



Planning for the Unimaginable: Puerto Rico and Strategies for Climate-Change Adaptation

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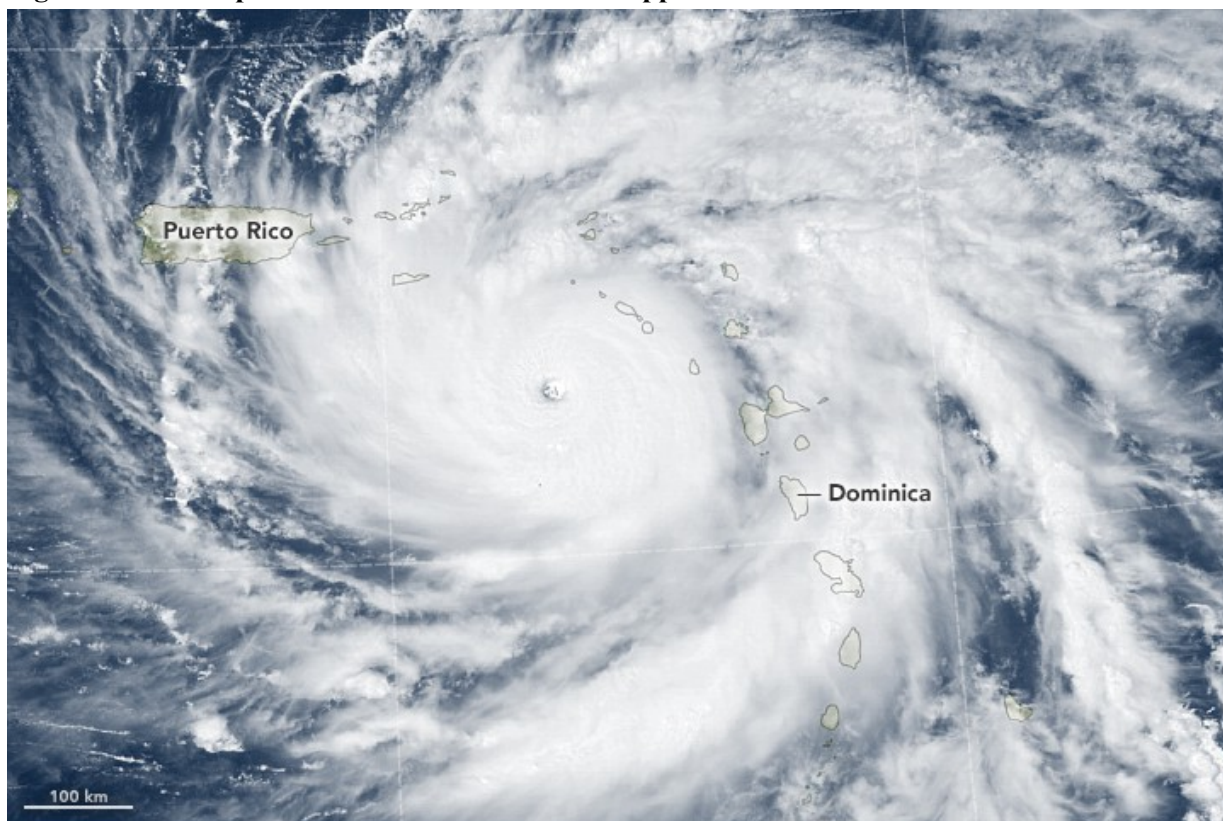
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The damage from the two hurricanes that struck Puerto Rico was multiplied by US austerity plans that deprived the island of resources to implement its carefully crafted climate plans. Public debt and calls for privatization are further hampering Puerto Rico's recovery. Repairing damaged housing, utilities, and creating greater resilience requires major investment and community-based adaptation initiatives.

During late September 2017, the island of Puerto Rico and its capital city San Juan were devastated by the impact of two storms: initially by the less intense Hurricane Irma, quickly followed by the overwhelming Hurricane Maria—a Category 4 storm that cut through the central portion of the island and destroyed the city and island's infrastructure over several days of high winds and flooding. Maria's cost to Puerto Rico is a projected \$95 billion in lost revenue and infrastructure damage (Goldstein 2017b). The death toll as a result of the two devastating storms is as high as some 1,000 victims (Robles *et al.* 2017).

Puerto Rico is an island located approximately 1,150 miles (1,850 km) off the coast of Florida, nestled within the Caribbean Sea on the Antilles archipelago between the island of Hispaniola and the Virgin Islands (see Figure 1). Incorporated by the US as a territory in 1898, its residents are American citizens. Puerto Rico remains semi-autonomous politically, with its sovereignty expressed through its capacity to elect a governor and constrained largely by US Congress (residents pay US taxes with the exception of income tax). The island's 2010 population was over 3 million (3,726,157 on April 1, 2010; 3,337,177 on July 1, 2017) with a significant decline of over 8% of its total population over the past six years. Of the 78 municipalities, 44 are located in coastal areas (PRCCC 2016) with just over 50% of the total population living within coastal municipalities. The country's natural environment—700 miles (1,130 km) of wide beaches, thousands of miles of coral reef, bioluminescent water, large forests, and mountain ranges—makes the island popular for tourism (PRCCC 2013).

Figure 1. Satellite photo of Hurricane Maria as it approaches Puerto Rico



Source: US National Oceanic and Atmospheric Administration (NOAA).

It is also a country whose population is highly vulnerable to climate disruptions. The 2007 Fourth Assessment Report of the International Panel on Climate Change (IPCC) highlighted that, within the hurricane-prone Caribbean region, the island is one of the most vulnerable to hurricane-related disasters because of its population density, with approximately 1,200 residents per square mile (PRCCC 2016), among the most densely populated areas in the Caribbean region. Projected climate changes to the island include intensified storms, rising land temperatures, landslides, significant beach erosion and a decrease in rainfall (DRNA 2015). Proposed climate-adaptation efforts seek to protect the natural environment, and include the construction of seawalls, refilling eroding beach sand, and the use of natural barrier islands and seagrass to prevent flooding due to rising sea levels (DRNA 2015).

More than half the population of Puerto Rico resides within the San Juan metropolitan area, itself located quite close to sea level. Prior to Hurricane Maria, San Juan's location posed a hazard to the city in terms of flooding and sea-level rise (PRCCC 2016). In addition, San Juan remains the primary site for economic activity on the island, "including most hotels, hospitals, and electric power plants; some power plants are less than 160 feet (50 m) from the waterline and less than six feet (1.8 m) above sea level" (PRCCC 2016).

Before and after hurricanes upended their lives, residents of San Juan and the surrounding area developed—and used—community-based adaptation strategies. As sea levels rose in the years before Hurricane Maria, coastal-community residents began to find ways to live alongside rising waters. Through the use of cement blocks, crates, and handmade stilts, some residents moved their entire living quarters to upstairs rooms in order to rise above encroaching seawater (Cantieri 2016). Local organizations also helped with creating adaptable infrastructure using the local environment with the help of community members. Corredor del Yaguazo, a nonprofit sustainability organization, helped regenerate wetlands near San Juan to hold back and protect the surrounding areas from rising sea levels (Cantieri 2016). The San Juan Bay Estuary project—a project first developed by the US Environmental Protection Agency in the 1990s—solicited community

residents for beach clean-ups and the planting of mangrove trees to help stop beach erosion around the San Juan Bay (NOAA 2017). Despite local planning reports and documents articulated on a community-based level, the lack of widespread implementation of these adaptation strategies has been a significant barrier towards creating sustainable infrastructure and land use—and protecting the island from future catastrophe. Prior extensive evaluation of climate vulnerabilities did not predict or provide strategies for dealing with a storm as destructive or as devastating as Maria.

Speaking recently with Ernesto Diaz, director of the Puerto Rican Climate Change Council (PRCCC), the implementation of adaptation strategies was planned and developed for five communities across the island in 2015/2016, and “then came Maria. [Our adaptation plans] were not prepared for a Category 4 hurricane. We had to go back to the drawing board.”¹ According to Diaz, implementation of adaptation strategies remains a concern. The Council—comprised of urban planners, social scientists, representatives from the University of Puerto Rico, NGOs, and private companies—will convene in May 2018 to evaluate and “strengthen adaptation approaches,” and to be “faster and more strategic” in managing eroding beaches, excessive rainfall, Category 4 and 5 hurricanes, and drought.

For Diaz, who has been working on climate change planning in Puerto Rico since the early 1990s, strategies for climate change adaptation serve as a “guide to [climate] resilience.” Ideally for Diaz and the PRCCC, the key towards building climate resilience and the “effective implementation of adaptation planning lies in a community driven approach.” Climate mitigation requires collaboration with other states and “we have not been able to significantly reduce GHGs [greenhouse-gas emissions],” reports Diaz. Some of Diaz’s and the PRCCC’s vision of community-empowered adaptation strategies have begun to be realized. Residents of the island have been able to apply their own creative internal capacities to transform and protect their built environment through community-based adaptation efforts. These strategies have included reliance upon locally developed efforts, as well as the use of governmental agencies’ and non-governmental organizations’ expertise for project planning and funding, along with the development of vulnerability and climate action plans. However, despite these plans, the destructive pummeling the island received in 2017 during the record-breaking hurricane season made it nearly impossible for residents to access the most basic of resources such as food, housing, electricity, and clean water. The enormous challenges for communities who find themselves trapped in a continual state of post-disaster crisis continue to present life-and-death consequences for the people of Puerto Rico. The island’s climate assessment reports provided diagnostic understanding of local climate vulnerabilities. Residents were able to do what they could to imaginatively create effective strategies for themselves and their communities. However, these internally developed strategies and plans could not prepare them for the hurricane that ripped through the center of the island in September 2017.

Powerful storms, vulnerable communities

The unfolding story reveals the extent to which climate adaptation (and mitigation) planning requires significant state funding and massive infrastructure and land-use transformations—an impossibility for poorer states and cities without the financial resources and external support that climate-planning implementation demands.

For Puerto Rico, attempts to mitigate and adapt to the effects of the swiftly changing climate and protect its natural resources emerged as the island has become less industrial, increasingly poor and more dependent upon austere government policies. During the 2000s, Puerto Rico emerged as a country with a massive debt problem, leading to the creation of the Financial Oversight Board established by US Congress in 2016. Resources for the implementation of the island’s well-

¹ Source: interview with Ernesto Diaz, Director, Puerto Rico Coastal Zone Management Program and PRCCC Executive Secretariat, 10 April 2018.

developed climate plans were scarce. By the 2010s, close to half of Puerto Rican residents (43.5%) were living below the poverty line.² The median household income stands at a little less than \$20,000.³ A significant decline in population began in 2010 with more than 80,000 residents leaving the island in less than a decade. The housing market declined, with house prices falling and foreclosed homes increasing by 33% since 2007 (Goldstein 2017a). Contributing to the island's economic weakening was the presence of US-based investors eager to capitalize on the Puerto Rican government's \$74 billion of public debt and increasingly depressed housing market. The results of these conditions have led Puerto Rico to become increasingly vulnerable to climate changes, with climate funding and disaster relief awarded from US Congress. The island as a site of rising poverty with declining—and then decimated—infrastructure was brought into painful view following Hurricane Maria.

Prior to the destruction of the hurricane, non-governmental organizations coupled with state agencies in a “public–private partnership” provided expertise for adaptation planning through the development of vulnerability assessment studies and climate action plans. For example, San Juan is a member of the Rockefeller Foundation's 100 Resilient Cities network,⁴ and the city was provided with a Chief Sustainability Officer as part of its membership. Most recently, the Resilient Puerto Rico Advisory Commission was formed in coalition with several powerful research foundations to provide recommendations to local governments on the rebuilding of San Juan and wider Puerto Rico post–Hurricane Maria.

Helping construct adaptation planning before and after Hurricane Maria are the Puerto Rican Climate Change Council (PRCCC; in Spanish, El Consejo de Cambio Climático de Puerto Rico), the Puerto Rican Department of Natural and Environmental Resources (DRNA), and the Climate-Adaptation Knowledge Exchange (CAKE). They are among the organizations instrumental in developing climate-change vulnerability risk-assessment reports regarding changes to the local environment, and provide subsequent recommendations for adaptation projects. In 2010, the PRCCC brought together experts with funding support from a range of US federal government organizations such as the US Forest Service, the US Department of Agriculture; from publicly funded scientific organizations such as the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Association (NOAA); and from non-governmental organizations such as the Nature Conservancy, Ridge to Reefs, the San Juan Bay Estuary Program, and the University of Puerto Rico. As of 2018, the PRCCC counts 165 members and partners comprising university faculty and federal and Puerto Rican governmental and non-governmental organizations. The group's extensive reports examined the extent of vulnerabilities within the natural and social environment, with particular attention paid to rising sea levels as a significant threat to the built environment and coastal communities.

Climate-planning agencies such as PRCCC prior to Hurricane Maria identified the island's vulnerabilities through regional assessments on anticipated climate impacts. However, the damages of Hurricane Maria reveal that the risks were understated and the proposed strategies were not enough for the “worst-case” disaster that became the Category 4 hurricane that destroyed much of the island's infrastructure. Since Hurricane Maria, climate-planning leaders have focused on the role of existing resources to help communities adapt to and further mitigate the effects of future devastating storms. Social networks within local communities are now viewed as foundational as resources of support, and can help spread adaptation efforts to mitigate the effects of future climate-related weather disasters. Informal and formal networks derived from such examples as families and local churches are now seen by local climate-planning experts as fundamental to the effective implementation of adaptation planning. According to Diaz, the vision of the PRCCC meant that pre-Maria strategizing on local adaptation measures focused upon local governments serving as “hubs” within their communities to implement adaptation efforts. However, this vision was not realized

² Source: US Census Bureau, 2016.

³ Source: US Census Bureau, 2016.

⁴ Website: www.100resilientcities.org.

given “the lack of capacity at the local level of leadership of mayors,” Diaz said. “Local governments would have been the ideal hub for articulating national and regional strategies. But [Maria revealed] we need to empower local governments by creating clearer channels for communications. Now, post-Maria, a ‘bottom-up’ approach is needed to ensure that local governments respond with community demands [driving] adaptation responses for the 44 coastal municipalities. There is much more to be done given that the implementation mechanisms are not in sync with the reality.”⁵ As Diaz points out, the role of community-based support following the hurricane revealed that adaptive strategies and steps to implement those strategies may be found within grassroots, community-level organizing to directly meet the needs of community members.

Puerto Rico, post–Hurricane Maria

Residents throughout the island now find themselves dependent upon resilient strategies more than ever. The lack of access to basic resources including clean water and food delivery in the days, weeks and months following the hurricane has begun to ease only slightly. And there is still much cause for concern regarding providing provisions to residents. US Congress recently pledged \$4 billion for recovery relief, of which half will go towards infrastructure recovery. The Federal Emergency Management Agency (FEMA) was initially criticized for its crisis management and has since been able to provide services. However, neither the amount allocated from Congress nor the handling of post-hurricane relief by FEMA, according to lawmakers and community members within San Juan and Puerto Rico, has been adequate to meet the emergency needs of the local population.

Nevertheless, industries within San Juan have begun to bounce back, with speculators lured by tax incentives, major-league baseball games played, tourist hotels reopening, and even fashion shows resuming. Still, the effects of Hurricane Maria as the worst natural disaster in Puerto Rico’s history are fast becoming long-standing and well documented. To date, almost seven months after the hurricane hit, a range of significant challenges persist, including the reality that many residents in less populated areas still lack access to basic necessities such as electricity, clean water, and food. The island’s struggles touch on every aspect of everyday life: energy production, housing, the spread of forced mass migration, access to clean water, a rise in violence and suicide, and the need for Puerto Rican debt relief. The tenuous power grid has been responsible for four massive power outages since the hurricane. In April 2018, the island experienced the most widespread blackout (Wagner and Robles 2018; Park and Almasy 2018) since the hurricane, with over 3 million residents impacted in what became the worst electrical blackout in US history.

The Puerto Rico Electric Power Authority remains a public organization with a multi-billion dollar debt and its troubles led the Puerto Rican governor Ricardo Rosselló to recently call for its privatization. If speculators are enticed by the incentives for capital investment, private investors and non-governmental organizations such as the Clinton Foundation are intrigued by the opportunities post–Hurricane Maria presents for embedding sustainable energy. For example, the US-based nonprofit organization Coastal Marine Resource Center has created Resilient Power Puerto Rico to bring widespread solar power to the island. Relatedly, the Clinton Foundation has partnered with the Solar Foundation to create the Solar Saves Lives program to increase solar technology and energy use on the island.

In addition to energy production, poorly constructed housing that was destroyed by the hurricane needs to be rebuilt—close to half of all housing on the island is makeshift and often constructed without official permits (Viglucchi 2018). Over 70,000 residences were destroyed and a quarter of a million homes damaged from the hurricane (Rense 2018). Community-based housing groups, through the use of community land trusts, have organized to rebuild more durable and

⁵ Source: interview with Ernesto Diaz, Director, Puerto Rico Coastal Zone Management Program and PRCCC Executive Secretariat, 10 April 2018.

extreme weather-resistant infrastructure such as the use of storm-safe roofs. But such climate-adaptable initiatives are costly, and the road forward, as San Juan mayor Carmen Yulin Cruz has stated, must be about massive transformation and not just redevelopment (Cheslow 2017). Without community-based adaptation initiatives and the necessary financial support for the implementation of those strategies and massive infrastructure and land-use transformations, San Juan and Puerto Rico face an all-too-familiar dilemma for struggling states and cities—particularly resource-poor communities—to survive and ultimately thrive following climate change-related weather catastrophes.

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