo Día* (January 19). https://www.elnuevodia.com/noticias/locales/nota/losmunicipiosluchanparalevantarsetraselpasodemaria-2391207/

Patel, Sonia, M. Brooke Rogers, Richard Amlôt, and G. James Rubin. 2017. "What Do We Mean by 'Community Resilience'? A Systematic Literature Review of How It Is Defined in the Literature." *PLoS Currents* 9: 9.

Patton, Michael Quinn. 2002. *Qualitative Research and Evaluation Methods*, 3rd ed. Thousand Oaks, CA: Sage Publications.

Pelling, Mark. 2003. *The Vulnerability of Cities: Natural Disasters and Social Resilience*. Earthscan.

Pretty, Jules. 2003. "Social Capital and the Collective Management of Resources." *Science* 302 (5652): 1912–14, https://10.1002/10.1126/science.1090847

Primera, Hora. 2008. "A flote por obra y gracia del agua." *Primera Hora* (July 28). https://www.primerahora.com/noticias/puerto-rico/nota/afloteporobraygraciadelagua-214373/

Putnam, Robert. 1993. *Making Democracy Work*. Princeton, NJ: Princeton University Press.

———. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York, NY: Simon and Schuster.

Quarantelli, Enrico L. 2005. "A Social Science Research Agenda for the Disasters of the 21st Century." In *What Is a Disaster: New Answers to Old Questions*, eds. R. W. Perry, and E. L. Quarantelli. Philadelphia: Xlibris Publishers. 325–96.

Rivera, Jason D., and Ashley E. Nickels. 2014. "Social Capital, Community Resilience, and Faith-Based Organizations in Disaster Recovery: A Case Study of Mary Queen of Vietnam Catholic Church." *Risk, Hazards & Crisis in Public Policy* 5 (2): 178–211. https://pdfs.semanticscholar.org/c517/099c5a589aa3fb18acba7aa302167fb65a1d.pdf

Rodriguez-Díaz, Carlos. 2018. "Maria in Puerto Rico: Natural Disaster in a Colonial Archipelago." *American Public Health Association* 108 (1): 30–2. https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.2017.304198

Ross, Ashely D. 2016. "Perceptions of Resilience Among Coastal Emergency Managers." *Risk, Hazards & Crisis in Public Policy* 7 (1): 4–24. https://10.1002/10.1002/rhc3.12092

Ross, Steven. 2018. *Puerto Rico's Slow Recovery Leaves Health System Exposed for Next Major Storm* (September 8). https://www.modernhealthcare.com/article/20180908/NEWS/180909959/puerto-rico-s-slow-recovery-leaves-health-system-exposed-for-next-major-storm

Rossello, Ricardo, August 30, 2018. https://www.scribd.com/document/387440782/fema

Ryan, Gery, and H. Russell Bernard. 2003. "Techniques to Identify Themes." *Field Methods* 15: 85–109, https://10.1002/10.1177/1525822X02239569

Sherrieb, Kathleen, Fran H. Norris, and Sandro Galea. 2010. "Measuring Capacities for Community Resilience." *Social Indicators Research* 99 (2): 227–47.

Thomas, Kimberly, R. Dean Hardy, Heather Lazrus, Michael Mendez, Ben Orlove, Isabel Rivera-Collazo, and Robert Winthrop et al. 2019. "Explaining Differential Vulnerability To Climate Change: A Social Science Review." *Climate Change* 10 (2): E565. https://doi.org.ezproxy1.lib.asu.edu/10.1002/wcc.565

Tierney, Kathleen. 2013. "Only Connect!" Social Capital, Resilience, and Recovery." *Risk, Hazards & Crisis in Public Policy* 4 (1): 1–5. https://10.1002/10.1002/rhc3.20

Timmerman, Peter. 1981. *Vulnerability, Resilience and the Collapse of Society: A Review of Models and Possible Climatic Applications*. Toronto, Canada: Institute for Environmental Studies, University of Toronto.

U.S. Census Bureau. 2012. *2010 Census of Population and Housing, Population and Housing Unit Counts*. Washington, DC: U.S. Government Printing Office.

VERBI Software. 2017. *MAXQDA 2018 Online Manual*. https://www.maxqda.com/help-max18/welcome

Wilson, Geoff. 2012. *Community Resilience and Environmental Transitions*. Routledge.

Williamson, Thad. 2013. "Beyond Social Capital: Social Justice in Recovery and Resilience." *Risk, Hazards & Crisis in Public Policy* 4 (1): 28–31, https://10.1002/10.1002/rhc3.25

Wisner, Benjamin. 2016. "Vulnerability as Concept, Model, Metric, and Tool." *Oxford Research Encyclopedia of Natural Hazard Science* 1–50, https://10.1002/10.1093/acrefore/9780199389407.013.25

Yglesias, Matthew. 2018. "The Shocking Truth About the Hurricane Maria Death Toll Is Our Trump Nightmare Made Real." *VOX* (May 30). https://www.vox.com/2018/5/30/17407750/puerto-rico-maria-death-toll

Yin, Robert K. 1989. *Case Study Research: Design and Methods*, 2nd ed. London, UK: Sage Publications Inc.

Zhang, Qiaoyun. 2016. "Disaster Response and Recovery: Aid and Social Change." *Annals of Anthropological Practice* 40 (1): 86–97.

Appendix

Table A1. Archival Documents

Community	Document Title	Link of Document	Type of Document
Corcovada	Una organización promueve el acceso sostenible a recursos	https://www.elnuevodia.com/noticias/locales/nota/unaorganizacionpromueveelaccesososteniblearecursos-2451482/	Newspaper
Corcovada	Viven rodeados de animales muertos en Añasco	https://www.elnuevodia.com/noticias/locales/nota/vivenrodeadosdeanimalesmuertosenanasco-2362970/	Newspaper
Corcovada	Añasqueños se hidratan con agua de coco	https://www.elnuevodia.com/noticias/locales/nota/anasquenossehidratanconaguadecoco-2362971/	Newspaper
Corcovada	Comité Comunal de Corcovada: Servicios a la comunidad	https://comitecomunalcorcovada.weebly.com/servicios-a-la-comunidad.html	Community website
Corcovada	CENTROS TECNOLÓGICOS COMUNITARIOS—Corcovada	https://www.ctcpr.org/ctc-corcovada	Community organization website
Corcovada	Acueducto Comunal de Corcovada en Añasco asegura acceso ininterrumpido de agua potable a 600 residentes	https://www.fcpr.org/2018/09/17/acueducto-comunal-de-corcovada-en-anasco-asegura-acceso-ininterrumpido-de-agua-potable-a-600-residentes/	Blog article
Corcovada	SITUACIÓN POR MUNICIPIO: Añasco	https://huracanmaria.elnuevodia.com/2017/municipio/anasco/	Newspaper
Corcovada	El alcalde de Añasco perdió su casa y tuvo que "mudarse" a la alcaldía	https://www.elnuevodia.com/noticias/locales/nota/elalcaldedeanascoperdiosucasaytuvoquemudarsealaalcaldia-2373735/	Newspaper
Corcovada	Añasco (Puerto Rico) después del paso del huracán María: últimas noticias	https://www.univision.com/noticias/huracan-maria/anasco-puerto-rico-despues-del-paso-del-huracan-maria-ultimas-noticias	News report
Corcovada	CORPORATION INFORMATION: COMITE COMUNAL DE CORCOVADA, INC.	https://prcorpfiling.f1hst.com/CorpInfo/CorporationInfo.aspx?c=20259-121	Government document
Corcovada	A flote por obra y gracia del agua	https://www.primerahora.com/noticias/puerto-rico/nota/aflotepor obraygraciadelagua-214373/	Newspaper
Corcovada	Plan estratégico de emergencia (Añasco) PPT	https://documentcloud.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3Aa9bc9c3d-3903-483b-843b-84310b9366d3	Local government document
Mariana	Asociación Recreativa y Educativa Comunal del Barrio Mariana De	https://arecma.wixsite.com/arecma	Community organization

(*Continued*)

Community	Document Title	Link of Document	Type of Document
	Humacao, Inc.		website
Mariana	SITUACIÓN POR MUNICIPIO Humacao	https://huracanmaria.elnuevodia.com/2017/municipio/humacao/	Newspaper
Mariana	Extreme conditions spur innovative community response	https://www.unidosporpuertorico.com/extreme-conditions-spur-innovative-community-response/	Government website
Mariana	Los vecinos de Mariana levantan su antiguo barrio	https://www.elnuevodia.com/noticias/locales/nota/losvecinosdemarianalevantansuantiguobarrio-2403566/	Newspaper
Mariana	La actividad comercial agoniza en Humacao	https://www.elnuevodia.com/noticias/locales/nota/laactividadcomercialagonizaenhumacao-2424961/	Newspaper
Mariana	Angustia y desesperación en OMME de Humacao	https://www.elnuevodia.com/noticias/locales/nota/angustiaydesesperacionenommedehumacao-2359105/	Newspaper
Mariana	Humacao quedó irreconocible	https://www.elnuevodia.com/noticias/locales/nota/humacaoquedoirreconocible-2359511/	Newspaper
Mariana	How One Small Town In Puerto Rico Found Food And Community After Maria	https://www.buzzfeednews.com/article/mollycrabapple/how-one-small-town-in-puerto-rico-found-food-and-community	Newspaper
Mariana	Proyecto de Apoyo Mutuo—ARECMA Mariana	https://www.mariafund.org/arecma	Community organization website
Mariana	MARIANA, UNA HISTORIA ENTRE PANAS: Sistematización de experiencias de la Asociación Recreativa y Educativa Comunal del Barrio Mariana, Inc. (ARECMA) desde los procesos previos a su organización, sus estrategias de movilización y el desarrollo sustentable de la organización en Humacao	http://www.ts.ucr.ac.cr/binarios/pela/pl-000554.pdf	Unpublished Master Thesis

Table A2. Field Notes From Community Visits

Community	Date of Visit	Observation Site	Social Contexts Observed	Main Data Collection Modality	Data Collected by Topic
Mariana	December 29, 2018	Community crosswalk	Private homes, lunch service at ARECMA facility	Unstructured interviews and photos	Water and energy provision; community history; kitchen and restroom facilities
Mariana	December 30, 2018	Community crosswalk	Repurposed school by ARECMA to provide resources to the community	Participant observation and photos	Renewable energy; laundry facility; library; community services post-hurricane María
Mariana	December 31, 2018	Community crosswalk	ARECMA facility; ARECMA farm and community crosswalk	Participant observation	Reconstruction of facility; social networks; cooperation among residents
Mariana	January 2, 2019	Community crosswalk	Private homes and children's park	Participant observation and photos	Affected homes; water storage; community interactions
Corcovada	January 3, 2019	Community crosswalk	Private homes, community center and repurposed school	Participant observation and photos	Community service; technology space; gym and recreational space
Corcovada	January 4, 2019	Community crosswalk	Community aqueducts	Unstructured interview and direct observation	Renewable energy system
Corcovada	January 5, 2019	Community crosswalk	Community center and church facilities	Participant observation and photos	Water storage capacity; cooperation
Corcovada	January 6, 2019	Community event	Community center	Participant observation and photos	Community unity; cultural event
Corcovada	January 7, 2019	Community crosswalk	Community center, private homes	Participant observation	Cooperation among residents; community leader interactions