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A Community-based approach towards the Disaster Management of Puerto Rico: A case study of Hurricane Maria

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Bryan Alexis VICENTE ORTIZ

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CENTRAL EUROPEAN UNIVERSITY

ABSTRACT OF THESIS submitted by: Bryan Alexis Vicente Ortiz for the degree of Master of Science and entitled: A Community-based approach towards the Disaster Management of Puerto Rico: A case study of Hurricane Maria.

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After the passing of Hurricane Maria, the vulnerable sectors of the mountainous region of Puerto Rico faced numerous obstacles that resulted in negative impacts on their health and wellness. This unfortunate outcome seeded discomfort and fear in the residents and raises questions about the emergency response plan implemented by the Puerto Rican government. This research elucidates the pillars of the disaster management plan with special consideration for the vulnerable sectors. The mountainous region of the island was chosen as a focal point to examine the possibility for maximizing disaster management efforts in vulnerable communities. In particular, challenges were identified in interviews with relevant actors; and mutual opportunities for strengthening government collaboration, maximizing bureaucratic efficiency and identifying key needs of mountainous residents were explored. These concerns served as a gateway to provide potential changes to the disaster management plan based on a community-based approach that emphasises governmental collaboration and communication and the concept of community resilience. This new approach denominated community-based disaster management (CBDM) should evaluate the socioeconomic impact that natural hazards have on the vulnerable communities in the less advantageous municipalities in the island and ensure that the disaster management plan is contextualized and considerate of their special necessities.

Keywords: Social vulnerability, Disaster Management Plan, Puerto Rico

1. Introduction:

In September 2017, the passing of Hurricanes Irma and Maria over the island of Puerto Rico proved how unexpected and painful disasters could be (Maxwell and Kelly, 2017). Property losses, fallen bridges, a prolonged blackout and the absence of remote communications for months were the resulting toll of the passing of Hurricane Maria. (Images can be found in Appendix B (pp. 73-74)) The resulting scenario elevated Maria from a hazardous event to a natural disaster. This heightened concerns, among the inhabitants, as hurricanes are expected to happen more frequently and more violently as climate change intensifies. This has led many experts to question how Puerto Rico's resilience could be improved and how the emergency and disaster planning of the island can be ameliorated.

This study researched the pillars Puerto Rico's disaster management plan and the emergency response put in action after the passing of Hurricane Maria. It glimpsed into the governmental structure and the handling of responsibilities at different levels of the Puerto Rican government, as well as the emergency response at the community level. The following diagram can help elucidate the components of the federal and local governments and how these components connect in addressing natural disasters:





During this research, the dynamics between these components were explored. It became noticeable that the collaborative communication between them needed to be strengthened to address local needs in a timely manner. As a research sample to examine the reasons behind the poor emergency response, representative municipalities in the mountainous region were chosen to identify the problematic sources and to enact recommendations that can help improve, for looming future events, the disaster management on the island.

These recommendations were based on reducing social vulnerability through the encouragement of community resilience and followed the model of the Environmental Inequity Formation utilized by Sze and London (2008) and based on Pellow (2000). This model emphasizes on the community, governmental, institutional and corporate decision-making. The expected outcome is to provide strategies to achieve a CBDM that can make more equitable the recuperation efforts and minimize the vulnerability of the representative municipalities.

2. Case Study:

The archipelago of Puerto Rico is comprised by the main island of one-hundred twelve miles (one-hundred eighty kilometers) by forty miles (sixty-four kilometers) and the islands of Culebra and Vieques. This archipelago is found in the northeast Caribbean Sea and is an unincorporated territory, denominated a commonwealth, of the United States of America. As such, its 3.5 million citizens possess American citizenship and, according to the Constitution of the United States of America, the ultimate governance of the island is retained by both the Congress and the President of the United States of America. (Keith, 2005)



Figure 02: Location of Puerto Rico in the world map

Due to its location in the Caribbean Sea (as seen in Figure 02), the island of Puerto Rico is susceptible to natural hazards, such as tropical storms, hurricanes and earthquakes. Scientists have denoted that the frequency and the intensity of these natural hazards are expected to increase because of the ever-warming waters of the oceans, deemed a consequence of climate change. (Mousavi, 2011)



Number of hurricanes over the Atlantic basin 1967-2016

Graph 01: Frequency and intensity of hurricanes in the Atlantic basin (AOML and NOAA, 2016)

Studies have demonstrated that major hurricanes (within the categories three, four or five) have been increasing in number through the last decades and are increasingly dominating the ratio of the number of hurricanes forming in the region, as showcased in Graph 01. As hazards, these phenomena are imminent and will continue to occur. Hazards may come in large scaleforms, as in the likes of forest fires, hurricanes or earthquakes, or as more localized events, such as mudslides or chemical spills. (Nelson, 2018) When a hazard catalyses a disaster, severe physical injuries, emotional distress, loss of life and property damage may occur. (Nelson, 2018) As a result, disasters have pernicious consequences on the economy, health and society of communities. To minimize the impact of these consequences, disaster management plans are designed and put in place. These multi-layered plans are expected to address such issues as natural disasters (floods, tropical storms, hurricanes, earthquakes, etc.), emergency disasters (wildfires, explosions, and even mass failures of utilities), complex disasters (war) or pandemic disasters (the rapid spread of disease). (IWA Publishing, n.d.)

During disasters, the most vulnerable sectors, the low-income and minorities communities, tend to be hit the hardest. (Maxwell and Kelly, 2017) Such is the case of many remote communities that rest at the outskirts of the less urbanized municipal centers, these predominantly poor households were out of reach for more than five months. Seeing the results of the current emergency response in the island, many have called out for an extensive federal response that is more of a comprehensive recovery assistance. (Cohan et al, 2017) Six months after the disaster, March 2018, the U.S. Department of Energy and Puerto Rico Electric Power Authority (PREPA) indicated that 11% of the population was still without energy services. (DOE, 2018) As weeks went by, various communities started to feel forgotten, as indicated by 214 families in the Vaga neighborhood in the municipality of Morovis. (Vélez, 2018) An island, which was and is economically unstable and with a declining infrastructure, with a debt of \$73 billion, has been deemed as incapable of fully recovering with minimal effort, as indicated by economists. (Egan, 2017)



Graph 02: Public Debt of Puerto Rico 2000 – 2015 (Lu and Alcantara, 2018) (Data source: Joffe and Martinez, 2016)

As evidenced in the Graph 02, the public debt accumulated through the years, increasing by forty-eight billion from two-thousand to two-thousand fifteen. In the Debt-to-GDP ratio, it constitutes 92.5 percent in contrast to the 73.8 percent of the United States. The local population in Puerto Rico has been burdened with increasing taxes, cuts in educational budgets and a decrease in investment from foreign companies, as a result of this accumulated debt. (White, 2015) These interdependent problems are becoming more complex as employment decreases, tourism is reaching all-time lows and poverty arises. (White, 2015) Many have noted the ill-structure of the establishment that leads "companies [to] hire less because of [the] burdensome costs, and [the scenario in which] workers lack incentive to work, since they know that welfare benefits can provide similar [or greater] income" (White, 2015)



Graph 03: Laboral Force in Puerto Rico 2000 – 2017 (Lu and Alcantara, 2018) (Data source: CIA World Factbook, 2017)

Since two-thousand seven, the fiscal crisis has led to a decrease in labor force and the local economy has drastically declined, as shown in Graph 03. Laboral force slowly increased from two-thousand to two-thousand six, reaching a peak of 1.4 million workers. But, since then, the number in the labor force has gradually decreased through the last decade. This has led many Puerto Ricans to leave the island and move stateside, which has in turn hindered the local economy as less labor force is present to carry the island through these dire times. The hurricane has aggravated the tumultuous scenario, leading more than 200,000 Puerto Ricans (6% of the population) to move to the States. (Mercy Corps, 2018) This exodus is expected to increase as, according to the 2012-2016 census, around 43.5% of the island population live in poverty. (US Census, 2017) This percentage is expected to have increased by 8% to 51.5%, post-Maria, based on research conducted by the University of Puerto Rico in Cayey. (CIC, 2017) Bringing more than 50% of the Puerto Rican population to be under the line of poverty, further encouraging the exodus of Puerto Ricans to the mainland.



Graph 04: Energy and Communications Data (Sept. 2017 – Feb. 2018) (Lu and Alcantara, 2018) (Data source: US Energy Department and Federal Communications Commission, 2018)



Figure 03: Energy restoration in the San Juan and Caguas municipalities (Lu and Alcantara, 2018)

Intertwining this scenario, the fragile socio-economic status of most Puerto Ricans, even before the hurricane touched land in Borikén (the original Taino name of Puerto Rico, meaning "the land of the brave lords"), with the troubling and unreliable power grid that is on charge of energizing most of the island, we end up with an extremely vulnerable society. One month after the hurricane, eighty-two percent of the population still lacked power with two of the most populated municipalities in Puerto Rico, San Juan (the capital city) and Caguas mostly in the dark (shown in figure 04). Five months after the disaster, the power grid of the island was still not fully recovered with governmental sources reporting that around eighty-one percent of energy restoration was achieved, and ninety-four percent of active cell service sites restored, as evidenced in Graph 04. (Irfan, 2018)

As the restoration efforts progressed, the local and international news outlets denoted that the slow-pace of the restoration resulted in many socially vulnerable communities to be endangered. These communities stand in remote locations, unenergized, due to snapped power lines, and uncommunicated, due to fallen bridges and debris-clustered roads, becoming increasingly vulnerable to health problems and detrimental socio-economic outcomes. (Associated Press, 2018) "After Hurricane Maria made landfall (September twentieth), [the] electricity service ceased for most residents of the U.S. territory of Puerto Rico. As of Monday morning (September twenty-fifth), the Puerto Rico Electric Power Authority (PREPA) had partially restored service to eighteen percent of customers in thirty-five of the seventy-eight municipalities." (Tsai and Zaretskaya, 2017)



Graph 05: Hurricane Maria-related energy outages (Tsai and Zaretskaya, 2017) (Data source: U.S. Department of Energy, 2017)

Graph 05 shows the sudden power outage immediately after the passing of the hurricane, which left more than one-million six-hundred thousand customers without electrical power. By mid-October, there was still above a million customer without the service, which comprise around eighty percent of the total costumers in the island. By March two-thousand eighteen, most of the regions in the island had around ninety-five percent of their population with electrical power service, with the exception of the Caguas region, which encloses most of the mountainous area of the island. This region lagged behind with seventy-three percent of the population with electrical power, six months after the hurricane. (as illustrated in Figure 05).



Figure 04: Percentage of population with Power (March 2018) (Lloréns Vélez, 2018) (Data source: USACE, 2018)

In addition to the fragile power grid and the economic crisis, Puerto Rico has placed high in multi-hazard exposure rankings. A global assessment of urban and rural population exposure to cyclones, droughts, and floods performed by the University of North Carolina, Chapel Hill, placed Puerto Rico as 17 out of the 181 countries and territories in the world, indicating that the island is very vulnerable to natural disasters. This denotes the importance of designing an efficient emergency and disaster plan that considers the intricate and interdependent struggles that the commonwealth confronts. If we look at a flooding exposure map (Figure 06), Puerto Rico's coastline has recurrently faced flooding during the past ten years. As a result, most of the studies and pre-emptive actions have been performed in the coastal towns.



Figure 05: Flooding Recurrence for the past ten years in Puerto Rico (Temblor, 2017)

The Category five hurricane's passing resulted in widespread flooding around the coastline and brought attention to the environmental vulnerability that central municipalities have, with many of them facing catastrophic flooding (as visualized in Figure 07) that left many Puerto Ricans without a home and brought down pivotal bridges that connected various remote communities to the urban centers.



Figure 06: Flooding catalyzed by Hurricane Maria (Temblor, 2017) (Data source: KatRisk, 2017)



Percent of Municipal Population not institutionalized with disabilities (2008 - 2012)

Figure 07: Percent of Municipal Population with disabilities (Padilla Elías *et al.* 2016) (Data source: CPSP-UPR, 2013 and U.S. Census Bureau, 2012)

Percentage Distribution by type of Disability for Children Aged 5 to 17 years in Municipalities with the largest proportion of disabled individuals:



Graph 06: Municipalities with the largest proportion of disabled individuals Prepared by: UPR-CPHP, 2013 Data source: U.S. Census Bureau ACS 2008-2012, 5 years. (Rivera Gutiérrez, 2013)

The resulting flooding in the central municipalities, mainly in the mountainous region, brought attention to the social issues that plague this region of the island. The mountainous region consists of sixteen municipalities found in the south-central zone: Aguas Buenas, Cidra, Cayey, Comerío, Aibonito, Naranjito, Barranquitas, Corozal, Orocovis, Morovis, Ciales, Florida, Jayuya, Utuado, Adjuntas and Lares, and has a substantial presence in studies that identify the municipalities with the largest proportion of disabled individuals, putting an emphasis in the percentage of disable individuals not institutionalized, mainly the municipalities of Morovis, Orocovis, Aibonito and Cayey (as shown in Figure 08), and disable individuals within the ages of five to seventeen years of age (as demonstrated in Graph 06). In the case of socio-economic studies, such as median household income evaluations, these municipalities oscillate between less than \$15,000 and \$19,999 annually (as showcased in Figure 09).



Figure 08: Median Household Income (2008-2012) (U.S. Census, 2014) (Data source: U.S. Department of Commerce)

These figures worsened through the next three years, with the median household income for Puerto Rico in 2015 being \$18,626, down from \$18,948 in 2014, and \$19,428 in 2013. (Puerto Rico Report, 2016) This same study denotes that, this contrasts with the increasing median household income in the fifty states. Alberto L. Velázquez Estrada, the manager of statistical projects at Pay Related Social Insurance (PRSI), indicated that the median household income decreased in sixty-five percent of the households in Puerto Rico between the census of 2011 and the census of 2016 (as shown in Figure 10).



Percentage change in the median household income: 2007-11 to 2012-2016

Figure 09: Puerto Rico Community Survey, 5-year estimates (Caribbean Business, 2017)

If we compare it with the median household income in the mainland, Puerto Rico's median household income is "thirty-two percent — less than one third — of the national average of \$56,500". (Puerto Rico Report, 2016) If we compare the commonwealth's median household income with "the state with the lowest household median income in 2015, Mississippi, which is approximately \$40,593. Median household income in PR is forty-five percent — less than half — of the median household income in Mississippi". (Puerto Rico Report, 2016) Highlighting the necessity to prioritize these municipalities in the scenario of a natural hazard.



U.S. Census's Estimates of population above 65 of age per municipality in 2016

Figure 10: Estimated percentage of population sixty-five years or older per municipality. (Data source: U.S. Census Bureau)

If we consider the percentage of elderly residents in the municipalities (shown in Figure 11), we can observe that within the municipalities found in the mountainous region of Puerto Rico, Cayey, Lares and Utuado have a high percent of population that is sixty-five years or older of age (nineteen to twenty-one percent). If we couple this data with other demographic studies of Puerto Rico, like percent of the population that stayed after the hurricane and the average household size, we can see that most of the elderly population in Puerto Rico (sixty years of age or older) remain in their household during the aftermath, opposite to the age groups younger than forty years of age (Graph 07). This becomes even more poignant if we look Graph 08, which was edified with data recollected by the American Community Survey (ACS) in 2016 and Kishore *et al* in 2018 that the household size in Puerto Rico is usually constituted by two individuals. It can be assumed that various households may very well be comprised by elderly couples, which denotes their vulnerability in the scenario of a natural hazard and highlights the importance of mobilizing help to these households with urgency.



Graph 07: Percent of persons that remained in the island vs. persons that left



Graph 08: Average household size in Puerto Rico in 2016 (Kishore *et al*, 2018)

As a result, this proposal suggests a social perspective to improve the disaster management plan in the island of Puerto Rico by evaluating how the government handled the recuperation efforts in the mountainous region of the island and how social vulnerability was incorporated in the planning process.

3. Literature Review:

The International Federation of Red Cross and Red Crescent Societies breaks down disaster management in three steps: Preparedness (Reduction of Risk), Response and Recovery (Strengthen Resilience) (as shown in Figure 12). The first step, preparedness, involves knowing the hazards that may occur in a given area, reviewing their potential environmental and health impact, training and guiding emergency responders to improve safety and reduce exposure risks during the emergency responses. (NIOSH, 2017) This step determines the efficiency of the second step, response. The response encloses the actions taken during the disaster. The third and final step, recovery, encapsulates the strategy implemented to mitigate and restore the area after the disaster.



Figure 11: Disaster management's components (IFRC, n.d.)

These three steps are analysed and assessed through emergency and disaster planning which "involves a coordinated, co-operative process of preparing to match urgent needs with available resources". (Alexander, 2015) Emergency and disaster planning is "the procedure of preparing systematically for future contingencies. It, usually, comes in the form of a document that specifies tasks and responsibilities adopted in the multi-agency response to an emergency." (Alexander, 2015) Emergency and disaster plans are pivotal for the economy as it ensures that businesses still operate even after serious disturbance (Kopytoff, 2012) and that lives be saved with the appropriate response. When the plans are inadequate and fail to achieve their role, the impact of disasters is exacerbated and may result in greater damage to the economy and more lives being lost after the disruption.

To fully achieve efficiency in the emergency response, experts have recognised and endorsed the need to incorporate social vulnerability data into the planning process. (Cutter et al, 2003) The necessity to assess vulnerability in disaster management has been embraced as a requirement to develop an efficient and comprehensive emergency plan, with many researchers highlighting social vulnerability as one of the pillars to understanding the risk component of natural hazards (Blaikie et al., 1994) (Tapsell et al., 2010). Previous research has concluded that within the social repercussions that arose due to storms and floods, "the impact on socially vulnerable populations has been woefully overlooked and underestimated." (Dunning, 2009) (Tapsell et al., 2010) A CRN report titled: "Factsheet: Social Vulnerability to Disasters" denoted that "ninety-four percent of all people killed by disasters between 1975 and 2000 were from the low-income or the lower-middle income strata". (Bara, 2010) This brings to attention the definition of vulnerability. The International Federation of Red Cross and Red Crescent Societies defines 'vulnerability' as "the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard". The CRN report defines it as "a susceptibility to harm". Vulnerability can result from poverty, but as the IFRC states, "it can also arise when people are isolated, insecure and defenceless in the face of risk, shock or stress". For example, "young children, pregnant and nursing women, unaccompanied children, widows, elderly people without family support, disabled persons" (IFRC, n.d.). In the scenario of a disaster, vulnerability increases, hindering these individuals' capacity to cope with the risks that arise. This is the definition of social vulnerability, as explained by Füssel in his work "Vulnerability to climate change and poverty" (2012): "the lack of capacity of individuals, groups or communities to cope with and adapt to any external stress placed on their livelihoods and well-being". On a general level, "the concept of social vulnerability recognizes that these risks are not equally distributed within society, and that this risk difference is not solely attributed to the hazard, but to inequalities and conditions that exist in everyday life, prior to the onset of a specific hazardous event." (Bara, 2010 (pp. 5))

Social vulnerability was incorporated into disaster management and hazard literature between the 1970's and 1980's. (Bara, 2010) In the CRN report, this inclusion is implied to have been catalyzed by the words of the American geographer and pioneer of social-ecological studies Gilbert Fowler White: "Floods are 'acts of God', but flood losses are largely acts of man" This brought a social perspective to the nature of disasters. This ramified to changes in the step of preparedness like "building capacities to withstand the hazard and tackling the roots of vulnerability like inadequate access to resources and livelihoods" (IFRC, n.d.). Since its incorporation, the importance of social vulnerability in disaster management has been highlighted by various outlets. "An Associated Press report on Hurricane Katrina [unveiled that] nearly 25 percent of those living in the hardest-hit areas were below the poverty line, about double the national average." (Dolan and Messen, 2012) In this same report, it was denoted that "20 percent of the low-income households had no car." (Dolan and Messen, 2012) This impacted their ability to evacuate in a timely manner the risk areas.

Cutter et al attested that "socially created vulnerabilities are largely ignored, mainly due to the difficulty in quantifying them, which also explains why social losses are normally absent in after-disaster cost/loss estimation reports". This study also denoted that social vulnerability should "also include place inequalities-those characteristics of communities and the built environment, such as the level of urbanization, growth rates, and economic vitality, that contribute to the social vulnerability of places." This exemplifies the dynamic nature of vulnerability research. "The fact that the concept of vulnerability has been used in different academic disciplines has led to a myriad of vulnerability definitions and various conceptualizations" (Bara, 2010 (pp. 5)) Regardless of the definition or the conceptual approach, "social vulnerability data has become a sine qua non element for decision-making". (Mavhura et al, 2017 (pp. 104)) Social vulnerability data allows setting up "priorities by deriving knowledge about spatial social vulnerability patterns, monitor progress in vulnerability reduction, and measure the effectiveness of mitigation approaches against disasters" (Mavhura et al, 2017 (pp. 104)) This is the root of the intrinsic nature of social vulnerability in disaster management, its ability to elucidate where the response step need to be more immediate and assertive.

Research conducted on local governments in the state of Virginia, United States, and their responsibility on assessing and incorporating social vulnerability to their disaster management plans has displayed that "local governments recognize that completing this endeavor comes at an expense and requires technical expertise. Such assistance is important for local governments, particularly in rural areas, that lack financial and staff resources to mitigate and adapt to their flood risk." (Schiavinato and Payne, 2015 (pp. 4)) As the most proximate governmental body, local governments, have the ability to aid social capacity building to minimize the vulnerability within their jurisdiction. The research denotes the responsibility that governmental bodies have to identify the appropriate sectors "where projects can be prioritized to aid in resilience, leading to reduced disaster impacts." (Schiavinato and Payne, 2015 (pp. 4)) The researchers brought to question "How local governments can increase their chances of receiving state and federal assistance?" (Schiavinato and Payne, 2015 (pp. 4)) This connects the role of government in the

amelioration of social capacity building and the reduction of social vulnerability. Underlining the concept of social capacity, which is described as "the interpersonal and intrapersonal links in the community, relations and motivations among the people and the amount of interaction between people. During and after a disaster has struck in an area the ability of the local people to [act] and guarantee the sustainability of the ongoing projects" (Rahman and Kausel, 2013 (pp. 56)), it is a pillar of community-based resilience in the scenario of a natural hazard (Patel *et al*, 2017).

Community resilience has become a concept of interest in disaster management in recent years (Patel et al, 2017). It seeks to "focus on how best to help communities to help themselves, with a concomitant focus on understanding what factors contribute to making a community resilient to disasters" (Patel et al, 2017). The U.S. Department of Health and Human Services has denoted the necessity to improve and adopt this concept in communities, "addressing these threats calls for an approach that combines what we know about preparing for disasters with what we know about actions that strengthen communities every day. It focuses on enhancing the day-to-day health and wellbeing of communities to reduce the negative impacts of disasters." (HHS, 2015) This concept and the overarching inclusion of social vulnerability in disaster management have been proven to be beneficiary in various countries, such as Australia and the United Kingdom (Coles and Buckle, 2004) It is, usually, addressed to as communitybased disaster management (CBDM), an approach that encourages capacity building in communities "to assess their vulnerability to both human induced and natural hazards and develop strategies and resources necessary to prevent and/or mitigate the impact of identified hazards as well as respond, rehabilitate, and reconstruct following its onset" (PreventionWeb, 2008).

Community resilience, CBDM in general, is known to provide extensive benefits, such as "preventing loss of life and injury, reducing property damage to home and businesses, reducing business interruption and revenue loss and helping to lower emergency response and disaster recovery costs". (FEMA, n.d.) It constitutes three directional traits that attend the necessities of a community in the scenario of a hazard: "a) the resistance direction, which refers to the ability of a community to absorb perturbation. b) the recovery direction, which focuses on the speed and ability to recover from the stressors. c) the creativity direction, which addresses the ability of a social system to maintain a constant process of creating and recreating, so that the community not only responds to adversity, but in doing so, reaches a higher level of functioning" (Kimhi and Shamai, 2004 (pp. 441)) It "empowers communities to be pro-active

and creates a space for them to develop strategies on their own terms rather than waiting for already overstretched governments and NGO's [efforts]" (PreventionWeb, 2018) The research conducted by Coles and Buckle (2004) indicated that visualizing resilience as "a multi-dimensional attribute" has "in its different forms contributed in various but equally important ways to disaster recovery".

Taking into consideration the socio-economic state of Puerto Rico, a CBDM can prove to be very beneficial to reduce social vulnerability in the island and minimize the adverse effect of a natural hazard in the vulnerable sectors of the mountainous region. This will improve disaster preparedness as community resilience not only benefits the communities, but also disaster planners. (HHS, 2015) The U.S. Department of Health and Human Services consider that "strengthening public health, healthcare and social services, promoting wellness and health alongside disaster preparedness, expanding communication and collaboration on a governmental and community-level and building social connectedness" (HHS, 2015) are key strategies to achieve community resilience and help disaster planners achieve successful emergency response plans. "These strategies have become increasingly important in the face of global climate change, increased populations expanding into more vulnerable regions, and the heightened recognition of a need for greater linkages between top-down governmental and community level responses" (PreventionWeb, 2018). Thus, this study will incorporate these elements of CBDM, namely community resilience, to find alternatives that can reduce social vulnerability and improve self-sufficiency in the communities of the mountainous region of Puerto Rico.

4. Theoretical and Analytical Framework:

The theoretical framework used to assess the applied knowledge on social vulnerability in the mountainous region of Puerto Rico in the disaster management is an adapted framework for approaching social vulnerability and qualitative research (Parker et al., 2009). This framework incorporates the structure of the Environmental Inequity Formation model by Sze and London (2008) in their "Environmental Justice at the Crossroads" research. Mavhura *et al* (2017) (pp. 109) also adopted this framework to: "develop context-specific social vulnerability variables that were identified by key informants from the community as relevant to the hazardous event that they had experienced."

The following diagram (Figure 13) details the research stage components of the framework: First, the negotiation stage in which the stakeholders are interviewed. The second stage is problem identification where the roots of the obstacles present in the disaster management response and the consequences are highlighted. Finally, the third stage is solution. In this stage, the problems are analyzed, and potential solutions are proposed. (Sze and London, 2008 (pp. 1333))



Figure 12: Model of the Environmental Inequity Formation based on Pellow (2000) (Sze and London, 2008 (pp. 1333))

Taking this into consideration, this framework will identify factors that have reduced or exacerbated the natural hazard's impact on the vulnerable population in the mountainous region of Puerto Rico through interviews with stakeholders and professionals in the field. Various factors can be identified as crucial to implement substantial change in the disaster management's steps (preparedness, response and recovery):

- Increment the allotment of funding for posthazards and disasters relief.
- Improve communication and preparedness on the administrative and executive level.
- Modify the impuissant perception against environmental resilience.
- Comprehend the necessity to increase postdisaster support and recovery.
- Improve the personal preparedness and the social dynamics of risk perception.
- Reduce the density of households edified in risk areas.

Table 01: Identifiable potential factors (Tapsell et al., 2010 (pp 28))

These factors are meant to be precursors to shift responsibility and improve community resilience, with them being grouped by themes that serve as pillars for social capacity building. (Tapsell et al., 2010) Acknowledging Tapsell's assessment of the 'social vulnerability perspective', this framework will aim to help identify and understand how to improve the community resilience of the sectors that are more susceptible to damage in the scenario of a natural hazard, as well as to aid reduce the hindrance in the aftermath. This study takes on a qualitative approach and targets potential solutions and strategies with the intention of ameliorating mitigation and fortify social capacity building.

5. Methodology:

This is a case study of disaster management in the vulnerable mountainous region communities of Puerto Rico during Hurricane Maria in 2017. Data collection methods included in-depth, open-ended interviewing, document and media analyses, and secondary data analysis to identify relevant factors and remedies to alleviate environmental inequalities and socio-environmental consequences. To execute this study, eleven interviews with stakeholders (five mayors, one municipal administrator and five professionals in the field that work in environmental affairs and planning or a related field (more information in Appendix A (pp. 72)) were conducted. The interviews emphasized the acknowledgement and incorporation of social vulnerability studies in the disaster management planning, as well as the identification of factors that have perplexed the efforts in the aftermath of the disaster. In this project, the economic status, the population with disabilities (physical or mental conditions that limit their activities and may restrict their social capabilities), the elderly and the children represented the vulnerable sector in the island. These interviews were coupled with data compiled through previous research, such as Ralph Rivera Gutiérrez's social vulnerability assessment, local news media and committee hearings.



Figure 13: 48-hour rainfall from 8 AM AST Sep 19, 2017 to 8 AM AST Sep 21, 2017

(NWS, 2017)

As showcased in Figure 14, the amount of rainfall that poured down the island during the first 48 hours of Hurricane Maria, reached between 35-40 inches in the central and mountainous region of the island (specifically, the municipalities of Cayey, Caguas, Cidra, Orocovis, Villalba and Juana Diaz) and a minimum of 10-15 inches around the coastline that resulted in floods. This research focused on the most physically affected municipalities found in the mountainous region of the island:



Figure 14: Focal Point Municipalities

(1) Morovis, (2) Orocovis, (3) Aibonito, (4) Comerío, (5) Cidra, (6) Cayey and (7) Caguas

	Table 02: Focal Point Municipalities		
	Area: 31.50 square miles (082.00 kilometers square)		
	Population: 26,493 (2010's Census)		
Aibonito	Socially vulnerable municipality with ~18% of the children surveyed between the age		
ΑΙθοπιο	of 5-17 possessing a physical disability. (Rivera Gutiérrez, 2013)		
	The town with the highest elevation in Puerto Rico, located at 2,401 feet (731 meters)		
	above sea level.		
	Area: 59.00 square miles (153.00 kilometers square)		
	Population: ~138,000 (2010's Census)		
	Fifth-largest municipality in Puerto Rico.		
	The median household income has either remain the same or decreased by 11% in this		
	municipality between the years 2011-2016 based on research performed by the U.S.		
	Census Bureau.		

	Cayey	Area: 50.20 square miles (130.01 kilometers square)
		Population: 48,119 (2010's Census)
		Socially vulnerable municipality with ~19% of the children surveyed between the age
		of 5-17 possessing a physical disability. (Rivera Gutiérrez, 2013)
		The median household income has either remain the same or decreased by 11% in this
		municipality between the years 2011-2016 based on research performed by the U.S.
		Census Bureau.
		19-21% of the population is sixty-five years of age or older.
-	Cidra	Area: 36.46 square miles (094.42 kilometers square)
		Population: 43,480 (2010's Census)
		Socially vulnerable municipality with 14.5% of the children surveyed between the age
		of 5-17 possessing a physical disability. (Rivera Gutiérrez, 2013)
		The median household income has decreased by 12-24% in this municipality between
		the years 2011-2016 based on research performed by the U.S. Census Bureau.
-	Comerío	Area: 28.24 square miles (073.13 kilometers square)
		Population: 19,983 (2015)
		The median household income has either remain the same or decreased by 11% in this
		municipality between the years 2011-2016 based on research performed by the U.S.
		Census Bureau.
-	Morovis	Area: 38.70 square miles (100.30 kilometers square)
		Population: 32,610 (2010)
		Socially vulnerable municipality with ~24% of the children surveyed between the age
		of 5-17 possessing a physical disability. (Rivera Gutiérrez, 2013)
CEU eTD Collection	Orocovis	Area: 71.10 square miles (184.17 kilometers square)
		Population: 23,423 (2010)
		Socially vulnerable municipality with ~16.5% of the children surveyed between the
		age of 5-17 possessing a physical disability. (Rivera Gutiérrez, 2013)
		The median household income has either remain the same or decreased by 11% in this
		municipality between the years 2011-2016 based on research performed by the U.S.
		Census Bureau.

They reflected the impact of the disaster management implemented, post-Hurricane Maria, in the mountainous region of the island and how it has either aided or exacerbated the aftermath scenario, as well as the municipality-level concerns of the strategy planning and the administrative perception of the emergency response of the state government and the federal government. Analyzing the repercussions of the poor disaster management response on the vulnerable sectors and examining the opportunities that the post-Maria scenario bring to the sustainable development of the island of Puerto Rico will answer the research question:

"To what extent, and how, were vulnerable communities supported in the disaster management response to Hurricane Maria in the mountainous region of Puerto Rico?"

The objective of this analysis is to explore the benefits that a community-based approach can bring to disaster management and examine how community resilience can reduce social vulnerability in the mountainous region of the island.

Interview protocol:

- Which were the pillars of the strategy implemented for the disaster management? In this strategy, were the vulnerable sectors priorities?
- 2) How was the environmental impact assessed in the vulnerable sectors?
- 3) For the planification process of the disaster management's strategy, were social vulnerability studies that defined the minority population, the population with disabilities and the low-income population in Puerto Rico considered?
- 4) If yes, how was the planification process modified to consider and aid these communities' necessities?
- 5) Did communities in the vulnerable sectors participate in the planification process of the disaster management's strategy?
- 6) Was there an assessment of the potential socioeconomic consequences that the vulnerable sectors would face during and after a disaster?
- 7) Do you consider that the implemented strategy was successful? What can be done to improve the strategy?
- 8) What is the most detrimental factor that has slowed down the restoration efforts?
- 9) Studies denote that the lax environmental policies and regulations in Puerto Rico have resulted in a deteriorated infrastructure and a damaged environment. The vulnerable sectors are the most impacted by these through increasingly regular power failures and significant increases in water pollution. Which actions have been taken to make environmental policies and regulations in the island stricter?
- 10) Considering the fragility of the energy grid after Hurricane Maria (the grid has collapsed twice after the hurricane), have the benefits of green energy been considered to resolve the ongoing energy crisis?
- 11) How would you describe the federal government's response to the disaster?
- 12) Has social vulnerability been incorporated into disaster planning going forward (including in the redesign of the energy grid)?

These questions provided the necessary data to analyze the strategy implemented for the disaster management post-Hurricane Maria in Puerto Rico and allowed the identification of problems that can be addressed with a community-based approach towards disaster management, if there were any, and the potential for improvement in the strategy planning. The relevant findings in their responses were grouped by theme and coupled with quotes and articles that contextualize the findings.

Additionally, to the interviews, secondary data was recollected from the local news media's document and media analyses. This data helped contextualize the gathered data from the interviews and expand in the consequences of the administrative decisions made during and after the passing of Hurricane Maria. This data ranged from televised interviews, federal hearing committees, law bills and statistical data gathered and analyzed by the U.S. Census Bureau.

6. Results and Analysis:

The data gathered from the interviews and the secondary data sources emphasized the importance of governmental communication and collaboration, as well as the positive impact that organized communities had on the emergency response in various municipalities. The usage of renewable energy has become a forefront topic after the passing of the hurricane denoting an openness and willingness to adapt and minimize social vulnerability albeit the economic crisis weighing down on the island. The data was grouped in seven themes that were emphasized as relevant by interviewees: Governmental collaboration and communication, environmental affairs, economic crisis, support mechanisms, logistics, historical/cultural practices and behavioural health. These themes encompass the concerns, the experiences and the opinions of the interviewees along with compiled information that contextualize their insights.

6.1. Government Collaboration and Communication:

Strengthening government collaboration and communication is one of the pillars to successfully promote community resilience and edify a CBDM (HHS, 2015). It induces trust and confidence in community members towards their leaders. It helps maintain a hopeful perspective and nurture an optimistic approach towards the mitigation efforts. The data recollected denotes that this theme is of outmost importance and possibly the most concerning problem to the officials interviewed, as they felt that the lack of communication was rooted in either distrust or the lack of a solid disaster management plan.

Defederalizing disasters will facilitate actions on a local level to provide relief.

"The federal government federalized the recuperation [process]. The answer of the USACE (United States of America's Corp of Engineers) was very slow. The lack of materials, for example: we had areas that were repaired completely [by the municipality], waiting for transformers to provide power to various sectors." - José A. Morales Rivera, referring to how the understock of materials from the federal agencies slowed the recuperation process in the municipality of Cidra. "The inhabitants come [to the municipal offices] asking for help. But, what can we do? I'm still waiting. Because, this is a wheel. I have to wait for the federal government or for the state government to send me funds, so I can help these families." - Carmen Maldonado González claimed as she expressed her frustration with feeling handtied

and unable to help her population. The interviewees denoted that past catastrophes in the mainland may have limited the funding from FEMA and impacted the quality of the relief efforts due to limited resources. This elucidates the importance of empowering the state government and the municipal governments to have a more active role in the recuperation efforts as they have a better understanding of the necessities of the Puerto Rican people. Albeit, this empowerment was deemed unlikely by the interviewed officials due to the lack of trust from the federal government towards the local government.

Trust-building between the federal and local levels of government is needed to promote efficiency and efficacy.

William Miranda Torres, the mayor of the municipality of Caguas, elaborated: "*The state* government as a result of years of bad administration now has a negative reputation. This has heightened the bureaucracy to receive [emergency] funds. The mayor of Bayamón shared with us, in a reunion, a situation he [had to endure]. FEMA has categories to disburse funds. These categories go from "A" to "G". The categories "A" and "B" are for emergency cases. Those are the first to be attended. He says that he hasn't been disbursed the emergency funds, because of three or four extra hours worked by a personal, that could be like \$100. But, how much money is detained for those \$100? \$8,000,000?" He denoted that it is understandable and necessary that such precaution be exercised, to avoid mishandling of governmental funds, but in the case of an emergency, such precautions can result in crucial time being wasted and life-or-death events not being addressed on time. These extensive inspections can be detrimental for vulnerable communities, as the longer the help takes to arrive, the more emotionally-damaging the aftermath becomes.

"In the scenario of an emergency, nothing arrives [from the state government]. This is, mostly, federal funds and those are handled by FEMA and it has been very slow. The level of bureaucracy is horrible. It comes as a consequence of untrustworthiness that the state government has created due to past decisions." – William Miranda Torres elaborated. This concern was also supported by Carmen Maldonado González, the mayor of the municipality of Morovis, who stated: "The government of the United States does not have trust in the government of Puerto Rico. That's the reality, we have seen that. That complicates [the restoration efforts], because we could have already received those funds and we would be in the streets reconstructing now." The wariness of the federal government regarding the state government of funds delayed the restoration efforts and limited various

municipalities from providing their support. This was perceived to be connected to the federal government's unawareness of the magnitude and the seriousness of the transpired disaster.

Ensuring that the Federal Government is acknowledgeable of the seriousness and the magnitude of the disaster.

"[Without the Federal Aid], the processes of recuperation would have been very slow and very unfortunate. [But], I also tell you that it wasn't at the speed nor the seriousness that the times warranted." - Rolando Ortiz Velázquez, the mayor of the municipality of Cayey expressed regarding the federal government's aid in the restoration efforts. The interviewed municipalities felt that these shortcomings ranged from insufficient food provisions, like Carmen Maldonado González related: "I had to go to the schools of my municipality. Open the school meals centers and take the stored food, so I could provide it to the people. Because, we didn't have enough food to provide. The food provided by the state wasn't enough. Too little for 32,000 inhabitants.", to a lack of urgency from the appointed officials as denoted by Guillermo Rivera Cruz, who indicated that: "There wasn't a sense of urgency from the federal agencies." This lack of urgency has been attributed to the miscommunication between the state government and the federal government by many of the interviewed officials and experts. This highlights the necessity to strengthen the communication between the state government and the municipal government as the state is the spokesperson of the municipalities. The state government can help provide relief in a timely manner if it has a more comprehensive understanding of the necessities of the municipalities, as these necessities should also be reflective of the necessities of the communities.

The importance of bureaucratic efficiency in facilitating speedy recuperation efforts.

In an emergency scenario, bureaucratic protocols need to be eased and should be less rigid, as extensive processes consume valuable time to treat the needs of the vulnerable sectors in the municipalities. Albeit, the municipalities indicated a desire to take immediate action in recuperation efforts, the necessary paperwork related to act took too much time. "*Too much protocol. We didn't pick up not even one pound of debris. Because, [we needed] to comply with the area for the gathering of these materials, we needed to make numerous constructions, as well as extensive consultation. When in an emergency, the state agency could have advised here.*" - José A. Morales Rivera, the municipal administrator of Cidra, highlighted the need for the state government to accelerate permission protocol associated to recuperation efforts. He

detailed the procedure followed in the reconstruction of the road no. one-hundred seventy-one that sank due to an aqueduct tube collapse in his municipality. "[The municipality could have] repair it and [the state government could have] paid [the municipality] later. This was [an exchange] with the state government. We had to close the road and wait for a private company to arrive. We lost like four or five months, when it could have been done in two months."

An indication of the willingness of the local governments to have a more active role in recuperation efforts, this scenario elucidates the role of the municipal government and its responsibilities in the scenario of a natural hazard. Municipal governments aren't responsible of reconstructing light poles, restoring electric power and fixing aqueduct tubes, as these are under the jurisdiction of the Puerto Rico Electric Power Authority (PREPA) and the Puerto Rico Aqueducts and Sewers Authority (PRASA), respectively. The municipal government plays an Emergency Support Function (ESF) role as attested by the Law of the State Agency for the Management of Emergencies and Disaster Management of Puerto Rico 25 L.P.R.A. § 172 (2008) (Government of Puerto Rico, 2008).

"Most of the infrastructures in a municipality is not owned by the municipality. It's owned by the state. Working in these areas is forbidden as instructed by the state agency. For example: Light poles fell, and the lines fell. The gestions of PREPA said 'my efforts are restoring electrical power, not picking up the cables on the ground'. Even though, those are also their responsibility. What happens? The municipality had to go to PREPA and formally ask for a communicate that indicated that they couldn't pick up the lines, so I can clean it up. We had to consult with FEMA before acting and ensure that we would get refunded the expenses to clean the electrical cables and the related debris." - Guillermo Rivera Cruz, the director of environmental affairs of the municipality of Caguas, related when inquired about the quality of communication with the government-owned corporations (PREPA and PRASA) and the supportive role provided by the municipality in the corporations' efforts. He emphasized the disposition of the municipal governments of aiding the restoration efforts. But, as it soon became clear, the restoration efforts are federalized in Puerto Rico. This brings into the equation, the pivotal role that governmental collaboration and communication plays in the disaster management plans in Puerto Rico.

As showcased in previous research conducted in the state of Virginia, United States, (Schiavinato and Payne, 2015), the local government has a desire and a responsibility of assessing and incorporating social vulnerability to their disaster management plans. The need

for collaboration between municipal (or local) government and state government, as well as the government-owned corporation, is key to ensure that the necessities of the communities are heard and accounted for. As municipal governments have a direct interaction with communities, their knowledge of spatial social vulnerability patterns and their ability to monitor progress in vulnerability reduction is key to measure the effectiveness of the mitigation strategies implemented. This means that the municipal government is the gateway to know if the emergency response is adequate and if it is being effective. It also is the spokesperson of the various community leaders within each municipality, which highlights their need to be more active in recuperation efforts. Their actions will be more reflective of the needs of the communities and solidify a community-based approach towards disaster management.

An efficient communication between the state government and the municipal government will ensure an adequate emergency response.

"There is a lack of communication with the directors on [the state] level. A lack of understanding of the capacities that the municipal government [possess] regarding other governmental agencies and the lack of planification on a state-level in relation to the recuperation process." - Rolando Ortiz Velázquez, the mayor of the municipality of Cayey, regarding the difficult collaborative process with the state government. This was echoed by Carmen Maldonado González who asserted: "It was terrible. We barely received any help from the state government. It was very difficult. From their end, there wasn't any communication. We, the mayors, relied on collaborating with each other. I asked for help from the diaspora and the exterior officials and, thankfully, that message was received."

The need for efficiency of the state government's plan was also addressed by Jaime Luis García Mercado, the Director of the emergency management division of the municipality of Comerío, who pointed out that: "*what the municipal governments hope for is that the federal government would allow us to have accessibility to the funding requests directly with them (the federal government). That the requests don't be channeled towards the state government, because by being channeled, the requests are dilated [into one giant and sole request]. As a consequence, the citizens don't receive the one-hundred percent of what was requested." This perspective may prove counterproductive as having seventy-eight municipalities requesting directly to the federal government would probably be overwhelming and less likely to be attended with the necessary urgency. But, his wariness towards the state government's plan of* action is supported by other interviewees, such as William Alicea Pérez, who voiced: "Be it the current administration of the state government or in future administrations, there should be better coordination with the municipalities. The Federal agencies should go hand-with-hand with the municipalities, so situations like this don't happen again."

The responses denote the need to ensure collaboration between the municipal government and the state government. Reinforcing a cohesive and synergetic approach between the municipality and the state will hasten the relief efforts for the vulnerable communities, as there will be an efficient communication with the most proximate government to the communities and the government most proximate to the funding source. This will result in actions being more reflective of the needs of the communities and an appropriate understanding of the urgency required to address them.

Previous research in social vulnerability of tribal governments has denoted that "government actions that promote self-governance, protect cultural integrity and strengthen local economies can begin to address societal inequity" (Sarcone, n.d.) In the context of the mountainous region of Puerto Rico, encouraging community integration and capacity building will strengthen community resilience in the face of a natural hazard, potentially adverting a looming disaster scenario for the vulnerable sectors. This can be achieved through the direct action of the municipal government. But, as the municipal government depends on the funding of the state government, an enrichened communication pattern between both governmental components will help pave the way for the funding necessary for such actions to be executed.

The efficient governmental communication will positively impact the federal agencies' efforts.

"The Federal agencies were disorganized. All of them, including FEMA and USCE. There wasn't coordination with us nor between themselves. For example, in the morning, the army sent a helicopter to bring food for certain sectors. Later in the day, the navy came to the very same sectors. In the evening, the FBI arrived in the very same sectors." - Jesús E. Colón Berlingeri claimed that with more collaboration between the federal agencies and the municipality, there would have been a better understanding of the needs of the residents and a faster pace in relief efforts. "The aid from the exterior arrived, from Puerto Ricans living in the mainland and other officials. They sent emergency roof tarps, because FEMA only gave us two-hundreds of those for more than one-thousand families that were left without a roof." - Carmen

Maldonado González highlighting how the relief efforts from the federal agency, FEMA, weren't reflective of the scenario that she was facing on a day-to-day basis in her municipality. She did claim that she, at least, was able to have communication with the federal government by being vocal through the local news. But, other mayors didn't exercise such outspokenness, like Jesús E. Colón Berlingeri, the mayor of the municipality of Orocovis. "*None, none, none*" – he answered regarding if there was communication with the federal agencies immediately after the passing of the hurricane.

He expressed frustration as his municipality was one of numerous that were completely uncommunicated as every single pathway to enter or exit from the municipality was blocked by landslides or debris. Other officials, such as Guillermo Rivera Cruz, detailed the inefficient process implemented by the federal agencies: "We had a lot of electric battery waste in our municipality, which cannot be sent to the dump. We, the municipality, edified a waste management project. To implement it we needed to consult and collaborate with the team leader of the brigades sent by FEMA. But, every time I reached an agreement with a team leader, this one was rotated with another one. This happened five times. The problem was that there didn't seem to be communication between them. So, I had to restart the agreement process with each of them, every time. These shifts happened, monthly. I was able to put the project to work with the fifth team leader. Do you know how many electric batteries ended up in the dump? The process took too much time." This follows the consistent testimony of the interviewed officials that ensured their willingness to spearhead and contribute with the recuperation efforts, as Rolando Ortiz Velázquez attested: "If the governor would have given space to the mayors to work in the recuperation of the energy grid, I think that the results would have been different. Now, the municipalities are resolving the details that the [hired private companies] had to attend but didn't attend on time."

It is important to mention that even though there's a willingness to take charge from the municipal governments, they cannot take full responsibility of the recuperation efforts as their funds are limited. Rivera Cruz denoted that whatever money comes from the federal government, it goes directly to the state government. He claimed that the money's first stop is there, and the state government allocates the funds for each municipality based on population size and the area of the jurisdiction. Here lies an obstacle that can be overcome by incorporating socio-economic studies in the planning process of the disaster management. The identification of the percentage of the population within the small-sized municipalities that are socially vulnerable can help ensure that the allocation of funding is more representative of the needs of

the communities. This underlines the importance of social vulnerability in the planning process as it contextualizes the strategies and refocuses the attention to the inhabitants that need the most help in an emergency scenario. The responsibilities of the municipalities are expected to be within the realm of support provision. They are allocated a budget that is destined to their responsibilities, as such their willingness to participate more actively is blocked by their expected handling of funds and the amount of funds possessed. Additional to the need to reinforce efficient governmental collaboration and communication, there was a claim of political bias from the part of the state government and its owned-corporations, such as PREPA.

Addressing bias to political affiliations in the state government and the governmentowned corporations will help tackle social inequities.

"I'm going to tell you the truth. This may sound cruel. I worked thirteen years in the Puerto Rico Electric Power Authority. I know how they function. [Morovis] was to be energized in the very first three months after the passing of the hurricane, but [in Puerto Rico] it does not work like that. This is politics. If you don't belong to the [political party] spear-heading the current government, they push you aside. And when there's time, then we'll go to where you are. That happened here." - Carmen Maldonado González mentioned. She also shared that she had to write, directly, to the U.S. Corps of Engineers for them to inspect what was happening with the water systems, because the Puerto Rico Aqueducts and Sewers Authority was also uncommunicative with the municipality. This connects with the rising concerns of the lack of transparency from the government-owned corporations that the local media has highlighted through a study they performed on May 2018.

This study consisted of a questionnaire sent to the mayors of the seventy-eight municipalities, fifty-two of these revealed a reality that differed from the numbers released by PREPA and PRASA of the sectors enjoying of their services. The sum of households without basic services, eight months after the hurricane, reach one-thousand. (Figueroa Pérez, 2018) Municipalities, such as Cayey and Orocovis, still have people without potable water. In this same study, the municipal government of Orocovis mentioned that they are still providing bottled water to thirty percent of their population. This contrasts with the communicate emitted by PRASA that claims that the services are running normally with the usual small interruptions. The mayor of Yabucoa, Rafael Zurillo Ruiz, in this same study, revealed that forty percent of his municipality is without electrical power. He grows even more concern as PREPA indicates that ninety-eight-point-five percent of the island is energized, mentioning that "Yabucoa is part of Puerto Rico

too." This expression has become a slogan for the people of Yabucoa who feel forgotten. Statistically-speaking, it is possible that the numbers of PREPA are accurate, but it also highlights the poor strategy implemented as Yabucoa, additionally to be a coastal town, was the entrance point of the hurricane and the first municipality left in darkness. This fosters the necessity to visualize environmental vulnerability and how certain sectors in the island need to be emphasize.

6.2. Environmental Affairs:

Social vulnerability and environmental affairs go hand-to-hand, namely through the implementation of renewable energy alternatives to provide basic services to the most vulnerable communities found in remote areas in the mountainous region of Puerto Rico. The governmental officials claimed ongoing work being done in the field to ensure that the unfortunate circumstances faced by these communities in the aftermath of Maria aren't repeated again. The environmental experts denoted that the passing of Maria shifted concerns and unveiled the latent environmental vulnerability that plagues this region of the island. This brought into attention the shifting struggles that vulnerable communities face and how reworking the disaster management plans to reflect their particular concerns is key to accomplish a successful emergency response.

"There are sectors that nobody expected to be vulnerable, specifically to flooding. Even the FEMA plans have incorrect delineations now. They need to be revised." – Hanna K. Rodríguez denoting how new vulnerable areas emerged and how the current flood models used for disaster management and planning have become obsolete. This was also supported by Félix Aponte González, an environmental planner. "Now, these plans need to be revised to illustrate the changes in population density and the emerging vulnerable sectors, specifically in the mountainous region." These changes came as a surprise, even to the few specialists that work on a municipal-level, as Rivera Cruz attested. But, he indicated that: "In terms of examining the environmental impact, we, the municipal government, do not have the power to evaluate it. As this role falls on the state government." This assertion contrasts with the municipality's responsibility of edifying emergency response plans. Rivera Cruz also mentioned that Caguas is one of the few municipalities that possess an environmental affairs department. This was acknowledged by the mayor of the municipality of Caguas, William Miranda Torres, himself: "Only eight municipalities out of the seventy-eight have an environmental affairs division."

Nevertheless, each municipality asserts that they are pursuing alternatives to minimize the socioeconomic impact that a natural hazard, like Hurricane Maria, can have in their jurisdiction.

Actions are being taken to incorporate renewable energy in each municipality.

"We are negotiating with a Canadian company to establish a factory and [supply] personal power generators." - José A. Morales Rivera asserted with delight, as a sign of the potential future ahead for the municipality of Cidra. A movement that Miranda Torres is also taking part of: "For years, we have been using models. We have done studies regarding wind power and have identified areas with lots of wind. [We have also done] demonstrative models of photovoltaic systems in communities. [These communities] accepted to change their lightbulbs for solar panels, representing a reduction of 20-25% of energy expenses and [other] alternatives have been explored."

"That is one of the proposals that I did to energize the remote neighborhoods in the municipality. I still have full neighborhoods without electrical power (May 2018). So that these households can have a source of renewable energy and they don't have to go through this experience again. These neighborhoods are three: "San Lorenzo", "Pasto" and "Vaga". The plan is to install solar panels in each household." - Carmen Maldonado González indicated regarding renewable energy initiatives on a municipal-level. Coincidentally, these very same neighborhoods that she mentioned, called "barrios" in Puerto Rico, were inaccessible for months, since the passing of the hurricane on September until the beginning of April, due to the collapse of the bridge that connected them to the urban center and other neighborhoods in the municipality. In April, a provisional bridge was edified. (Agencia EFE, 2018) "We are currently working on an ecotourism project with the hydroelectrical dam in our municipality where people can enter the dam and see the waterfalling within, which is quite impressive. We also hope to use the hydroelectrical system to produce energy once it gets repaired. We project the development to take two years." - Jaime Luis García Mercado and Heriberto Fernández López regarding similar initiatives in Comerío.

In some municipalities, the impact was so great that immediate movement towards renewable energy plans were put in action with the aid of overseas organizations, such as Orocovis, which saw local businesses being energized in the midst of the crisis. "Organizations came to lend a helping hand and set up solar panels, so the municipal economy and the businesses could continue, mainly to provide basic goods, like food." - Jesús E. Colón Berlingeri, who also mentioned that his municipality has been using solar panel-energized communal aqueducts that help provide drinking water to 40% of the inhabitants of the municipality. Communal aqueducts, known as NON-PRASA as they don't depend on the Puerto Rico Aqueduct and Sewer Authority, are present in 45 out of the 78 municipalities in the island and provides drinking water to more than three-hundred thousand residents in the island. (Inter News Service, 2016) These water supply systems are mostly found in communities with higher-levels of poverty. (Alvarado León, 2016) Interestingly, these initiatives come from the municipal governments, from the communities or from private corporations, which highlights how renewable energy strategies have a community-oriented approach in the island of Puerto Rico.

On the state-level, there has been a lot of opposing views regarding the future of renewable energy in Puerto Rico, especially with the Puerto Rico Electrical Power Authority. The executive director of this corporation, Walter M. Higgins, rejected a measure of the Senate of Puerto Rico that aimed to eliminate carbon-generated energy by 2028. (Caro González, 2018) He insisted that carbon-generated energy is the cheapest in the industry. He denoted that the cost of carbon-generated energy is \$0.08 per kilowatts, while energy generated through other means fluctuates between \$0.10 and \$0.15 kilowatts, highlighting that the solar energy is the most expensive. (Caro González, 2018) In this same interview, he expressed concern towards the unknown vulnerability of renewable energy in the presence of a natural hazard and pressed on the fact that carbon-generated energy is a known source and doesn't present the problem of uncertainty. Either way, the governor of Puerto Rico, Ricardo Rosselló Nevares, has communicated, along with the Department of Energy and the Senate's Committee of Energy, that actions are being taken and a draft denominated "Informe sobre las opciones de resiliencia energética y potenciales soluciones para la red de Puerto Rico" (Energy resilience options and potential solutions for Puerto Rico's power grid report) is being work on. (Delgado, 2018) This draft is expected to be sent to the U.S. Congress with the hopes of getting enough funding to execute it.

Guillermo Rivera Cruz denoted an important aspect of renewable energy practices, the educational component, and why the government may be wary of its implementation: "*We need to educate the population. It is necessary to implement conservation measures at home, which means searching and identifying where I can reduce consumption in the household. If that is done in each household, renewable energy practices will be more efficient.*" He denoted that the current population has a pattern of consumption that is not adequate to renewable energy practices. Before implementing them, we need to change this pattern. Another problem that he

highlighted is the billing of this service in housing projects, which has a fixed rate. He denotes that third parties will need to be brought in to take part of this billing through an individual billing system, as not every household will have the same consumption rate. He visualizes this as a potential problem, as residents may not favor that change.

Additional to billing concerns, every household, be it in a housing project or not, will have to pay PREPA for interconnection, as the law establishes it through the Puerto Rico Electric Power Authority Law Act No. 83 of May 2, 1941, 22 L.P.R.A. § 196b as amended. (OMB, 2017) This law establishes the plan of energetic relief in case the renewable energy source fails, the household will be provided a backup service. This insurance is charged and may be met with opposition from residents. Rivera Cruz describes it as: "*potentially unfair, but a logical law*". These are some of the reasons that are frequently highlighted as deterrents and have discouraged the state from pursuing renewable energy islandwide. A disjunctive that has been exacerbated by the economic crisis that has restricted investments on a state-level.

6.3. Economic Crisis:

Ongoing maintenance of the power grid infrastructure will minimize the eventual cost of restoration efforts.

"The United States Environmental Protection Agency (EPA) has fined the Puerto Rico Electrical Power Authority (PREPA) for the lack of maintenance of the power stations. We need to change this, but this requires monetary investment. We cannot segregate the disaster. We have an economic situation and the hurricanes worsened it." - Hanna K. Rodríguez expressed. This aligns with the local media coverage, who has denoted the hindered status of the government-owned corporations, such as PREPA, months previous to the hurricane. The president of the Electrical Industry and Irrigation Workers Union, Angel Figueroa Jaramillo, claimed in a radio interview that there's a lack of maintenance of the power grid from PREPA's part and that the management has worked irresponsibly. (Radio Isla, 2017) The previous executive director, Ricardo Ramos Rodríguez, one month before the passing of Hurricane Maria indicated that the corporation was prepared for the hurricane season, but that the status of the energy system is terrible. (Cybernews, 2017) (Ávila Claudio, 2017) As the state-government, due to the economic crisis, doesn't have enough money to pay PREPA to maintain the power stations and the electric power grid, the resilience of this system has decayed and the

consequence of this was experienced during Hurricane Maria. Many interviewees indicated that this isn't the only ongoing struggle in Puerto Rico, but that also the absent proactive behavior of Puerto Ricans exacerbated the impact of the hurricane in the island.

6.4. Support Mechanisms:

Social capacity building has been proven to be integral to a successful disaster management plan and this was attested by the responses of the interviewees. A clear difference was identified in the efficiency of the emergency response between the municipalities that counted with organized communities and the municipalities that didn't have the benefit of them. Social capacity can be defined as "the qualitative and/or quantitative development of e.g. population size, lifestyle, health, education, age, tolerance and participation" (Mauerhofer, 2010 (pp. 12)). It focuses on nurturing collaborative efforts and ensuring equity within the community, by "approaching the idea of development as economic growth and defined human development as the process of enlarging a person's capabilities to function" (Mauerhofer, 2010 (pp. 13)). The data recollected echoed this assertion through the pivotal role that ecclesiastical institutions played in the recuperation efforts.

Developing a social preparedness / response strategy can greatly reduce vulnerability.

"There were many inhabitants that thought in two days everything would return to normal again. They didn't prepare well. There was an excess of confidence. Preparation requires you that you have a plan in your household and not everyone has one." – William Miranda Torres denoted when inquired about which was the most harmful factor that was prevalent in the emergency response. This was reverberated by Hanna K. Rodríguez, who mentioned: "Individual preparation has a lot to do with the emergency response and in one way or another it impacts the collective." This brings into consideration how crucial individual organization is in the scenario of a natural hazard, as preparing ahead of time and appropriately will reduce the probabilities of facing a struggling aftermath. In the situation that individual preparation was deficient, interviewees denoted that the presence of community leaders helped a lot their recuperation efforts.

The presence of organized communities and community leaders facilitated and speed up recuperation efforts.

"We were helped a lot by community leaders. We have organized communities. Most of the communities in Comerío took part in the creation of a census that identified fragile infrastructures and the households with elderly and physical or mentally disable individuals. With our municipal ambulance, we moved them to nursing homes or the local hospital." - Jaime Luis García Mercado highlighting how organized communities eased the process of identification and resolving needs by generating a social vulnerability index. Jesús E. Colón Berlingeri, the mayor of Orocovis, affirmed that his strategy benefited greatly from the help of churches in the municipality. "We used churches. They helped spread the word of how to prepare and also aided identify and channel monetary aid to the families that needed to be helped." Taking into consideration that Orocovis is a small municipality and that the Puerto Rican culture is highly religious, churches became a powerful tool to document and to extend relief efforts to each citizen.

Various municipalities filled the community leader role with ecclesiastical institutions, as mentioned by William Alicea Pérez: "Groups from distinct churches came to the municipal government with many tools to attend certain necessities. When certain members of the congregation didn't show up to their sections, they started to visualize the potential presence of problems. As a consequence, they visited homes and identified property damages. They were essential to reestablish essential services and that those households would receive help." The presence of community leaders gave the management plans a multi-dimensional approach, but the fact that they carried out a lot of the reconstruction of the electric power grid and the cleaning of debris by themselves without the proper preparation and tools, as indicated by Rolando Ortiz Velásquez, it elucidated the flawed-nature of the strategy implemented by various of the municipalities. This was endorsed by Hanna K. Rodríguez: "I agree. [The recuperation efforts] ended up being spear-headed by the communities themselves." These responses affirm the benefits that social capacity building have in improving disaster management plans. The community resilience in some of the municipalities helped overcome the obstacles that Hurricane Maria presented by exercising ongoing communication with the vulnerable sectors (elderly that didn't attend the church service), taking a proactive approach to protecting themselves against the natural hazard (the social vulnerability index generated by the residents themselves to keep an eye in the vulnerable sectors in their respective communities) and, consequently, building considerable self-sufficiency.

6.5. Logistics / Planning:

An efficient planning is characterized by the comprehensive identification of problems (How to protect every sector of the population?), preparedness (Which pre-emptive actions ensure the resilience of every community?), usage of technology (How renewable energy practices can help mitigate the effects of a natural hazard?) and how the road to recovery will be traversed. (Teutsch, 2010) These pillars are key to edifying a disaster management plan that is multifaceted. But, additionally, to these pillars, social vulnerability should be a component of the planning process and must be accounted for through socio-economic studies to guarantee its efficiency to mitigate the impact in every sector of the population. The responses of the interviewees denoted the importance of involving social vulnerability in the planning process in a state level to appropriately advise the logistics associated with the recuperation efforts, the transportation of brigades and to proficiently inform and deftly organize funding from the federal government in a manner that reflects the needs of the population.

The inclusion of socio-economic studies in disaster management plans will improve the emergency response and competently attend social vulnerability.

"[Social vulnerability] studies weren't considered. What was taken in account was previous experiences with other hurricanes, distance from the urban center was taken into consideration." - José A. Morales Rivera, the municipal administrator of the municipality of Cidra, responded when inquired if social vulnerabilities studies were involved in the planning process of the emergency response strategy implemented. This brings attention to the planification of their disaster management plan, the prioritization was based on population density and in, historically, environmentally-vulnerable sectors, independent of socioeconomic status, age and disabilities. The same was echoed by the mayor of Morovis, Carmen Maldonado González: "The truth is that specific socio-economic studies weren't taken in consideration [in the planification process]." As well as Jesús E. Colón Berlingeri, the mayor of Orocovis: "In the planification process, frankly, we didn't reach that level of specificity. We were broader. But, once the event passed, we realized that was an issue." Coincidentally, these are municipalities with a small area and neither asserted the presence of organized communities in their jurisdiction. This underlines the imperative necessity to address social capacity building in the social preparedness associated to disaster management. As these municipalities possess less funds and, in many cases, don't have the resources to conduct socio-economic studies by themselves, it would be of outmost importance to ensure that community resilience is promoted

and exercised thoroughly in their domain. In the absence of such metrics, the emergency response constitutes a utilitarian form of justice in which it is assumed "greatest good for greatest number of people" (Jeremy Bentham) An approach that counters the community-based perspective that disaster management should have to maximize its efficiency in the mountainous region of Puerto Rico. This region is characterized by a wide diversity of socioeconomic statuses and most of the poorer communities are small in population and looked farther from the urban centers rendering the former approach as ill-advised and inadequate to address the social vulnerability that afflicts this region.

The logistics of the recuperation inform should be designed acknowledging the advice of local governments.

José A. Morales Rivera denoting that the logistical centralization of the federal brigades hindered their productivity in the municipality of Cidra: "Lack of communication. It can be lack of logistics. For example, one of the brigades that came from the United States to restore [in Cidra] was staying in Humacao. We have a hotel here, but no, they had to stay in Humacao. They travelled from Humacao, wasting one hour in the morning. Wasting another hour in the evening, when they could have stayed here. They wasted two hours of service daily." In other municipalities, such as Orocovis, the brigades didn't show up in time, as a result many communities and the municipal government had to undertake the responsibility of cleaning debris and opening paths all by themselves. Highlighting the community-based recuperation efforts that permeated the mountainous region due to the delayed arrival of brigades, as the mayor of Orocovis, Jesús E. Colón Berlingeri, communicated: "The state-level emergency plan didn't work. The office of emergency management disappeared and only appeared months later. It was everything ourselves, municipal government. We had to clean the roads. The hospital that is not under our responsibility, it's a private facility, had to be attended by us for the first month." This reaction spearheaded by the community exemplifies one of the directional traits of resilient communities. By overcoming the physical uncommunication obstacle, the community showcased recovery direction. The mayor denoted how the presence of community leaders helped direct the received aid to the areas that mostly needed attention, as this sense of direction wasn't present in the state government's emergency response.

Representativeness of Puerto Rico's distinctive demographic composition should be established in the state government's disaster management plan.

Hanna K. Rodríguez emphasized the necessity to incorporate social vulnerability studies in the planification process of the disaster management's strategy. She does acknowledge that there are very apt professionals in the field in Puerto Rico, but that, sadly, this has been a historical practice in the island. "It is supposed to be like that. Ahead of any program, that is the typical commentary against the exercise of taking a plan from the exterior and making a copy/paste. We end up with plans that don't apply [to Puerto Rico]. We need to integrate these studies in the planification process. This is the responsibility of the municipalities to incorporate such data." This detail stood out to me, as the state government is charged with implementing a disaster management plan for the entire island and is the administration directly communicated with the federal government, but the tailoring of this plan to attend the specific needs of the municipality is relied to the municipal government. This brings into question the reason why the municipal government aren't given a more active role in the emergency response, beyond their support function. The municipal government have a front-row seat in the disaster, they receive the concerns of community leaders directly, which means that they have the knowledge to design an emergency response that is adequate to their jurisdiction. If the municipalities are bestowed more authority in the scenario of a natural hazard, the velocity of recuperation efforts would be more urgent and reflective of the needs and the times.

As an extension of this problem, the poor disaster management has overestimated the durability of the emergency roof tarps which are meant to be used for a maximum of three months but are still being used by many households as they wait for reconstruction of their home. Efforts that are going slow and are, in some areas, halted. "In a forum in the Puerto Rico Professional College of Engineers and Land Surveyors, [it was mentioned that] one of the common aspects of the planification of an emergency response [in Puerto Rico] is to design and prepare emergency generators that can last seventy-two hours. No one expected that the power outage would last longer than three days." – Hanna K. Rodríguez referring to the unexpected magnitude of the hurricane and how shortcomings in the current emergency response plans were identified. This brings into consideration, if the federalization of the disaster management in Puerto Rico is reversed, then the local government can push forward a plan that is comprehensive of the needs of the population and how to access them with ease.

Municipal governments' involvement will synergize the recuperation efforts.

"Regarding the [slow restoration of the electrical grid], the poor inherency of the municipalities." - José A. Morales Rivera referring to the most detrimental factor that slowed down the pace of restoration efforts in his municipality. "There wasn't any communication from the end of the Electric Power Authority, because it was already decided by the Federal Emergency Management Agency and the United States Army Corps of Engineers that the Corps of Engineers was going to be the one on charge of restoring the power grid system. This was requested by the state government and agreed on by the president which declared Puerto Rico a disaster zone. This meant that we weren't provided information regarding the areas where the failures were present." - Jaime Luis García Mercado referring to the fact that the municipality felt limited in their actions to help in the restoring the electrical power. This feeling was echoed by William Alicea Pérez: "FEMA brought the Corp of Engineers, whose commander-in-chief arrived and said we are the ones on charge of restoring the electrical grid in Puerto Rico. Private companies were hired to work here. We said: 'Let me do it', but they didn't allow us. At the end, we were the ones restoring the power grid due to the delayed arrival of the brigades and the lack of materials on their end." He also denoted that there isn't enough funding on the municipal level to cover the full cost of recuperation and that these expenses, that aren't responsibility of the municipal government, represent a void in their budget. Municipalities grew concerned with the lack of understanding of the cultural aspects that should be involved in a disaster management plan. As mentioned before, the exercised disaster managements have been categorized as copy/paste by professionals and municipal officials, a frequent example of this and a well-documented one is the lack of home ownership of many residents in the poorer regions of the island.

6.6. Cultural / Historical Practices:

For centuries, poorer communities found in remote and rural areas, where a considerable percentage of households have been illegally constructed for decades (It's a, historically, common practice to build homes in lands inhabited intergenerationally, but never legally registered), are not receiving federal aid due to not possessing the proper documents to prove home ownership. "In smaller municipalities, like Comerío, most people build their homes in land with the consent of the landowners, be it their parents or any other family member. As such, those properties don't possess the appropriate documents and, until now, haven't received any financial aid. That has been the greatest problem we have had with FEMA." -

Jaime Luis García Mercado asserted. This was voiced by Carmen Maldonado González too, who denoted: "Many families here in [Morovis], the ones that live in a higher level of poverty, live in terrain that were given to them by their parents. Often their parents allowed them to build a house in their terrain. As a result, they don't have ownership of the land. FEMA didn't want to help them, because they didn't have ownership. I had around three-thousand cases of these. The process took months. Six months after the passing of the hurricane, the agency said that they could provide some form of aid through the declaration of a lawyer that affirmed the fact that they, indeed, live in that land." She also mentioned that: "These people were feeling terrible. Because, they are being denied the help. They don't have anywhere else to go. That's the little that they have. They were feeling psychologically ill." This conflict illustrates the necessity to know the traits of the vulnerable population in the mountainous region of the island. For the government to aid and protect these communities, it needs to be familiarized with the features that make them vulnerable and diminish their capacity to cope and recover from the impact of a hazard. This is pivotal for the collaborative role of the government to execute actions that consider and size up to the needs of these sectors.

6.7. Behavioral Health:

Behavioral health has become a concern in the aftermath of a traumatic event such as Hurricane Maria. As denoted by the mayor of Morovis, a detrimental effect in the mental health of residents has been documented by the local media. SAMHSA indicates the importance of behavioral health responders in the scenario of a disaster. Their presence is necessary to "provide quality support to survivors" (SAMHSA, n.d.) Their expertise would have been valuable in the municipality of Yabucoa as suicide rate spiked in the months following the passing of Hurricane Maria.

"The Yabucoan mayor expressed discontent with the state and federal agencies responsible of restoring the service of electrical energy. A service that his municipality has not had for eight months. It is estimated that six thousand households in Yabucoa, particularly in the mountainous area, are without electrical power." – Puerto Rican reporter, Charito Fraticelli, referenced statements made by the mayor of Yabucoa, Rafael Surillo Ruiz, on May 2018 regarding eleven suicide attempts, within the month of April, and a twelfth suicide attempt, within the month of May, in his municipality. Fraticelli interviewed a community member, Juan Eliza Colón, and he indicated: "Various neighborhoods, that are enormous, have been *completely abandoned. The people are desperate.*" Since January, more than thirty calls to 9-1-1 have been reported from residents of this municipality indicating a desire to kill themselves. (Figueroa Rosa, 2018) Unfortunately, no research has been conducted yet to elucidate the reasons behind this sudden spike in suicidal intents within the municipality of Yabucoa. But, the feeling of abandonment that has plagued the residents of this municipality has been reaffirmed by the local media in numerous occasions. (Figueroa Loza, 2018) By May 2018, about sixty percent of the population was without electrical services, over one-thousand five hundred residences were destroyed, and two hundred deaths have been calculated as either directly or indirectly caused by the passing of Hurricane Maria in this municipality alone. (Figueroa Rosa, 2018) As a result, the municipality has voiced concern towards the mental health of their inhabitants. (Figueroa Loza, 2018)

In this same month, in the municipality of Morovis, the nursing home "Hogar Estancias de Paz" saw three of their elderly die as a direct result of the lack of electrical power. (Ramírez, 2018) The nursing home counts with thirteen elderly patients. In this report, the owner of the nursing home, Nick Adorno, declared: "The situation is critical. I have two bed-ridden patients that depend on supplemental oxygen. Basically, meaning that I need to have the power generators activated 24/7." The reporter estimated that fuel expenses to keep the generators running reach, approximately, \$900 - \$1000 monthly. A sum that is unbearable for the facility to keep on spending. This scenario has been seen islandwide through the months that followed the disaster. Due to the slow response, the needs of the vulnerable sectors weren't attended on time and led to an increase in the death toll-associated to the hurricane. (Hernández and McGinley, 2018) A Harvard study that was published in the New England Journal of Medicine revealed that "health-care disruption for the elderly and the loss of basic utility services for the chronically ill had significant impacts, and the study criticized Puerto Rico's methods for counting the dead — and its lack of transparency in sharing information — as detrimental to planning for future natural disasters". (Hernández and McGinley, 2018) The death toll in this study was counted to be above four thousand-six hundred. (Kishore et al, 2018) A number that contrasts with the death toll of sixty-four fatalities communicated by the Puerto Rican government. (Ruiz Kuilan, 2018) This unveils a questionable protocol towards disaster-related deaths and provides the opportunity to assess and improve the mobilization of response operation in the island. (Hernández and McGinley, 2018) As a result, this aftermath has become a learning ground for the executive and the administrative divisions in the local government.

The logistics of the mobilization of response operations in the island need to emphasize which sectors are more vulnerable to the detrimental effects that a traumatic event has on behavioral health. Once again, the poorer sectors are more fragile to this impact due to their economic and social uncertainty. (Figueroa Rosa, 2018) This brings into relevance the necessity to prioritize these sectors through a CBDM and the beneficial repercussions of nurturing community resilience in them. By reinforcing communication with governmental bodies and community support, these vulnerable residents can experience a glimpse of hope and will reduce their likelihood to experience a sense of abandonment. (SAMHSA, 2015) Traumatic stress relief can be provided by experts in the field, but also by community support, be it community leaders or local responders. (National Center for PTSD, 2018) This support constitutes the education component of community resilience: "One way to build resilience is through educating yourself about how disasters affect people, how to cope effectively, how to give and receive social support, and how to get further help if needed." (National Center for PTSD, 2018)

Overall, the themes arose in the interviews highlight three elements of concern: the necessity to strengthen governmental collaboration and communication, the necessity to fortify community resilience and the necessity to address the effects of traumatic events in the behavioral health of vulnerable communities. These sources of concern enclose the wide variety of factors that the interviewees mentioned as relevant to improve the disaster management in the island. Albeit, the research covered the sentiment of the municipal officials in the mountainous region of the island, the additional data sources contextualized these concerns as reflective of the struggles faced by municipal officials in other regions, such as in the municipality of Yabucoa. With these concerns identified, it is possible to provide potential strategies that may address and resolve them through a community-based approach towards disaster management (CBDM).

7. Recommendations:

Considering the recollected data from the interviews and secondary data sources, potential changes can be suggested to the planning process of the disaster management executed during the aftermath of Hurricane Maria in the mountainous region of Puerto Rico. As the interviewees denoted: The emergency response became a learning experience for all governmental levels and for the communities. This was asserted by Carmen Maldonado González: "*The [municipal governments] always have a plan for emergency management. In that moment, there was no way to execute a plan, though. We weren't really prepared to receive a hurricane of that magnitude. No one in the island was prepared. From this, we all learned.*" These changes should be rooted in the concept of CBDM to address and countermeasure the social vulnerability in the region. This perspective was vocalized by environmental engineer, Hanna K. Rodríguez: "*From now on, there won't be a better emergency response strategy than one that involves communities. As a person that manages emergency plans and responses, that takes time. You must know your community and identify a leader. We realized that without electricity, water and communication, our communities are left by themselves."*

A community-based emergency response that incorporates community resilience and reduces social vulnerability in the scenario of a natural hazard should consider:

Elucidating the emergency response and the recuperation efforts legislation.

This is important to clarify the lines of authority and responsibility in the aftermath of a hazard to minimize the time wasted in confusion and responsibility adjudication. This should reinforce the collaborative nature of the governmental bodies and secure communication between them. As highlighted by the HHS, this is one of the pillars to encourage community resilience by improving communication between government and community. This can be achieved by edifying amendments to bestow municipal governments special authority in the scenario of an emergency, ensure refunding of expenses made during this period, execute the proper evaluation of expenses if needed, and establish a regional office that will connect directly the municipalities with the federal government. In this case study, a regional office for the municipalities of the mountainous region. This will allow the municipalities to have a more active role in the disaster management and permit the municipalities to have direct communication with government that provides the aid. This will improve the efficiency in the

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exchange of knowledge to maximize the recuperation efforts and avoid ill-advised decisionmaking, as well as promote the building of social connectedness.

Developing a social vulnerability index (SVI).

In 2012, the government attempted to generate a social vulnerability index to identify vulnerable residents through the act "Registro de poblaciones con necesidades funcionales y de acceso" (Register of population with functional and accessibility needs). Based on Padilla Elías *et al* research, this register is not available to the public, which ensures its confidentiality. But, as she denotes, this register hasn't been met with much participation of the population. To maximize its efficiency, encouragement should be exercised for residents to sign up and facilitate the government's ability to aid them. With the experience of Hurricane Maria, there isn't a more ideal time to emphasize the importance of such register to ensure that every resident receives the help that he or she needs. Additionally, the identification of vulnerable sectors within the communities will help municipal governments focus attention and edify a community-level emergency response that is adequate and considerate of the needs of every member. Basically, an SVI will be a tool to ease community integration and build social capacity.

Promoting social capacity building

The municipal officials highlighted the usefulness and the importance of organized communities. A community-based disaster management plan needs the inclusion and the fomentation of organized communities and community leaders. They need to be encouraged and sought out in every municipality, be it through ecclesiastical institutions (community churches) or through other means.

Contextualizing disaster management plan

Redefinition of the conceptual framework of the disaster management and intertwining it with socio-economic studies that reflect the specificities of the vulnerable population in Puerto Rico. As a result, the disaster management plans will overcome the shortcomings of the copy/paste practice that was denoted by governmental officials and professionals in the field. This revaluation should consider the pillars of the disaster management: Preparation, response, recuperation and mitigation by including bottom-up practices: Preparation (Community organization and preemptive communication and contingency efforts), Response

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(collaborative action between municipal government and community leaders), recuperation (community support) and mitigation.

• Strengthening public health, healthcare and social services.

The commission for the prevention of suicide released, in February 2018, that two-hundred fifty-three residents committed suicide in Puerto Rico during 2017. (Perez, 2018) This same report, indicated that twenty of these occurred in December 2017. Coupled with the data recollected regarding the high incidence of suicide-related calls to 9-1-1 in the municipality of Yabucoa after the passing of Hurricane Maria, this social issue has become a major source of concern. Strengthening public health support through community resilience would prove to be very beneficial, especially if the individuals live in remote areas. Encouraging the inclusion of healthcare and social services as part of social preparedness in vulnerable sectors can help overcome the feeling of abandonment and protect these citizens.

These strategies can help minimize the vulnerability of various sectors that have faced difficulties during the Hurricane Maria's aftermath. It is important to denote that a phenomenon like Maria hasn't been experienced in Puerto Rico in over a century, consequently it gives the opportunity to analyze how disaster management was perceived and defined in the island and the qualities of the vulnerable communities. Overall, it should be visualized with an optimistic point-of-view. This experience can become a learning lesson instead of a chapter of failure in Puerto Rico's history.

8. Conclusion:

The passing of Hurricane Maria revealed the fragility of the infrastructure of Puerto Rico, as well as the obstacles that a flawed governmental collaboration and communication can catalyze. These obstacles were experienced in the mountainous region of Puerto Rico. The municipal officials, along with experts, related how the disaster management implemented in the aftermath of Hurricane Maria was plagued of extensive bureaucracy that adjourned urgent actions that needed to be taken to address the needs of vulnerable sectors in their municipalities. The inefficient governmental communication and collaboration propitiated a lack of urgency towards the vulnerable sectors in the emergency response. As a result, residents with mental and physical disabilities faced hindrance that resulted in worsened behavioral health conditions. This brought to light the importance of incorporating socioeconomic studies in the planification process of the disaster management of the island, especially in regions with substantial percentage of vulnerable sectors, as is the case of the mountainous region, and the necessity to promote community resilience.

Edifying a CBDM will help the Puerto Rican government avoid experiencing the dreadful and somber aftermath that followed Hurricane Maria. This can be achieved by defederalizing the recuperation efforts and enhancing governmental collaboration and communication. This will improve the competency of the emergency response and ensure a direct and efficient impact in the population. The benefits of community resilience will ease and accelerate the pace of the recuperation efforts by strengthening teamwork and social support. Emphasizing the role of community and acknowledging the specificities of the vulnerable communities, as evaluated in the mountainous region, will help reduce social vulnerability in Puerto Rico.

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10. Appendix A – Interviewees:

The interviewed individuals for each municipality were:

Aibonito:

William Alicea Pérez (Mayor of the Municipality)

Caguas:

William Miranda Torres (Mayor of the Municipality)

Guillermo Rivera Cruz (Director of the Environmental affairs division)

Cayey:

Rolando Ortiz Velázquez (Mayor of the Municipality)

Cidra:

Javier E. Carrasquillo Cruz (Municipal Administrator)

Comerío:

Jaime Luis García Mercado (Director of the Emergency Management division) Heriberto Fernández López (Assistant of the Mayor)

Morovis:

Carmen Maldonado González (Mayor of the Municipality)

Orocovis:

Jesús E. Colón Berlingeri (Mayor of the Municipality)

Additional interviews were conducted with professionals in the disaster management field: Hanna K. Rodríguez, Project Engineer, SC Environmental Engineer and Félix Aponte González, PhD, PPL Environmental Planner.
11.Appendix B - Images of the passing of Hurricane Maria in Puerto Rico:



Image 01: Flooded Highway, "Román Baldorioty de Castro", San Juan, Puerto Rico [Upper photo: September 21, 2017] [Bottom photo: March 19, 2018] Photograph by Ricardo Arduengo for Telemundo



Image 02: Destroyed Home, Corozal, Puerto Rico [Upper photo: September 24, 2017] [Bottom photo: March 19, 2018] Photograph by Ricardo Arduengo for Telemundo



Image 03: Flooding (Aerial View), "Barrio Juana Matos", Cataño, Puerto Rico [Upper photo: September 22, 2017] [Bottom photo: March 19, 2018] Photograph by Ricardo Arduengo for Telemundo