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Identifying Strategies for Lessening Hydrological Disaster Vulnerability: A Case Study

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ABSTRACT

This qualitative exploratory single case study identified strategies for lessening population vulnerability during a hydrological disaster. The research occurred in a densely populated county in the South Atlantic region of the United States. Semi-structured interviews and thematic data analysis served to address the research question. Methods involved n = 15 semi-structured interviews with uniformed and sworn personnel working in emergency management and public safety roles from agencies and divisions within the county. The data analysis found four generic strategies for lessening population vulnerability to hydrological disasters, (1) resiliency management, (2) resiliency partnership, (3) safety preparedness, and (4) backup preparedness. These four strategies support previous empirical findings and identified best practices. The four generic strategies offer practical approaches that can become a part of a community's overall emergency management plan to assist in lessening the challenges associated with hydrological disaster vulnerability.

KEYWORDS

case study, disaster, emergency managements, preparedness, qualitative, resiliency, safety, vulnerabilities

IDENTIFYING STRATEGIES FOR LESSENING HYDROLOGICAL DISASTER VULNERABILITY: A CASE STUDY

The impact of climate change in influencing the severity of tropical systems and the increasing number of hurricanes and floods has become an increasing focus of study (Woodward & Samet, 2018). An overburdened hydrological cycle triggered by climate change has escalated the prevalence of hydrological disasters such as floods (McClymont et al., 2020). Atmospheric scientists have drawn attention to the destructive nature of hydrological events on human activities (Woodward & Samet, 2018). A projection based on current trends predicted that by 2050 approximately 68% of the world's population will live in densely populated urban areas, many adjacent to large bodies of water and prone to flooding (McClymont et al., 2020). This anticipated and expected increase in people,

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infrastructure, and buildings, coupled with specific geographical features and climate changes, infer a more vulnerable society.

This qualitative exploratory single case study set forth to discover strategies for lessening vulnerabilities to hydrological disasters in a county located in the U.S. South Atlantic region. The purpose of selecting the specific region and county for the study was that the region had been negatively affected for decades by floods and hurricanes. The specific county is densely populated, with a large urban coastal city and a population of 2 million. In 2017 there were many destructive hurricanes across the United States, Central America, and the Caribbean (Woodward & Samet, 2018). August 2017 saw the development of Hurricane Harvey, followed by Hurricanes Maria and Irma in September and Hurricane Nate in October. Hurricanes Harvey, Maria, and Irma, each classified as category four hurricanes, caused widespread destruction along their South Atlantic path (Woodward & Samet, 2018). While the chosen county faces multiple hydrological disasters, they are known for effectively managing such disasters; hence they were chosen as a single case study to amplify the 'best practices'.

This single exploratory case study applied a qualitative methodological approach to a hydrological disaster-prone county's emergency management program to identify best practice strategies for reducing hydrological disaster vulnerabilities. The researchers chose this county as the focus of the study because of the county's experience with both previous disasters and the ongoing threat of future hydrological disasters. The central question that helped guide this study asked, what community-resilient strategies can be used to minimize the impacts of hydrological disasters in a U.S. South Atlantic region county?

Based on previous studies, the study reiterates areas that emergency managers and public safety personnel could focus on to reduce community vulnerability, increase community resiliency, and lessen the impact of hydrological disasters. The researchers built a convergent line of inquiry following a strict case study protocol focusing on semi-structured interviews with emergency management professionals in the county and archived county data sources (Yin, 2018). Specifically, the study used data from interviews with the county's Emergency Management Division, the Risk Management Division, and the Environment Planning and Community Resilience Division. Additionally, data were collected from previous studies conducted by the county and publications from the federal government and other archived, open-sourced, governmental, and media sources. Being a single exploratory case study, the research findings are limited to the county; however, they are analytically generalizable to other regions prone to hydrological disasters. Moreover, the study's findings reiterate previously identified best practices for reducing community vulnerability to disasters.

South Atlantic Region Background

Chapter 252 of the South Atlantic Region Statutes mandates that the political subunits establish emergency plans that are interrelated and consistent with the emergency planning of the region (Henry, 2020f). The county agencies and governments are obligated and responsible for managing and administering emergency management functions throughout the province, including mitigation, preparedness, prevention, protection, recovery, and response activities (Henry, 2020f). Tropical cyclones frequently produce torrential rainfall above six inches, resulting in dangerous and destructive flooding (National Oceanic and Atmospheric Administration [NOAA], n.d.). According to Milman (2019), evidence exists that hurricanes were getting stronger faster, resulting in more category four and five storms.

Likewise, tropical systems that quickly strengthened into formidable hurricanes have increased threefold in the last 30 years (Milman, 2019). For example, the annual Atlantic Hurricane season, which starts on June 1st and ends on November 30th, was increased by two days in length per year between 1980 and 2007 (Karloski & Evans, 2016). In the aftermath of hydrological disasters, communities usually struggle to recover due to the damage inflicted. For example, communities experience prolonged power outages after natural disasters. (Moreno & Shaw, 2019).

An increase in sea-level rise and other climatic variations have amplified the potential for flooding in the county. Henry (2021b) estimated that the county's sea level will rise by about two feet by 2060. Currently, the county experiences an annual average rainfall of around 57 inches, and anticipates the rainfall to increase and become more intense in future years. Increased urbanization, reduced drainage capacities, and elevation of groundwater compound the potential for flooding (Henry, 2021b).

LITERATURE REVIEW

The social and economic costs sustained by significant natural disasters in the U.S. have increased in recent decades (Jaganmohan, 2021). Between 2016-2020, natural disaster events cost the U.S. approximately $121.3 billion annually, amounting to $600 billion in damages over five years (Smith, 2021). In 2020, climate and weather natural disaster events cost the U.S. about $95 billion in damages (Jaganmohan, 2021). During the first ten months of 2021, there were 18 climate and weather events in the U.S., with each disaster costing more than $1 billion. These disaster events have resulted in the deaths of around 538 persons (NOAA, 2021). Hurricanes in the U.S. are the most destructive and costly of all-natural disasters (Grinsted et al., 2019). Since the 1900s, hurricanes have become far more destructive, and the more violent ones occur three times more often than 100 years ago (University of Copenhagen, 2019).

In 2020, the U.S. experienced 22 different climate and weather disasters exceeding the previous record of 16 in 2011 and 2017 (Smith, 2021). These disasters included thirteen extreme storms and seven tropical cyclones costing the nation damages amounting to $95 billion. Since 1980, the U.S. has had 285 climate and weather events that reached a minimum of $1 billion in damages (Smith, 2021). The total cost to the country in weather and climate damages since 1980 is approximately $1.875 trillion. Furthermore, in 2020 the U.S. had 30 named storms surpassing the previous number of 28 in 2005 (Smith, 2021).

NOAA (2019) considered the mid-1990s the beginning of the Atlantic high activity era. Since the origination of this era, 17 of 25 hurricane seasons have generated more storms than average (NOAA, 2019). Before the 1992 start of the Atlantic high-activity era, Hurricane Andrew brought considerable devastation and damage to communities in the South Atlantic Region, resulting in about 26 billion dollars in losses and 43 fatalities (NOAA, 2017a). In addition, Hurricane Andrew caused partial damage to 108,000 structures and destroyed 49,000 homes (NOAA, 2017a). Similarly, in 2017, Hurricane Irma caused six million residents in the South Atlantic Region to evacuate from coastal areas, killed ten people in the United States, and caused 50 billion dollars in damages (NOAA, 2017b).

A review of the historical trends in the literature showed that residents in communities affected by natural disasters suffer hardships due to disruptions to everyday life and critical infrastructure such as roads, domestic water supply, and electricity services (Baussan, 2015; Grosfield, 2018; Moreno & Shaw, 2019; Sharrieff, 2018; Smith, 2019). Likewise, buildings and houses may be damaged or destroyed, disrupting economic activities (Moreno & Shaw, 2019). An example of hardships that resulted in fatalities was reported in 2017 when Hurricane Irma disrupted the power supply at a rehabilitation center nursing home in the county (Kaplan, 2019). The loss of electricity resulted in the buildup of extreme heat. Investigators concluded that power outages triggered by the hurricane affected the air conditioning system, causing it to become inoperable. Prolonged heat exposure led to the deaths of 12 patients (Kaplan, 2019).

Hurricanes and Floods

Hurricanes generally produce high winds and storm surges, which could cause disruptions to businesses; and damage crops, homes, and critical infrastructure (Pielke, n.d.). These tropical systems can also damage water treatment plants that are very expensive to reconstruct. In addition, Hurricanes can cause damage to tourism-related businesses by affecting arrivals causing a reduction in revenues such as sales tax collection (Pielke, n.d.). Moreno and Shaw (2019) stated that developing community

resilience helps reduce prolonged disruptions of essential services, such as power outages. Increased resilience in the availability of essential services would reduce hardships for the county's people (Moreno & Shaw, 2019).

Ninety percent of all worldwide disasters occur because of water, and it is through water that climate change is most destructive (Adeyeye & Emmitt, 2017). For example, in 2015, flooding caused 42% of all-natural disaster events worldwide and 24% of 23,000 deaths. If change does not transpire, by the 2070s, the number of people exposed to flooding could increase threefold to approximately 150 million. This increase is due primarily to population growth, increases in storms, urbanization, and sea-level rise (Adeyeye & Emmitt, 2017).

While examining the literature on resilience and natural disasters, several themes emerged from Klotzbach et al. (2018), who asserted that hurricane-associated damages had grown substantially since the 1900s. La Nina seasons were inclined to generate more Continental United States hurricanes than the El Nino seasons. Likewise, the positive Atlantic multidecadal oscillation cycles were more likely to generate more landfall in Continental United States hurricanes than in negative phases. Regional wealth and expansion in coastal populations were the overbearing reasons for increased hurricane damage.

Klotzbach et al. (2018) noted that growth in wealth and population in the U.S. coastal areas has resulted in greater vulnerability and exposure of properties along the U.S. East and Gulf Coast. This growing vulnerability was exposed in the 2017 hurricane season when Hurricanes Harvey and Irma made landfall in Texas and Florida, respectively. The economic damage from both hurricanes was approximately 125 billion dollars. The expansion of coastal populations likely will continue. Therefore, when hurricanes land in the future, the damage cost is expected to be more extensive and severe.

Community Vulnerability and Resilience

Patel et al. (2017) define community resilience as the ability of a society, community, or a system exposed to hazards to absorb, resist, cater for, and recover from the consequences of a hazard in an efficient and timely manner, including restoration and preservation of its basic essential functions and structures. Improved resilience can be built through science, technology, and innovation and by creating awareness among the various public stakeholders to reduce the threat (United Nations, 2019).-

Street et al. (2019) pointed out that climate change activities and extreme weather, the most impactful natural disasters, are the highest risk to society in the last ten years. The vulnerabilities and hazards linked to these events are forecasted to adjust because of climate change and as modifications to determinants of vulnerability such as demographics and land use.

The Department of Homeland Security (2020) considers climate change and community resilience to hazards a national security and resilience issue. Building community resilience and combating climate change are continuously being shaped by federal policies (Bailey, 2021). The enactment of federal policies such as the National Flood Insurance Program (NFIP) has influenced how communities approach disaster preparedness, building construction, conserving natural spaces, and implementing economic development (Bailey, 2021). Resilient communities work to protect and build private and public services and assets that assure livability, sustainability, and equal access for all Americans (DHS, 2020). In the United States, most actions to improve community resilience capacities occur at the domestic level (DHS, 2020). Federal programs provide vast resources necessary for community strengthening capacity across the country. Leaders aligned with several federal agencies have supported common indicators of community resilience to help prioritize and inform resilience capacity-building strategies, policies, and outcomes (DHS, 2020).

Federal programs typically help improve community resilience by using the following factors: Intrinsic community functions, risk management and mitigation action, and disaster recovery and redevelopment (DHS, 2020). Intrinsic community functions strengthen resilience by supporting central community services such as public health, transportation, community infrastructure, housing, economic development, environmental protection, and natural resources (DHS, 2020). The federal

government, through various agencies, provides support to communities through technical assistance, climate data, and planning tools to improve resilience (Bailey, 2021). For example, a bipartisan bill passed by the U.S. Senate in August 2021 includes $ 3.5 billion for Flood Mitigation Assistance (FMA) and $1 billion for Building Resilient Infrastructure and Communities (BRIC). The bill also contains funding for critical infrastructure and transportation programs like the Federal-Aid Highway Program (Bailey, 2021).

Risk management and mitigation action strengthen resilience by supporting communities to identify, manage, and mitigate risks and hazards. Likewise, the program reinforces community activities by incorporating advanced risk information into decision-making, implementing risk-informed development standards, and reducing asset vulnerabilities to hazards. Disaster recovery and redevelopment programs have a built-in component for disaster assistance that combines prospective resilience objectives into community redevelopment and recovery activities (DHS, 2020).

Adeyeye and Emmitt (2017) argued that the push by humans for modern and urban development has led to occasional or repeated flooding. This flooding has exposed vulnerabilities and caused risk to economic activities, quality of life, and shelter. Flooding is often a storm-generated event that is cyclical or immediate, and scientists expect recorded occurrences to increase (Adeyeye & Emmitt, 2017). The U.S. has increasingly become a more modern and urban society (Konrad, 2016). Such urbanization involves constructing buildings and roads in flood-prone areas, and modifications of stream channels to facilitate urban development have escalated the impact of hydrological events (Konrad, 2016). Changes in land use by removing soil and vegetation, reshaping the topography, and constructing drainage systems increase waterway runoff from precipitation (Konrad, 2016). As a result, the volume, peak discharge, and frequency of flooding increase in communities. Resilience emphasizes strategic significance regarding protection from likely threats to the population, security, safety, the environment, and the economy. Effective governance and public-private partnerships are critical for accomplishing social, economic, and physical resilience (Adeyeye & Emmitt, 2017).

The Community Planning Act

The South Atlantic Region passed the Community Planning Act (CPA) in 2011, incorporating Adaptation Action Areas (South Atlantic Region Planning Council, 2013). The region used Adaptation Planning Initiatives and Post Disaster Redevelopment Planning to advance resilience (American Planning Association, 2021). The South Atlantic Region statutes section 163.3177(6)(g)(10) provides communities with the choice to develop Adaptation Action Areas. This statute is a policy tool to enhance resilience in low-elevation areas against coastal flooding, storm surge, and other consequences of sea-level rise (American Planning Association, 2021).

One of the objectives for designating zones as Adaptation Action Areas through policies is to provide priority funding for seawalls, stormwater retrofits to enhance local drainage, beach re-nourishment, and other infrastructure programs (South Atlantic Region Department of Economic Opportunity, 2020). The county's Division of Emergency Management and the Department of Economic Opportunity created the Post Disaster Redevelopment Plan Planning initiative to assist communities in planning for long-term disaster recovery resilience. The plan involves policies, roles and responsibilities, and operational strategies that help to guide the redevelopment of a community following a disaster (Donaldson, 2018).

This approach allows local governments to rebuild more effectively after disasters. Planners receive tools to promote more resilient community planning through the leadership and research conducted by various counties, organizations, cities, and agencies (American Planning Association, 2021). Many counties use this toolkit to improve resilience. Of those counties using the toolkit program, the county's Comprehensive Plan is among the most influential. The county's Comprehensive Plan has a climate change component with policies and objectives relating to the adaptation of natural systems, management of disasters, emergency preparedness, water resources and services, building environment, and transportation systems (American Planning Association, 2021).

METHODOLOGY

The researchers set forth to identify strategies that can be used to lessen the vulnerability of natural disasters in a U.S. South Atlantic region county prone to flooding and hurricanes. The study employed a qualitative methodology with a single exploratory case study design (Kennedy, 1979; Seawright & Gerring, 2008; Yin, 2018). The reason an exploratory case study design was chosen over other qualitative designs is its strength when looking at unique situations in a manner that can reveal theoretical propositions (Yin, 2018). The researchers used a type of sampling known as non-probability expert-purposive sampling (Corbin & Strauss, 2008; Patton, 2002). The justification for using the sampling strategy was that sampling from a pre-selected specific group of experts allows for theoretical discovery in specific cases where expertise matters (Patton, 2002). Data collection involved n = 15 semi-structured interviews and archival data specific to the county's emergency management program. The n = 15 participants were all uniformed and sworn emergency management and public safety personnel employed with the county where the study occurred. The researchers followed a systematic case study approach for thematic data analysis. The researchers used data saturation to determine the study's sample size; saturation was reached when answers to interview questions no longer revealed anything novel (Mason, 2010).

Data collection consisted of fifteen individual open-ended audio-recorded interviews. The researchers removed personal identifiers from the transcribed interviews to protect the study participants and destroyed the audio recordings once the transcriptions were complete. The researchers triangulated data sources from the multiple participants and archival data, had another researcher analyze theme comparison, and presented the data as in-depth, detailed thematic descriptions in the results section to ensure trustworthiness (Yin, 2018). The researchers followed a specific, systematic case study approach to collect and analyze the data, establishing a secure data collection and storage database to ensure data reliability (Patton, 2002; Yin, 2018).

Using a systematic, hierarchical approach, the researchers developed case descriptions to analyze the data (Stake, 1995; Yin, 2018). The data analysis began with the researchers organizing and preparing the transcripts for analysis, removing personal identifiers from each participant's transcripts to protect their anonymity, and then reading the transcribed scripts to become familiar with the data. Each participant was assigned a "P" and then a corresponding number.

In the results section, the researchers developed narrative case descriptions using the words of the participants (Yin, 2018). To formulate the narrative case descriptions, a hand-coding process was used to color-code the data (Basit, 2003). The hand-coding process allowed researchers to spend a lot of time reading and rereading the data, color-coding different attributes, and writing notes and ideas down (Basit, 2003; Corbin & Strauss, 2008). Strategic propositions were generated from the thematic analysis of the themes and are presented in the discussion section of this article (Stake, 1995; Yin, 2018).

RESULTS

The study's semi-structured interview script comprised open-ended questions developed to glean a rich understanding of the n = 15 study participants. For example, participants were asked about existing programs, community disaster awareness, strategies for addressing hydrological disasters, and areas they interpreted as effective measures for community preparedness based on their professional experiences in preparing for, responding to, and recovering from hydrological disasters. The thematic analysis of the data seemingly identified strategies that can be used to minimize the impact of hydrological disasters in the county. The data analysis and coding resulted in four thematic strategies: (1) resiliency management, (3) resiliency partnership, (3) safety preparedness, and (4) backup preparedness; Table 1 lists the thematic strategies, codes, and sub-codes.

Table 1. Themes, codes, and sub-codes on community strategies for lessening disaster vulnerability

Themes (Strategies)	Frequency	Codes & Sub codes	Frequency
Resiliency Management	31	Emergency management	3
		Resiliency personnel	5
		Resiliency maps	4
		Planning	5
		Investment in infrastructure	5
		Laws and regulations	3
		Climate change adaptation	3
		Protecting vulnerable groups	3
Resiliency Partnership	20	Collaboration and Shared responsibility	8
		Private property owner involvement	4
		Community involvement	5
		Private sector involvement	3
Safety Preparedness	55	Evacuation system	6
		Building standards	49
		Resiliency structure	8
		Roofing	4
		Windows and doors	3
		Shutters	5
		Building codes	6
		Drainage system	4
		Flooding	7
		Shelters	6
		Insurance	6
Backup Preparedness	22	Solar energy	7
		Water storage	8
		Generators	3
		Food	4

Resiliency Management

It was gathered from the thematic analysis that resiliency management was an essential strategy for mitigating the effects of hydrological disasters. The general feeling was that emergency management was at the heart of resiliency management, so the county agencies were staffed with resiliency personnel for the effective execution of resiliency management strategies. Participant 1 said, "The county has its Emergency Operations Center (EOC) to deal with the city's issues and coordinate emergency management programs."

Participants also viewed resiliency planning as integral to the resiliency management strategy. As stated by Participant 10, "You are starting to see private businesses and private sectors taking emergency management and planning . . . seriously [since] this pandemic . . . [to put] alternative plans in place".

Resiliency maps were seen among interviewees as planning tools for facilitating resiliency management. Participant 3 stated, "In the county system, we have a series of maps called future conditions maps. These include groundwater maps, rehabilitation maps, flood maps, shelter maps, and lighting maps". These maps "help with the design of floor elevations" for mitigating the impact of hydrological disasters. Participant 7 said, "We do not know if sea-level rise is going to happen, so most recently, we are working on a map for future floor elevations." Most respondents felt that the government should invest more in resiliency infrastructure within the county to mitigate hurricanes and floods.

Respondents saw climate change adaptation as essential in the long-term management of resiliency. These climate change activities associated with extreme weather patterns were causal

to many natural disasters (Street et al., 2019). Some participants mentioned that the county had established a program to train staff on the climate change aspect of resiliency. Participant 10 said, "Starting with county staff, every summer, we provide a climate change toolbox training to train any staff who are interested in [climate change] or who are required [to be trained] by their department."

Three participants suggested that the effective execution of a resiliency management strategy should seek to protect vulnerable groups. As indicated by Participant 5, "The catastrophic impacts [of disasters] on communities that are not appropriately prepared are, unfortunately, [more devastating] on the vulnerable populations, such as the poor and elderly." One participant noted that laws and regulations are already in place to address resiliency in the county despite the need for improvement in resiliency management.

Resiliency Partnership

Participants conveyed that a resiliency partnerships strategy was required among critical stakeholders to curtail the effects of hydrological disasters. Participants viewed this partnership as characterized by collaboration and shared responsibility among stakeholders. For example, Participant 3 shared,

If an ambulance needs to be dispatched, it should be dispatched centrally so it does not have to be one city's ambulance; it could be any city's ambulance that happens to be closest to the emergency. If one city loses its capabilities, the county can fill that gap with other cities and county agencies, so it is a concerted effort to address any natural disasters that might occur.

Interviewees saw private property owners' involvement as essential to this partnership. Other stakeholders identified among respondents for this partnership were the owners of businesses, nongovernmental organizations, and the residents within the community.

Safety Preparedness

Safety preparedness was determined to be another strategy to mitigate the impact of hydrological disasters in the county. A few respondents suggested putting an effective evacuation system in a state of readiness for an emergency operation during periods of disaster. Participant 5 summed it up:

Start evacuating people from areas, depending on the size and strength of a hurricane, or if it is a fire, the strength of a fire and where it might be located, or if it is an accident out at the seaport or fuel tanks or if it is an airplane crash at the airport, we must ensure that we can react to these challenging situations. We [must also ensure that we] know how to identify areas to be evacuated and ensure that the people living in these areas are notified.

Participants also suggested the central management of shelters that house the vulnerable population in crisis. For example, Participant 15 described this centralization attitude when noting that the county should "coordinate all of the emergency shelters, so if anybody has to evacuate to a shelter, those are coordinated by the county and are staffed by county."

Some participants also viewed that the county should encourage homeowner's insurance to protect residents from hurricane and flood damages, as the risk of not having insurance was significant during hurricane periods. Flooding is often a storm-generated event with recorded occurrences increasing and can immediately affect people's lives and livelihoods (Adeyeye & Emmitt, 2017). Participant 12 argued:

Everyone should go online and check what flood zone they are in and ensure their flood insurance is sufficient, or [alternatively, they could] consider what property damage they will be willing to pay if they cannot afford the insurance.

Homeowner insurance is central to a safety preparedness strategy as it advances resiliency by accelerating the rebuilding and recovery efforts and provides post-disaster liquidity, resources, and funding (Kousky, 2019). Notably, the South Atlantic Region makes it optional for homeowners to have insurance coverage for the facility. However, mortgage providers require this coverage (Zoecklein, 2016).

Participants felt the county should maintain high building standards as an integral part of the safety preparedness strategy. Areas highlighted for improved standards included building structures, roofing, windows, doors, shutters, building codes, drainage, and flooding systems. Notably, the resilience of structures has improved significantly in the South Atlantic Region. Today, the county is frequently praised for the strong building code it adopted since the destruction by Hurricane Andrew in 1992 (Henson, 2018). Moreover, the federal government addressed resiliency standards through the National Institute of Standards and Technology (NIST), developing a community resilience planning guide (Cutter & Derakhshan, 2019).

Backup Preparedness

Respondents identified backup preparedness as another strategy for containing the impact of hydrological disasters in the county community. Participants highlighted alternative energy utilizing solar systems as a critical area for backup preparedness, despite solar panels being susceptible to hurricane damage. As explained by Participant 2 in the interview:

Solar is susceptible to wind damage, just like everything else, but it is at a lower level, and, in most cases, the solar panels survive hurricanes without too much trouble. Moreover, houses need to be retrofitted with solar and new houses should be built with it . . . and the solar panels to be used must meet the hurricane code.

Participants also mentioned water storage tanks as a crucial part of the preparedness strategy. As stated by Participant 10, "Water storage tank is a good idea, as long as it can add some sort of filtration system on it." Participants identified traditional generators as a crucial part of the backup and emergency plans. In addition, they noted food security as critical, particularly during hurricanes and other natural disasters. Backup preparedness is an essential strategy for mitigating the effects of a natural disaster. These disasters are associated with lengthy power outages, disruption in health care, reduction in drinking water supply, and food shortages (Moreno & Shaw, 2019).

DISCUSSION

The findings from this single exploratory case study indicated that (1) resiliency management, (2) resiliency partnership, (3) safety preparedness, and (4) backup preparedness were the four key strategies that could minimize the impact of hydrological disasters on the county. The findings of this study are not novel but support previous works and findings associated with natural disasters (Canton, 2019). This section of the discussion presents a brief overview of the strategies that could minimize the impact of hydrological disasters to lessen a community's vulnerability.

Resiliency Management Strategy

Relevant laws and regulations should underpin a community's resiliency management strategy to ensure that building and environmental breaches are subject to legal proceedings. Resiliency planning should be foremost in this strategy. This planning must include resiliency mapping of resources and capabilities for responding to the effects of natural disasters. Planning for disaster should take climate change and emergency management into consideration. It must also address responding to the vulnerable population regarding preparedness for natural disasters and their aftermath. Actions

such as investment in infrastructure (e.g., hardened sea walls surrounding vulnerable coastal lands) are also central to a sound resiliency management strategy. *This finding is aligned with the work of Kapusu et al. (2012), who argued for governments to take a more active approach to fostering resilient communities.*

Resiliency Partnership Strategy

The resiliency partnership for a community is holistic and characterized by collaboration and shared responsibility among critical stakeholders such as government, the private sector, private property owners, non-governmental organizations, and community residents. The community's Comprehensive Emergency Management Plan needs to be central in coordinating emergency management efforts between external and internal partners (Henry, 2020f). For example, the county's Environmental Planning and Community Resilience Division has been a South Atlantic Regional Climate Change Compact member. As a member, the Environmental Planning and Community Resilience Division coordinate resiliency planning strategies with local, federal, and state agencies (Henry, 2020b). Chen et al. (2013) identified such partnerships across different agencies, jurisdictions, and stakeholders in resiliency building as essential for effective emergency and disaster preparedness and response. Such strategic partnerships strengthen the larger organization and the individual communities.

Safety Preparedness Strategy

Building standards were found to be central to the safety preparedness strategy. Building codes facilitate good building standards, considering resiliency issues such as structures, roofing, windows, doors, shutters, drainage systems, and flooding (Canton, 2019). The safety preparedness strategy must address tactical issues, including evacuation systems, shelters, and insurance.

The South Atlantic Region, for example, does not mandate homeowners to have insurance coverage. However, mortgage providers generally require their borrowers to have insurance coverage (Zoecklein, 2016). Current mortgage standard insurance terms give lenders the authority to provide insurance coverage for mortgagors if they need to catch up in maintaining insurance coverage on their property. Companies request that the borrower pay the premiums for the insurance coverage (Zoecklein, 2016).

Backup Preparedness Strategy

The backup preparedness strategy is seemingly generic and adaptable to specific localities. Proactive preparedness and establishing redundant systems in the event of failure is deemed a best practice in emergency preparedness (Mojtahedi & Oo, 2017). A backup preparedness strategy, though not exhaustive and flexible to an individual community's needs, will consist of solar energy systems, water storage tanks, generators, and food supply systems, made operational during periods of natural disaster. Such identified backup strategies are essential for building community resilience against natural disasters. These backup preparedness strategies prove to be significant in sustaining lives. They can assist residents to be less dependent on utility and governmental infrastructure, which can be destroyed, damaged, or disrupted during times of disaster.

LIMITATIONS AND FUTURE RESEARCH

The study has two overarching limitations. The first is that the study concentrated on a single county within the United States. Being a single case study specific to a county, the work is put forth as an exploration versus offering prescriptions, solutions, and recommendations. Though this county represents many other locations within the South Atlantic region, it is still specific to one geographical area. Future research is needed to understand other strategies and possible best practices from other locations and prior experiences. A case study specific to a single geographical region limits the

study's generalizability. The second limitation involves the sample size and the specific professional experiences of the participants. The study was limited to uniformed and sworn emergency management and public safety personnel. As experts, these participants can have a biased view and not understand natural disasters from the lens of a civilian. Future research is needed to understand how civilians interpret their vulnerabilities to disasters and what strategies they take to strengthen their resilience.

CONCLUSION

This single exploratory qualitative case study identified strategies necessary for lessening disaster vulnerability in a count in the South Atlantic region of the US. The data analysis revealed four generic strategies for containing the impact of hydrological disasters (1) resiliency management, (2) resiliency partnership, (3) safety preparedness, and (4) backup preparedness. The findings in the study support previous empirical works focused on strategies for reducing disaster vulnerabilities. The study supported previous arguments for resiliency programs, better backup preparedness for communities, improved zoning strategies, and excavating beaches and flood plans to contain flooding. Though these strategies appeared from county-specific research, they support previous works on the subject, are theoretically generalizable, and hold promise in strengthening other communities prone to hydrological disasters.

In the final analysis, communities with a high probability of hydrological disasters should utilize the findings from this study to help improve their emergency management programs. Resiliency management is imperative for an area prone to hydrological disasters such as flooding and hurricanes. It is essential for a community to be proactive to lessen the effects of hydrological disasters by taking steps to reduce disaster vulnerability.

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