## Original Research

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# Resilience of Communities in Puerto Rico Following Hurricane Maria: Community-Based Preparedness and Communication Strategies

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## Abstract

**Objective:** This study aimed to examine factors that may have contributed to community disaster resilience following Hurricane Maria in Puerto Rico.
**Methods:** In April 2018, qualitative interviews (n = 22) were conducted with stakeholders in 7 Puerto Rican municipalities (9% of total). Transcripts were deductively and inductively coded and analyzed to identify salient topics and themes, then examined according to strategic themes from the Federal Emergency Management Association's (FEMA) *Whole Community Approach*.
**Results:** Municipal preparedness efforts were coordinated, community-based, leveraged community assets, and prioritized vulnerable populations. Strategies included (1) multi-sectoral coordination and strategic personnel allocation; (2) neighborhood leader designation as support contacts; (3) leveraging of community leader expertise and social networks to protect vulnerable residents; (4) Censuses of at-risk groups, health professionals, and first responders; and (5) outreach for risk communication and locally tailored protective measures. In the context of collapsed telecommunications, communities implemented post-disaster strategies to facilitate communication with the Puerto Rican Government, between local first responders, and to keep residents informed, including the use of: (1) police radios; (2) vehicles with loudspeakers; (3) direct interpersonal communication; and (4) solar-powered Internet radio stations.
**Conclusions:** Adaptive capacities and actions of Puerto Rican communities exemplify the importance of local solutions in disasters. Expanded research is recommended to better understand contributors to disaster resilience.

## Introduction

Hurricane Maria made landfall on September 20, 2017, as a Category 4 storm that devastated Puerto Rico, resulting in major damage to infrastructure and a lengthy and challenged recovery.[1–3] The Government of Puerto Rico's disaster plans, resources, and preparedness guidance to local communities were misaligned with the magnitude of this natural hazard, which severely limited the government's ability to reach local communities with aid and exchange timely and reliable information with residents.[4,5] In this context of catastrophic impact and delayed support, the experiences of local communities in Puerto Rico shed light on their important role in disaster resilience. With the increasing frequency and magnitude of natural hazards,[6,7] it is important to identify community-based solutions for risk reduction that employ local assets, capacities, and resources to address challenges and promote resilience.

Traditional risk management approaches rely heavily on government resources, yet increasing attention has been placed on engaging community stakeholders as legitimate partners in crisis preparedness and mitigation.[8–13] The literature proposes several resilience factors that contribute to disaster readiness[10,13–16] and several operational models to strengthen community disaster resilience.[8,12,17–20] These models describe how communities, through participatory processes with government entities, employ "adaptive capacities" to identify vulnerabilities and create solutions, thus fostering resilience.[14,21,22] A growing body of research shows that local-level social networks and communication strategies can support communities for greater resilience when government-centric models fail.[10,23] Locally, efforts supporting resilience span the disaster life cycle, and opportunities for communities to lead efforts can, in turn, contribute to greater efficiency and effectiveness.[8,10,11,13,14]

A study at the George Washington University (GW) estimated excess mortality, evaluated the death certification process, and assessed crisis and emergency risk communication by the Puerto Rican Government following Hurricane Maria.[4,5,24–26] While this study's original aims were to explore local community experiences regarding lives lost and examine handling of

mortality by disaster managers, this study also uncovered community narratives of resilience in the face of seemingly insurmountable adversity. This paper presents findings from a secondary analysis of the GW study data set, which explored local preparedness and response efforts that may have supported community resilience in the context of catastrophic disaster impact, limited outside response support, and delayed resources during an extended recovery. Recommendations regarding practice and future research are also offered.

## Methods

The analytical framework for this secondary analysis was informed by *A Whole Community Approach to Emergency Management* of the Federal Emergency Management Association (FEMA).[13] This approach outlines actionable strategic themes conceptualized as leading to enhanced community disaster resilience, including: (1) Understand community complexity; (2) Recognize community capabilities and needs; (3) Foster relationships with community leaders; (4) Build and maintain partnerships; (5) Empower local action; and (5) Leverage and strengthen social infrastructure, networks, and assets. Additionally, for this analysis, resilience was conceptualized as the linking of adaptive community capacities to protect against injury, sickness, or death, and to minimize disruption to services or resources after a disaster.[14] Since the *fostering of adaptive capacities for resilience begins well before disasters occur*, this analysis examined pre-hurricane community "preparedness" and post-hurricane "response" actions.

### Data Collection

As part of the GW study,[4] in-depth individual interviews (n = 22) with participants from 7 Puerto Rican communities (9% of municipalities) were conducted in April of 2018, or 7 months posthurricane. A semi-structured protocol was translated into Spanish, pilot tested, and approved by the GW Institutional Review Board to guide interviews. Interviews explored hurricane-related experiences and local preparedness, response, and recovery efforts from the perspective of representatives with specialized knowledge given their occupation/role in preparedness, local governance, or community leadership. Examples of standardized questions asked across all interviews for both pre- and post-hurricane time periods included: (1) Describe the experiences of your community or organization with Hurricane Maria (*probes:* Were people prepared for what happened? What kinds of damage occurred? Were there any injuries, illnesses, or deaths?); and (2) Describe public health and safety communications given/received for Hurricane Maria (*probes:* How was information provided? What was the information source/channel? Which communication channels were available post-hurricane?). Study participants were recruited by identifying and contacting municipal mayors, with additional participants recruited using snowball sampling. Municipalities were purposively sampled to represent all 6 regions and San Juan, and to exemplify a range of experiences given municipal diversity in socioeconomic status, political affiliation, terrain (mountainous vs coastal), geographic isolation, and health facility proximity. Additional sampling considerations included the ability to contact potential participants and access communities given persistent telecommunications outages and roadway blockages. Participants included municipal mayors, community leaders (ie, local civic organization leadership), first responders, faith leaders, health care providers, and

non-profit organization staff. In-person, Spanish-language interviews lasting approximately 1 hour each were conducted by 2 bilingual investigators experienced in qualitative methodologies and audio-recorded and transcribed in Spanish.

### Data Analysis

We coded Spanish transcripts using deductive and inductive coding. A codebook was developed to reflect a priori areas of inquiry derived from the interview protocol, and the set of codes augmented to account for participant responses outside of predetermined areas of inquiry (listed above). Data coding was accomplished using NVivo version 12 software (QSR International, Burlington, MA). To ensure coding reliability, each interview was coded by 1 investigator and reviewed by a second for discrepancies, with discrepant text segments resolved by agreement. Node reports were produced, consisting of Spanish language transcript excerpts by code. Node reports were analyzed to identify salient themes that represent response patterns, and as such, provide insight into shared stakeholder views, as well as unique experiences, related to Hurricane Maria.[27,28] Findings were reviewed in accordance with strategic themes outlined in the *Whole Community Approach*. More specifically, the degree to which community stakeholders were engaged in the preparedness processes that recognized needs and applied capabilities, community leaders were integrated into this process, and social infrastructure, networks, and assets were leveraged. Illustrative quotes were translated to English for publication.

## Results

Results below are organized by theme and presented chronologically, first with preparedness strategies to coordinate across sectors, engage community leaders, and protect vulnerable populations, followed by post-hurricane adaptive strategies to facilitate communication with the Government of Puerto Rico and between responders, and to inform community members.

### Local preparedness efforts included multi-sectoral coordination and strategic allocation of municipal personnel

Study respondents described substantial efforts at the municipal level to coordinate preparedness across multiple sectors. Study participants described the implementation of emergency plans for first responders, which included the positioning of responders in strategic locations during the storm to coordinate response efforts, as well as the allocation of non-emergency personnel to fulfill key disaster response functions. Respondents also described planning meetings among mayors, emergency responders, and directors of municipal departments that took place in the days leading up to the hurricane, during which decisions were made regarding how resident needs would be met:

> *We had an established work plan of how we were going to face the atmospheric phenomenon where all directors sat down together with the mayor, including offices in the area of emergencies, department of family, housing, to see how we were going to work . . . – Municipal Director of Emergency Management*

> *We had an operational plan. I make the plan every June. There, I document the staff I have, where I will allocate them before, during, and after, what functions we will serve, what units and equipment we will use, there I have everything detailed. – Municipal Police Commissioner*

### Community leaders were empowered to play an important role in coordinating and implementing preparedness efforts, and serving as neighborhood points of contact for help

Community leaders detailed their activities, including the organization of leader networks that served as designated points of contact for help, facilitated communication between neighborhoods, and helped with the distribution of resources before and after the hurricane:

> *Including the urban core, there are 14 neighborhoods in our town. During the hurricane, we kept watch. Communication failed, but we had a contact person in all neighborhoods that was in charge of maintaining control in the community, because we didn't know the magnitude of the hurricane.* – Community Leader

### Knowledge and expertise of local community leaders were leveraged to identify and protect vulnerable individuals and households

Study respondents described how community leaders used their familiarity with local residents and community trust to implement preparedness measures, coordinate response to arising needs, and ensure safety of homes that would not withstand the hurricane's impact and wellness of vulnerable individuals (ie, those with chronic health conditions, bedbound, elderly, and those with disabilities):

> *Community leaders know their community, they know who is well, who is not, who moved there recently, who has lived there a long time, who lives in a place that always has flooding problems . . . "How can I move you? Look, you don't want to go to a refuge, go stay at this neighbor's house. Let's go ask.* – Community Leader

> *We worked with our neighbors that had generators to save some ice and bring it to people who would need it to refrigerate medicines.* – Community Leader

### Community censuses were conducted pre-hurricane to assess assets and needs

Community leaders recounted their efforts, in collaboration with municipal emergency responders, and coordinated using a mobile app to conduct community-wide censuses prior to the hurricane to identify vulnerable individuals who would need special preparations pre-hurricane or care post-hurricane, as well as health professionals and individuals who could serve as first responders during response efforts:

> *We created a chat using the WhatsApp application to communicate: here we have so many people, here I have bed-bound people, I have children, women, and all the information that would help us know what to expect, who we were going to look for if there was destruction of such great magnitude that we had to look for missing people. Once we did the census, we submitted it to the municipal Office of Emergency Management.* – Community Leader

> *As community leaders, we were asked to do a census of health professionals, firemen, and police . . . in case of an event where we couldn't get to the town center, where the offices are. So, we were able to create a small safety and health structure to attend to critical incidents.* – Community Leader

### Community-based, multi-disciplinary teams conducted outreach to deliver risk communication and implement protective measures tailored to local needs and context

Teams of municipal personnel, emergency responders, social workers, nurses, and community leaders, among others, worked diligently with every household for hurricane preparedness according to the unique risks and vulnerabilities of household members, educated about potential risks to health and safety, and made arrangements to ensure they meet resident needs. Outreach was described as being predominantly door-to-door visits and discussions with families, which surpassed general risk messaging received by residents from the central government. For example, instead of simply instructing high-risk families to evacuate, they provided instructions on what to bring (ie, important documents such as birth certificates and social security cards) and guidance depending on the household's composition. Municipal emergency responders also discussed their pre-hurricane community outreach to ensure that bedbound individuals and residents living in high-risk flood zones or in precarious housing received assistance with relocating to refuges:

> *I had to watch over households . . . I went around to homes with colleagues to educate families about having to refuges . . . so, we prepared . . . all the people were moved, thank God . . . the word got out.* – Municipal Police Commissioner and Director of Emergency Management

> *We had a communications plan for the community, for structures that wouldn't withstand the winds . . . and we were educating people who had to evacuate to prevent loss of life. Our office, the municipal pólice, and emergency management, we did this in the neighborhoods that were furthest away.* –Municipal Emergency Medical Services Director

### Some population segments experienced financial barriers to adequate preparedness

Despite implementation of the community-based strategies outlined above, study respondents reported that some segments of the public were not able to adequately prepare for the hurricane, in part due to economic barriers. Respondents described many cases where households lived paycheck to paycheck and did not have the means to procure sufficient water, food, gasoline, cash, medications, or generators in advance of the hurricane:

> *Here, there are barriers for preparing the physical structure. It's almost impossible because putting on shutters is expensive. The majority that I saw didn't have them. Stocking up, even with limited money, yes, there were families that had stored wáter and food, but at the general level. Nobody did it in terms of what we were living. Everyone prepared for a week or les, like two or three days. Puerto Rico seemed like a paradise, but the hurricane exposed social inequality, poverty, many things that were not seen before came to light . . .*
> – Non-profit Organization Personnel

### Post-Hurricane Adaptive Communication Strategies

Following Hurricane Maria, one of the biggest challenges facing communities was the complete loss of telecommunications and contingency failures:

> *We were totally without communication. Not by cellular, nothing. There was only one radio station that was on the air.* – Community Leader

> *This was impactful because there are always areas that aren't affected [in a disaster], but in this case, it was the totality of the island, and the most difficult was the loss of communications.* – Non-profit Organization Personnel

> *There was no communication. And that was one of the most maddening things. So, if a patient had a situation in their home, to call an ambulance was impossible. Totally without communication.* – Local Health Center Personnel

*Satellite phones didn't work at all . . . I think none of the mayors had theirs work.*
– Municipal Mayor

Severed communication was described by study respondents as a major threat to health and well-being of their communities, prompting them to create local solutions to navigate this challenge. In the context of widespread telecommunication failures, there were 4 mechanisms used by local communities to facilitate post-hurricane communication, including direct interpersonal communication with the Government of Puerto Rico and locally, use of police radios to coordinate local multi-sectoral response efforts, dissemination of status updates and resource availability information to residents using loudspeaker-equipped vehicles, and use of a solar-powered Internet radio station.

### *Direct interpersonal communication was described as time-consuming, yet effective and reliable for the exchange of information in local communities*

Direct in-person communication was used by municipal disaster management teams to coordinate daily response efforts and monitor and respond to emerging community needs, and by community leaders who relayed information:

*In the meantime, communication was on foot and by mouth.* – Faith Leader

*The municipal police took 12-16 hour shifts going to every corner of our town to make sure there weren't any extreme needs . . . and to be available in the streets, to see what we could resolve, what was happening . . .* – Municipal Mayor

*To communicate with the mayor he organized that we would meet every afternoon to receive instructions and to inform about everything that was happening because each team had an area of responsibility.* – Police Lieutenant

*The community leader came here and we got in a pickup truck and we drove with Young mean clearing branches from the roads . . . we had to relay messages – I tell you, you tell them, like that, like in old times."* – Community Leader

### *Local communities relied on direct interpersonal communication with the Government of Puerto Rico in San Juan, but this strategy was uncoordinated, problematic, and inefficient*

Communications between municipalities and the Center for Operations in Emergencies (COE) proved to be more challenging. Many respondents indicated that, for sometimes weeks, the only way to communicate with the central government was to send a municipal representative to exchange information and inquire about assistance or supplies:

*To San Juan to see what there was, what supplies were being given, if there was help from FEMA, if there was food, the Honorable Mayor had to go there. I went like three times and emergency management went another three times to coordinate.* – Municipal Police Commissioner

As indicated by this respondent, individuals responsible for interpersonal communication on behalf of the municipality varied by community, and there was no consistent, coordinated communication plan between local and central governments, which ultimately compromised efficiency and effectiveness. Furthermore, the resources required to travel to the COE were unreasonable,

given widespread fuel shortages post-hurricane. One community clinic physician highlighted the number of municipal representatives seeking to have their community's needs met as a contributor to inefficiencies:

*So, the government made a command center . . . in San Juan, but there was so much congestion, and the mayors there in a line making requests, and it was so difficult to get what you needed . . .* – Physician

### *In the absence of communication and guidance from the central government, local communities used direct communication among municipal departmental leadership for decision-making*

Stakeholder respondents indicated that interpersonal communication in municipalities was the main mechanism for information-sharing and decision-making in the absence of formal communication from federal agencies, such as FEMA, the Puerto Rican Government, and the Department of Health:

*We did not receive information here – not federal, not state. The municipality has a group of directors in every area. We met and we made decisions together with the mayor. We made our own decisions because there was no support from the state. The Department of Health never visited us, they never gave us information.* – Health Center Personnel

### *Other successful local communication strategies for the coordination of response efforts involved the use of local resources, such as police radios, loudspeaker-equipped vehicles, and solar-powered Internet radio stations*

Police radios offered a workable solution for coordinating disaster response, despite radio frequency congestion from the high number of users:

*That's how we did it . . . we met early each day, instructions were given, we distributed radios, we organized groups, and we communicated through radio frequency. We used the Municipal Police radio frequency . . . including groups for rescue and cleanup. It was not easy because 100, 150, 200 people were on one frequency, but we kept it under control.* – Municipal Police Commissioner and Emergency Management Director

*They brought a satellite phone, but the best communication was through the police radio system.* – Municipal Police Commissioner

Additionally, vehicles equipped with loudspeakers for drive-by announcements were used to disseminate information about the distribution of supplies or situational updates to the community at large:

*At the municipal level they used vans with speakers to inform people about in which communities they were going to distribute food, or whatever.* – Community Leader

Finally, 1 community described the use of a locally managed Internet radio station that was powered by solar energy to provide status updates from the local community to the US mainland:

*We have an internet radio station that never failed because it's powered with solar energy, so through that station we communicated to the United States.* – Non-profit Organization Director

### *Limitations*

Study findings should be interpreted with the acknowledgment of certain limitations. The paper discusses findings from a secondary analysis, and study protocols and sampling were developed according to the original study's aims and overall methodology (described above). Findings presented herein constitute a predominant

narrative that emerged during data analysis for the original study's aims; consequently, it is possible that saturation was not reached with regards to actions contributing to community disaster resilience. Furthermore, study findings are based on the accounts of individuals from only 7 of 78 municipalities in Puerto Rico, or 9% of the total. While purposive sampling intended to represent diverse stakeholders from communities with varied experiences from Hurricane Maria, responses may not represent the breadth of experiences for all Puerto Rican communities. Furthermore, these experiences may not be generalizable to other hurricane-prone communities outside of Puerto Rico. While recall bias is certainly a possibility with interviews conducted 7 months post-disaster, many impacts described by participants were still ongoing, and concordant accounts by different stakeholders from the same community aided in triangulating results; this is not deemed to be a significant source of bias.

## Discussion

Community experiences with Hurricane Maria highlight the important role of local stakeholders and residents in processes that promote disaster resilience. The capacity of government administrations to implement effective disaster preparedness and response measures depends on the degree to which local stakeholders are engaged as legitimate partners in planning, whereby community needs and capacities can be better understood, local resources leveraged, and existing social infrastructure used to build resilience.[13] A review of the literature shows examples of the community's role in disaster preparedness, response, and recovery, including for Hurricane Katrina[11,29] and Fargo, North Dakota floods,[19,30] among others, and proposes several community-level factors that contribute to resilience.[10,13–16,31] Several operational models also exist to strengthen community disaster resilience using community-based emergency plans.[8,12,17–20] These models describe how community residents, through a participatory process, can work with government entities to identify vulnerabilities, create solutions, and equitably implement disaster management tasks.

In the case of Hurricane Maria in Puerto Rico, numerous municipalities undertook efforts to coordinate preparedness activities, many of which engaged residents in this process. These strategies built on existing strengths and capacities, used local leadership and social networks, and demonstrated the ingenuity of Puerto Rican communities. Social networks and physical/human resource assets were leveraged for community censuses, resident protection, and resources coordination for refuges. Communities sought to assess their needs and capabilities using censuses that high-risk identified individuals (ie, medical conditions or immobility) and households at risk from flooding or other hurricane impacts. By identifying these at-risk residents, tailoring risk communication to the local context, and addressing immediate needs, it is possible that morbidity and mortality from the hurricane's impact were minimized. Additionally, the assessment of skilled human resources (ie, first responder and health professionals) enabled their strategic allocation throughout the community and in refuges to ensure service continuity for high-risk populations. This workforce was supplemented by engaging community leaders in the risk assessment process and empowering them as designated points of contact for neighbors.

After Hurricane Maria, response from Puerto Rican and federal governments were slow, inadequate, and under-resourced,[1,32] creating circumstances in which many municipalities found themselves isolated and on their own for protecting residents. In the post-hurricane period, local level "adaptive capacities" included communication and decision-making, evidenced by efforts to identify adaptive ways to facilitate communication between first responders and with community residents despite telecommunication failures, and local government leaders coordinating decision-making among actors in the absence of external guidance. Cross-sector partnerships enabled both adaptive decision-making and communication strategies. Emergent strategies employed by local communities were crucial to coordinating response activities for disaster managers, providing community members with information, and connecting residents to resources. Disaster practitioners should consider integrating similar adaptive communication strategies into emergency plans for catastrophic disasters resulting from natural hazards.

While study findings identify a number of adaptive capacities that were present during preparedness and response, there is an area of potential concern for disaster resilience. A significant body of literature suggests that economically disadvantaged and minority communities are more vulnerable to disasters.[33–38] Norris et al. describe the need for economic development, that is, economic resources to reduce risk, resolve resource inequities, and attend to areas of greatest social vulnerability.[14] According to the current study's findings, sampled communities, including those with lower socioeconomic status, showed a great deal of cooperation, community engagement in preparedness and response, and flexibility with adaptive communications. However, while findings indicate that communities implemented strategies to reduce risk for medically vulnerable individuals and high-risk households, there was no mention of similar actions to address financially vulnerable populations who were underprepared for the hurricane. Estimates of excess mortality following Hurricane Maria in Puerto Rico were disproportionately higher among populations in municipalities with the lowest levels of socioeconomic development.[23] Future research should seek to systematically and more comprehensively assess factors that may contribute to disaster resilience among the most financially vulnerable communities.

## Conclusion

Despite numerous challenges to disaster preparedness, response and recovery, including federal and Government of Puerto Rico failures, local communities were resourceful when faced with catastrophe. This paper highlights local, community-based strategies that were employed to minimize disaster impact, facilitate communication, and prepare for and recover from Hurricane Maria. Using the many lessons from Hurricane Maria, the Government of Puerto Rico and Puerto Rican communities can strengthen and leverage adaptive capacities and community assets for enhanced resilience and readiness for future disasters. Additional research should also be pursued to further understand factors that contribute to resilience in the context of catastrophic disasters.

## References

1. 2017 Hurricane Season FEMA After-Action Report. July 12, 2018. https://www.fema.gov/sites/default/files/2020-08/fema_hurricane-season-after-action-report_2017.pdf. Accessed October 11, 2021.
2. **Zorrilla CD.** The view from Puerto Rico – Hurricane Maria and its aftermath. *N Engl J Med.* 2017;377(19):1801-1803. doi: 10.1056/NEJMp1713196

3. **Román MO, Stokes EC, Shrestha R, *et al.*** Satellite-based assessment of electricity restoration efforts in Puerto Rico after Hurricane Maria. *PLoS One*. 2019;14(6):e0218883. doi: 10.1371/journal.pone.0218883

4. **Santos-Burgoa C, Sandberg J, Andrade EL, *et al.*** Ascertainment of mortality after Hurricane Maria in Puerto Rico. George Washington University. 2018. https://publichealth.gwu.edu/sites/default/files/downloads/projects/PRstudy/Acertainment%20of%20the%20Estimated%20Excess%20Mortality%20from%20Hurricane%20Maria%20in%20Puerto%20Rico.pdf. Accessed October 11, 2021.

5. **Andrade E, Barrett N, Edberg M, *et al.*** Mortality reporting and rumor generation: an assessment of crisis and emergency risk communication following Hurricane Maria in Puerto Rico. *J Int Crisis Risk Commun Res*. 2020;3(1). doi: 10.30658/jicrcr.3.1.2

6. **Watts N, Amann M, Ayeb-Karlsson S, *et al.*** The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *Lancet*. 2018;391(10120):581-630. doi: 10.1016/S0140-6736(17)32464-9

7. **Centre for Research on the Epidemiology of Disasters**. Natural disasters 2019. https://emdat.be/sites/default/files/adsr_2019.pdf. Accessed August 4, 2020.

8. **Chen L-C, Liu Y-C, Chan K-C.** Integrated community-based disaster management program in Taiwan: a case study of Shang-An village. *Nat Hazards*. 2006;37(1-2):209-223. doi: 10.1007/s11069-005-4669-5

9. **Covello VT.** Best practices in public health risk and crisis communication. *J Health Commun*. 2003;8(Suppl 1):5-8. doi: 10.1080/713851971

10. **Hyvärinen J, Vos M.** Developing a conceptual framework for investigating communication supporting community resilience. *Societies*. 2015;5(3):583-597. doi: 10.3390/soc5030583

11. **Patterson O, Weil F, Patel K.** The role of community in disaster response: conceptual models. *Popul Res Policy Rev*. 2010;29(2):127-141. doi: 10.1007/s11113-009-9133-x

12. **Wells KB, Tang J, Lizaola E, *et al.*** Applying community engagement to disaster planning: developing the vision and design for the Los Angeles County Community Disaster Resilience Initiative. *Am J Public Health*. 2013;103(7):1172-1180. doi: 10.2105/AJPH.2013.301407

13. **Federal Emergency Management Agency**. A whole community approach to emergency management: principles, themes, and pathways for action. 2011. https://www.fema.gov/sites/default/files/2020-07/whole_community_dec2011__2.pdf. Accessed October 27, 2021.

14. **Norris FH, Stevens SP, Pfefferbaum B, *et al.*** Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Community Psychol*. 2008;41(1-2):127-150. doi: 10.1007/s10464-007-9156-6

15. **Mathbor GM.** Enhancement of community preparedness for natural disasters: the role of social work in building social capital for sustainable disaster relief and management. *Int Soc Work*. 2007;50(3):357-369. doi: 10.1177/0020872807076049

16. **Cagney KA, Sterrett D, Benz J, Tompson T; Moore S**, ed. Social resources and community resilience in the wake of Superstorm Sandy. *PLoS One*. 2016;11(8):e0160824. doi: 10.1371/journal.pone.0160824

17. **Reynolds B, Seeger MW.** Crisis and emergency risk communication as an integrative model. *J Health Commun*. 2005;10(1):43-55. doi: 10.1080/10810730590904571

18. **Mat Said A, Ahmadun F, Rodzi Mahmud A, Abas F.** Community preparedness for tsunami disaster: a case study. *Disaster Prev Manag Int J*. 2011;20(3):266-280. doi: 10.1108/09653561111141718

19. **O'Neill HK, McLean AJ, Kalis R, Shultz JM.** Disaster averted: community resilience in the face of a catastrophic flood. *Disaster Health*. 2016;3(3):67-77. doi: 10.1080/21665044.2016.1219575

20. **Crabtree C, Braun K.** PhotoVoice: a community-based participatory approach in developing disaster reduction strategies. *Prog Community Health Partnersh Res Educ Action*. 2015;9(1):31-40. doi: 10.1353/cpr.2015.0012

21. **Aldrich DP, Meyer MA.** Social capital and community resilience. *Am Behav Sci*. 2015;59(2):254-269. doi: 10.1177/0002764214550299

22. **Smit B, Wandel J.** Adaptation, adaptive capacity and vulnerability. *Glob Environ Change*. 2006;16(3):282-292. doi: 10.1016/j.gloenvcha.2006.03.008

23. **Eisenman DP, Cordasco KM, Asch S, *et al.*** Disaster planning and risk communication with vulnerable communities: lessons from Hurricane Katrina. *Am J Public Health*. 2007;97(Suppl 1):S109-S115. doi: 10.2105/AJPH.2005.084335

24. **Santos-Burgoa C, Sandberg J, Suárez E, *et al.*** Differential and persistent risk of excess mortality from Hurricane Maria in Puerto Rico: a time-series analysis. *Lancet Planet Health*. 2018;2(11):e478-e488. doi: 10.1016/S2542-5196(18)30209-2

25. **Sandberg J, Santos-Burgoa C, Roess A, *et al.*** All over the place?: differences in and consistency of excess mortality estimates in Puerto Rico after Hurricane Maria. *Epidemiology*. 2019;30(4):549-552. doi: 10.1097/EDE.0000000000000970

26. **Santos-Burgoa C, Sandberg J, Suárez E, *et al.*** Mortality risk within counterfactual models: Puerto Rico and Hurricane Maria – authors' reply. *Lancet Planet Health*. 2019;3(5):e209. doi: 10.1016/S2542-5196(19)30020-8

27. **Bernard R.** *Research methods in anthropology: qualitative and quantitative approaches*. 5th ed. Walnut Creek, CA: Altamira Press; 2011.

28. **Maxwell J.** Designing a qualitative study. In: Bickman L, Rog DJ, eds. *The SAGE Handbook of Applied Social Research Methods*. Thousand Oaks, CA: SAGE; 2009:214-253. doi: 10.4135/9781483348858.n7

29. **Leeds M.** Ruth Rales Jewish Family Service prepares pre-enrollment hurricane emergency care contact list. Ruth Rales Jewish Family Service of South Palm Beach County. 2006. https://ralesjfs.org/news/pr/. Accessed December 17, 2020.

30. **Sellnow TL, Seeger MW, Ulmer RR.** Chaos theory, informational needs, and natural disasters. *J Appl Commun Res*. 2002;30(4):269-292. doi: 10.1080/00909880216599

31. **Aldrich DP.** *Building resilience: social capital in post-disaster recovery*. Chicago: University of Chicago Press; 2012. doi: 10.7208/chicago/9780226012896.001.0001

32. **Willison CE, Singer PM, Creary MS, Greer SL.** Quantifying inequities in US federal response to hurricane disaster in Texas and Florida compared with Puerto Rico. *BMJ Glob Health*. 2019;4(1):e001191. doi: 10.1136/bmjgh-2018-001191

33. **Davies IP, Haugo RD, Robertson JC, Levin PS; Jones JA**, ed. The unequal vulnerability of communities of color to wildfire. *PLoS One*. 2018;13(11):e0205825. doi: 10.1371/journal.pone.0205825

34. **Sharkey P.** Survival and death in New Orleans: an empirical look at the human impact of Katrina. *J Black Stud*. 2007;37(4):482-501. doi: 10.1177/0021934706296188

35. **Cutter SL, Finch C.** Temporal and spatial changes in social vulnerability to natural hazards. *Proc Natl Acad Sci*. 2008;105(7):2301-2306. doi: 10.1073/pnas.0710375105

36. **Cutter SL, Barnes L, Berry M, *et al.*** A place-based model for understanding community resilience to natural disasters. *Glob Environ Change*. 2008;18(4):598-606. doi: 10.1016/j.gloenvcha.2008.07.013

37. **Bethel JW, Foreman AN, Burke SC.** Disaster preparedness among medically vulnerable populations. *Am J Prev Med*. 2011;40(2):139-143. doi: 10.1016/j.amepre.2010.10.020

38. **Elliott JR, Pais J.** When nature pushes back: environmental impact and the spatial redistribution of socially vulnerable populations. *Soc Sci Q*. 2010;91(5):1187-1202. doi: 10.1111/j.1540-6237.2010.00727.x