# Chapter 2
# The Hurricanes of 2017: Pre-María and Immediate Social and Technological Effects

## Contents



*As the pressure falls my transformation is launched.*
*Ascending, I spiral towards space, dragging battalion clouds in my wake.*
*You see the ocean's tides, but the air's flow is invisible.*
*It brings me my founding rains. And in my command they quench the earth.*
*All of nature is a balance, an ancient flux to which I add my weight.*
*The sun's heat is captured by the sea, I reclaim it.*
*As do the thunderstorms that form and fade in the daily rhythm of the tropics.*
*But sometimes the forces of the distillery are overwhelming.*
*I will be no ordinary storm.*

When listening to Ricardo Rosselló, Governor of Puerto Rico, preparing the population of Puerto Rico for María, someone asked him about contingencies in case the communications failed after the hurricane. His answer impressed me because he was quick to respond that they had anticipated this event and were ready to use the Police and Fire Departments radio networks to keep the government connected. I felt confident that the government was ready. Then, after the passage of María, I turned the radio on to learn what had happened and found no radio station broadcasting, not even the one that islanders had always counted on during these events. This was a surprise. As it turned out, only one radio station



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network was on the air, the one that had remained analog and defied Federal and local regulations to turn digital.[1] This station was the only means of island-wide communication for all of us, even for the government who lost the Police and Fire Department radio networks along with all their expected communications. Immediately one realizes that something extraordinary had just happened in the age of modern communications.[2]

## General Effects

María devastated a large fraction of structures and infrastructure including modern technological infrastructure[3] (Table 2.1); pushed the ocean deep into the terrestrial-maritime zone[4]; flooded extensive urban and rural areas in the lowlands and highlands; modified the topography of the island through landslides and changes in river channels and beach profiles; affected the vegetation through defoliation and snapping or downing trees; and scattered and disoriented people and wildlife. In urban

**Table 2.1** Immediate effects of hurricane María on Puerto Rico's infrastructure

| Category and unit | Total number | Percent functioning |
|---|---|---|
| Banks (number of branches) | 313 | 0 |
| Containers (dispatched daily at ports)[a] | 1400 | 0 |
| Gasoline Stations (number) | 1100 | 40[b] |
| Post Offices (number) | 132 | 0 |
| Pharmacies (number) | 1045 | 0 |
| Roads (miles) | 5073 | 8 |
| Supermarkets (number tracked) | 456 | 0 |
| Telecommunication Antennas (number) | 2671 | <10 |
| Telecommunication Towers (number) | 1619 | 20 |

These data are for the day after the hurricane. "Total Number" corresponds to the 100% value for the "Percent Functioning" column and for the scale of percent recovery after the hurricane of various figures in this essay

[a]As activity picked up, the ports became chocked with containers, order was difficult to establish, and material were lost while recovery was delayed

[b]Many had no gasoline to sell or because of lack of electricity could not pump the gas

[1] A month after the hurricane, 54% of the 72 AM and 70 FM radio stations were not operational.

[2] Five days after the hurricane, the government still had no contact or communications with six municipalities.

[3] The Commonwealth estimated that 124,600 million dollars would be required to recover the island's economy after María.

[4] A house located blocks away from the ocean in the municipality of Naguabo was littered with seaweed (Sargasso) and marine debris, after the ocean surge inundated inside the house several feet deep.

areas, the loss of vegetation cover contributed to unbearable heat, which affected daily living routines and resulted in sleep depravation. All these effects are things that we expected. What we did not expect was the extensive area that was affected (essentially all of the island) and the profound effects of María on the social fabric and people of Puerto Rico.

María deposited enormous amounts of debris on roads and city streets,[5] greatly impeding transportation and the movement of people (see Frontispiece). The collection and disposal of so much debris is an expensive, energy-dependent, and time-consuming operation. This led to piles of vegetative materials throughout the landscape months after the hurricane. Along with vegetation debris, clandestine garbage dumps proliferated, creating a health hazard.

Days, weeks, and months after María, the average islander had no communications, no access to the banking system, any electricity or potable water, and limited food stores. Cash was needed for transactions at a time when mobility was dramatically reduced, but cash was unavailable because it was safely stored in closed banks without power or Internet. Access to medicines, medical attention, dialysis treatment, oxygen, blood, food, and ice was extremely limited. There were no government services, not even deliveries by the US Postal Service, the justice system was not functioning, and police protection was limited. Individuals and communities were left to protect themselves against criminal activity. While the judicial system was struggling to recover from María, the greatest demand for judicial action was processing arrest orders (680 between María on September 20 and October 13) and domestic violence (442 cases). Hurricane effects caused a 1-month delay in the functioning of civil courts. Twenty-seven roads were closed, 17 bridges undercut by raging runoff, 44 roads and bridges required repair, and most roads and streets were cluttered with debris.

Under the confusion, government blunders ensued. For example, the government announced on September 23 the potential collapse of the Lake Guajataca reservoir, involving the relocation of 70,000 people. This was a blunder based on a false perception of potential collapse, not using existing emergency plans,[6] and ignoring knowledge that even if it collapsed, this reservoir could not affect so many people. The temporary panic created by this action, as well as national news, eventually dissipated when cooler heads prevailed.

As the days passed, we learned of the social and technological consequences of the lack of fuel and power. The pumps required for keeping floodwaters from flooding neighborhoods, to prevent ocean water from seeping into neighborhoods, and to keep sanitary waters from mixing with storm runoff, all failed. The resulting mixing of ocean and freshwaters with sanitary and runoff waters flooding neighborhoods

[5] The US Army Corps of Engineers estimated a volume of 3.8 million cubic yards of which 2.28 million cubic yards was vegetation, including 45,000 logs with commercial value.

[6] The Commonwealth had, but did not use, a detailed region-by-region and agency-by-agency emergency plan for dealing with hurricanes, including the issue of reservoir collapse.

created a toxic soup with serious negative public health implications. Estuaries, coastal waters, and beaches were polluted. Potable water, when available, could not be pumped to users because without fossil fuel, water pumps could not operate. A large portion of the task of delivering potable water to people in Puerto Rico requires the use of fossil fuels. Those who received water by gravity (a free form of energy) had no problems. Sewage plants also failed to operate and this failure resulted in the flow of raw sewage into streams and coastal waters.

We learned after Hugo of the importance of ice, but who could have anticipated that laundromats would have longer waiting lines than ice factories? Lines at the Post Office were equally long, provided the person knew where to make the line, as packages were delivered to a variety of novel locations and it was up to the recipient to find them. The gasoline lines were, of course, the longest and most wasteful of time: 11 h for 3 gallons of gas! Who could have predicted that María so scattered the people, that initial hurricane recovery would be limited to access by truck drivers[7]? Or that the number of trucks with the right hose coupling for refueling diesel electric plants would limit the refueling of hospitals and other vital locations?

Calls for help and assistance originated from every corner of the island. As tempers flared, criminal activity spiked,[8] and anarchy loomed in the background. The state of mind of significant portions of the population is reflected in the number of calls for psychological help managed by the Administration for Mental Health and Against Addiction. They received 5000 calls in September and 4500 in October, compared to an average of 3500 per month. Calls reached 777 in the 2 days before the hurricane.

A variety of circumstances brought the fishing industry to a halt, none of which had to do with the availability of fish. As with other industries, the lack of electrical power was a principal cause because, without it, fisherman could not preserve the catch and, without fossil fuel, they could not operate their boats. Moreover, demand for fish plummeted. Also, navigational obstructions made coastal fishing hazardous. Among registered boats, 334 were affected and 272 were underwater and the government had difficulties locating owners.

María affected human behavior and made Puerto Ricans reacquaint themselves with a life style many had not known or already forgotten, but which proved handy to deal with post-María conditions (Box 2.1). These behaviors were critical for survival in isolated communities and in communities missed by government relief efforts.

[7] Thousands of truck drivers were interviewed for jobs, but told to go home and wait to be called; a call that never happened or could not, given the poor communications at the time.

[8] The federal government transferred 1000 prisoners to the USA, while in Puerto Rico, 20-escaped prison after the hurricane.

**Box 2.1 After Hurricane María, Puerto Ricans Adopted Actions and Behaviors Associated with Conditions Long Thought to Have Passed in the Island**

- Practicing medicine as in the 1970s.
- Washing clothes by hand in the river with large soap bars, washing clothes at home using *tablas de lavar* (wooden washing boards), and air-drying clothes.
- Using wood and gas for cooking and reinstating the use of *anafres* (small stoves made out of large cracker metal cans).
- Resurgence in the use of matches to light fires.
- Filling water buckets at springs and streams.
- Going to bed at sundown, up at sunrise, and using mosquito nets.
- Using *el quinqué* (kerosene lamp) or candles during the evening.
- Communicating person to person, including the revival of *pregoneros* (neighborhood criers) to transmit information.
- Back to paperwork and rediscovery of wooden pencils.
- Cash only.
- Communal living, kids on the streets playing ball; table games and reading inside the house.
- Increased level of poverty and experiencing hunger as in the 1930s (one meal a day).
- Self-sufficiency in remote areas.
- Keeping cadavers in the houses where they passed.
- No refrigeration or air conditioning but plenty of heat.
- No garbage pick-up.
- Hydrating with coconut milk.
- Eating breadfruits instead of *plátanos*.
- Barbers back to using scissors.
- All back to listening to AM radio.
- Analog over electronic.
- Wielding a machete.
- Bathing outdoors or cold-water showers.
- Restoring or completely re-building bridges and other infrastructure.

## Difficulties Faced by Rescuers

People wondered why the delivery of assistance was so slow given the small geographical area of the island (100 by 35 miles). But the small geographic area of Puerto Rico masks the complexity facing the government rescue effort. Consider two complicating factors.

First, the topography of Puerto Rico is extremely rugged and complex, which adds a difficulty factor in comparison with rescuing similar land areas with flat

topography attached to a functioning continent. Being an island located over 1000 miles from the nearest United States of America air and seaports obviously do not help. Also, the US Government controls the air and seaports of Puerto Rico and does not allow help from other countries or from air and seaports close to Puerto Rico. This is based on the Jones-Shafroth Act of 1916, which awarded citizenship to Puerto Ricans and established that only the US Merchant Marine could haul cargo to Puerto Rico. Although the President of the United States allowed foreign vessels to enter the ports of Puerto Rico for 10 days after María, the US Merchant Marine lobbied heavily against this permit when foreign competition reduced their profits as 11 ships from other countries delivered cargo to Puerto Rico. The cost to Puerto Rico of dealing with only the US Merchant Marine is in the millions of dollars because it charges much more than ships from other jurisdictions. When the permit was withdrawn, the island became a victim of scarcity. Even though the US Merchant Marine charges more for hauling cargo than anyone else, it lacked the capacity to satisfy demand after María.[9] As a result, cargo intended for Puerto Rico accumulated in mainland ports. For example, after 2 months, supermarkets lacked 37% of the products they normally carry while, at the mainland ports, there was a backlog of 2032 containers with such articles.

Second, the population density of Puerto Rico averages ten times higher than in Florida and Louisiana where recent hurricanes also affected cities and rural areas. Dealing with so many people embedded and scattered within a complex landscape compounds the difficulty of the relief effort. Experienced mainland responders unanimously agreed that they had never dealt with conditions such as they faced in Puerto Rico after hurricane María. Federal officials deemed María the worst natural catastrophe in the history of the United States of America. Such an event affected a location already facing great economic disadvantage in comparison to the states of the union (Fig. 2.1). The people of Puerto Rico are mostly poor (Table 2.2), a condition that further affects the island's vulnerability to extreme events.

## The Role of the Dead

The dead made many headlines post María, but not the kind of headlines that one expects after extreme events. For example, in the municipality of Lares, the Municipal Government had ignored for years warnings from scientists indicating that the Municipal Cemetery was located on a landslide-prone area and should be relocated. After María, the landslides moved the cemetery downhill along with sediments, rocks, monuments, and caskets. Cadavers were exposed and an estimated 1772 tombs were affected, making the Municipal Cemetery useless and forcing families to cremate their dead or seek cemeteries elsewhere in the island. Other problems with the lack of construction codes for the building of

[9] In an ad, the Maritime Industry indicates that 25 American ships supported by 1000 employees visit Puerto Rico every week.

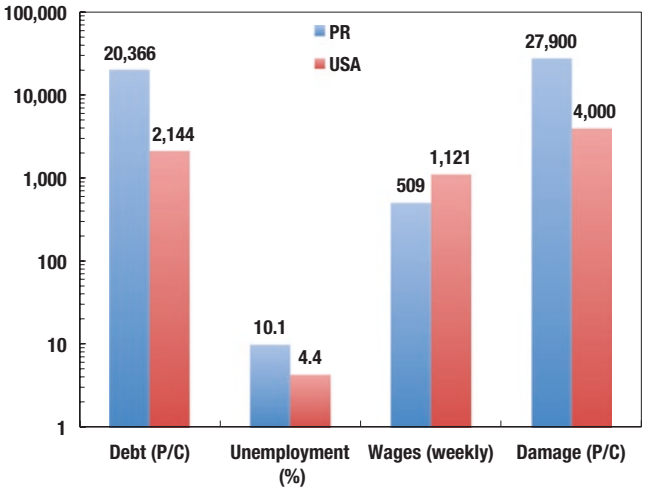


**Fig. 2.1** Some economic comparison between Puerto Rico and the United States of America (USA). Note the logarithmic scale. "Damage" in the USA refers to hurricane losses in the states of Florida and Louisiana. Per capita is P/C. All values are in US dollars. Data are from Vick [38]

**Table 2.2** Poverty statistics for Puerto Rico based on the 2016 US Census

| Indicator | Number |
|---|---|
| Households without access to: | |
| Refrigerator | 18,895 |
| Stove | 23,572 |
| Shower or bathtub | 14,167 |
| Potable water | 29,280 |
| Water heater | 578,858 |
| Faucet in sink | 14,474 |
| Households with: | |
| Incomplete plumbing | 40,643 |
| Incomplete kitchen | 32,094 |

Overall, 43% of the population was below the poverty line before hurricane María

mausoleums emerged after María, when shoddy work resulted in greater damage to structures than normally expected. However, no one could have imagined that counting the number of dead, as well as the number of deaths attributed to María, would transfix Puerto Rico and reach into the presidential and national press levels on CNN and MSNBC.

The Commonwealth government reported 16 deaths attributed to María on September 23, 2017. Yet 121 Puerto Ricans died on October 3, 2017 alone when President Donald Trump visited Puerto Rico. This level of mortality was 40 above average for that day, although no one knew this at the time. The President said that

because of the low number of deaths reported by the governor, María was not as bad as hurricane Katrina, which officially killed 1464 (a figure that is also controversial). That statement by the President, and media pressure, led the governor of Puerto Rico to order a recount, which eventually raised the number to 55 killed by November 2. At this point, the controversy intensified with estimates reaching 500–1000 dead by December 18, depending on the reasoning used to determine the probable cause of death. The government, however, refused to revise the estimate beyond 55 killed by María.[10] Finally, on February 23, 2018, the governor of Puerto Rico, to the chagrin of local professionals and academicians, announced the hiring of the Public Health School of George Washington University to conduct a study that would establish the mortality associated with María.

Once a person died after María, the disposal of the cadaver became a problem because of the difficulties with communications, transportation, and lack of electricity. Those dying on September 18, 19, and 20, 2017 required 11, 15, and 20 days for disposal. Thereafter an average of 9 days was needed until mid-October when the time was reduced to 5 days. Thirty seven percent of the cadavers were cremated compared to 32% in 2016.

The controversy about how many people died after the passage of María resulted in many insights about death and mortality in Puerto Rico. Normally the number of people dying annually in the island ranges from 28 to 30 thousand, and a large funeral parlor may handle 70 funerals during the month of October. The Institute of Forensic Medicine normally receives about 500 cadavers a month, but after María, they were not arriving. Cadavers were accumulating in homes, homes for the aged, funeral parlors, or elsewhere where the lack of refrigeration made them a health threat. Funeral homes were running out of space to store cadavers, which had to be stored in refrigerated trucks located in different regions of Puerto Rico. The policy for unclaimed cadavers was cremation after 30 days. Nine hundred and eleven cremations were authorized between September 20 and 18 October. Funeral homes reported record numbers of funerals. One funeral home reported 50 in 10 days of October, and a large funeral home reported 151 between September 21 and November 6. In October, they had 112 funerals, much higher than normal for that month.

Funeral homes attributed deaths to hurricane-related causes resulting from conditions after the hurricane. For example, hospitals without electricity dismissed patients so they could die at home. Families reported deaths due to lack of electricity and for lack of dialysis treatments.[11] There were 472 more deaths during September 2017 than in September 2016. Ten days after the hurricane, there was a 30% increase in the average daily death rate and 2890 deaths were recorded in September.[12] The pulse of daily mortality after María, compared to the same days during the past 2 years leave no doubt

[10] The government revised the death toll to 64, 181 days post María.

[11] Initially there were 26 treatment centers, later increased to 46 treating up to 6000 patients.

[12] On October 23, 2017, 217 people were listed as missing, a list that included all island sectors. On February 22, 2018, 946 people were reported missing for 2017, a situation causing stress to families in light of little official action to locate the missing (261 for which their location is unknown).

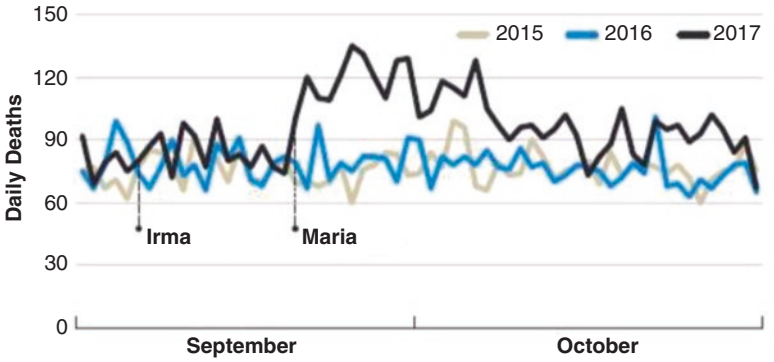


**Fig. 2.2** Daily mortality rate for September and October of 2015–2017 as reported in a local newspaper. Deaths increased after hurricane María but not after hurricane Irma relative to deaths in 2015 and 2016 (Modified from *El Nuevo Día*, December 30, 2017)

of the effect of the hurricane on lost lives (Fig. 2.2). Such numbers following days, weeks, and months after the initial effect of the hurricane would evoke horror and recriminations in any of the 50 states of the nation.

Another aspect of the situation was the availability of caskets. In 1975 there were 11 manufacturers of caskets in Puerto Rico but, at the time of María, only one was operating with a manufacturing capacity of 40 caskets per day. After María, local production was raised to 160 caskets above average. However, they could not meet all of the demand. Normally Puerto Rico imports 60% of its caskets from Mexico and China, which produce the caskets at a lower price, but also at lower quality, according to local manufacturers.

Public health authorities identified gastrointestinal diseases, respiratory infections, Hepatitis A, skin infections, tetanus, tuberculosis, conjunctivitis, leptospirosis, scabies, dengue, zika, chikungunya, malaria, and rabies among potential health hazards. The vectors included mosquitoes, Acari, rats, dogs, mongoose, and bats. Some epidemiologists suggested that the list was exaggerated by the Commonwealth, and highlighted scabies and leptospirosis (over 128 cases and several deaths in at least 17 municipalities by November 2) as the real dangers associated with the hurricane. In fact, on March 1, 2018, the Commonwealth announced that after María not a single case of dengue, chikungunya, or zika had been reported in Puerto Rico. A potential explanation was that the hurricane and its aftermath affected mosquito populations associated with the diseases predicted but that did not show up.

Between July 2017 and December 2018, the number of monthly deaths attributed to Septicemia, the presence of bacteria in the blood of patients, was 42, 49, 101, 96, 96, and 71, respectively. These are high numbers of grave infections reflective of poor health conditions within the population such as lack of potable water or delayed access to medical attention. Lack of transportation contributed to delayed

medical attention. Lack of electricity and the resulting high indoors air temperatures and humidity levels, also induces conditions that lead to Septicemia. Older people and the infirm are more vulnerable to these infections.

Nine months after María, the multiple accountings of deaths as a result of the event had coalesced around three estimates, with the study commissioned by the governor of Puerto Rico still pending completion. One of the three estimates was the official number of 64 deaths, held by the Commonwealth, which asserts that this was the number of people killed directly by the storm. A second estimate by Harvard University scientists established a range of deaths between 793 and 8498 (median of 4645). This study was a statistical analysis based on field interviews (3299 homes), a series of assumptions, and scenarios. Finally, the Commonwealth's *Registro Demográfico* (Demographic Registry) estimated 1397 deaths based on their records corrected for normal mortality rates the years prior to 2017. This figure was later revised to 1427. They found that 2320 people died during the first 20 days after María, 700 more than in the same number of days in 2016. These data were not available to Harvard University scientists or to anybody else because the government decided to share information only with researchers from George Washington University from whom the governor had requested a study. As each of the three estimates is based on a different set of assumptions and database, the issue remains unresolved. Nevertheless, it is clear that the initial estimates attributed to the direct effects of the storm were just the tip of an iceberg.

Finally, at the end of August 2018, George Washington University announced their findings[13] about the mortality caused by María. They estimated 2975 deaths due to María, which is more than Hurricane Katrina and similar to the 2996 killed in New York City after the terrorist attack of September 11, 2001. Needless to say, this report caused a new round of insular and national news and recriminations. The University asked for more money to refine their $305,000 study.

[13] Ascertainment of the estimated excess mortality from Hurricane María in Puerto Rico. Milken Institute School of Public Health, The George Washington University. 42 pages + 11 pages of annexes.