



Double Environmental Injustice — Climate Change, Hurricane Dorian, and the Bahamas

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Climate change has been linked to changes in Atlantic hurricane behavior, making storms more destructive to the built environment and vital infrastructure, more harmful to the physical

and mental health of island-based and coastal populations, and more deadly in their aftermath.¹ These escalating effects on population health represent a double environmental injustice: socioeconomically disadvantaged and marginalized populations sustain disproportionate harm and loss, with more hazardous storms exacerbating the inequity; and while the populations most vulnerable to Atlantic hurricanes, especially those in small-island states, contribute virtually nothing to climate change,² they are among those most exposed to risks that are worsened by the carbon emissions from higher-income countries.²

Anthropogenic climate change amplifies storm hazards through

such intermediaries as anomalously warm ocean and air temperatures, rising ocean heat content, and increasing atmospheric moisture capacity, compounded by a rise in sea levels. Atlantic hurricanes have become stronger, wetter, and slower-moving over the past few decades, with likely contributions from human actions.¹

Hurricane Dorian's catastrophic trajectory across the northwest Bahamas dramatically highlighted these trends. Dorian intensified at an unprecedented rate just before reaching the Bahamas and slammed into Great Abaco Island with sustained winds of 185 mph, tying the record for the greatest Atlantic-hurricane wind speed at landfall. It produced deluges of rain and dragged a two-story-high

storm surge onshore, submerging entire neighborhoods. And its forward motion stalled as it moved onto Grand Bahama Island, where residents were battered by the strongest eye-wall winds for 40 hours, resulting in one of the most prolonged known population exposures to extreme hurricane hazards. Yet despite its distinguishing features, Hurricane Dorian fits into a discernible pattern of increasingly harmful Atlantic storms. Dorian was the fifth Category 5 Atlantic hurricane to make landfall over four consecutive seasons, preceded by Matthew (2016), Irma (2017), Maria (2017), and Michael (2018).

All hurricanes have public health effects. In addition to living through the storm hazards during impact, affected populations face health consequences arising from widespread power outages, water contamination, inoperative sanitation systems, and acute food insecurity in the after-



Widespread Destruction in Marsh Harbour, Abaco Islands, Bahamas, after Hurricane Dorian.

math. Storm-affected citizens grapple with the severe structural damage that leaves many homes uninhabitable and triggers population displacement. Survivors are often left to swelter in health-compromising heat and humidity and are vulnerable to vectorborne diseases. Health services are disrupted for many people with acute or chronic medical conditions.^{2,3} Patients with special medical needs, including those who are immunosuppressed, recovering from surgery or undergoing rehabilitation, or dependent on electronic devices or life-sustaining therapies, may face real threats to survival. School closures, damage to worksites, unemployment, and financial losses challenge the resilience of storm-ravaged communities.²

Mental health consequences are among the most salient, and they are a focus of the current recov-

ery initiatives in the Bahamas. Survivors who were directly exposed to extreme storm hazards during Dorian's impact are at elevated risk for developing post-traumatic stress disorder.^{2,4} Those who sustained massive losses may develop major depression or anxiety disorders.⁴

Climate-change-driven hurricanes tend to inflict two types of environmental injustice. One is that socioeconomically disadvantaged and racial or ethnic minority populations experience disproportionate harm, loss, and life changes. The increased severity of climate-change-related storms portends a worsening impact on marginalized people

that can exacerbate preexisting health gaps and social inequities. As Dorian moved over the northwest Bahamas, for instance, the most severe destruction affected thousands dwelling in shantytowns on Great Abaco Island. Many of those affected were undocumented migrants. Similarly, after Hurricane Harvey, flooding around Houston was worst in socioeconomically deprived neighborhoods with higher proportions of black and Latino residents. And after Hurricane Maria, many rural, disadvantaged Puerto Rican municipalities struggled without electricity for as long as a year. The death toll rose steadily into the thousands, as frail, elderly, and chronically ill people died preventable deaths. Disparities in health, as measured by multiple indicators, were magnified.^{2,3}

At a more fundamental level of

environmental injustice, the contribution of island-based populations to global carbon emissions is negligible.² Collectively, the Caribbean's 44 million residents generate just 0.4% of total global emissions, and the Bahamas' share is well below 0.01%. The countries designated by the United Nations as small-island states face climate-change-associated hurricane risks that are not of their own making. Rather, high-income countries that produce fossil fuels and expend massive amounts of energy generate most of the emissions that elevate hurricane risks for small-island populations.

Dorian's devastation of the northwest Bahamas is the latest installment in a series of Atlantic storm impacts on the 29 United Nations-designated Caribbean small-island states. In 2016, Hurricane Matthew ransacked Haiti's breadbasket, destroying staple crops. In 2017, Hurricane Irma brought Category 4 or 5 winds to eight small-island states and tropical storm winds to six more.² Hurricane Maria affected 16 island states, bringing major hurricane winds to 5 of them, including Dominica and Puerto Rico. All told, 22 of 29 Caribbean small-island states were affected by at least one 2017 storm.²

These states are geographically vulnerable because they're in warm Atlantic Ocean latitudes where hurricanes form and flourish. Most residents of these islands are unable to evacuate in order to avoid traumatizing exposure to hurricanes.^{2,4} In the aftermath of a hurricane, recovery support must be physically transported to geographically isolated populations of storm survivors who may be spread across multiple islands.²



Destruction of Buildings and Trees in Central Abaco.

The ferocity of cyclonic activity may have additive effects: the vulnerable are disproportionately affected, while the capacity of small-island states is decimated. Cars, trucks, and supplies intended to provide relief are destroyed. Relief workers, security officers, disaster coordinators, and health team members themselves become victims. Often the most climate-resilient structures end up being repurposed as shelters, which renders them unavailable to serve their usual functions. These multiplicative effects further magnify social injustice.⁵

Ultimately, this whole dynamic contributes to widening health gaps. We believe that recognition of this reality compels action on several fronts.

First, communities need to prepare strategically for the onslaught of stronger storms by revising building codes and redesigning neighborhoods to redress existing socioeconomic inequities in affordable, safe housing. Also critical is making infrastructure more resilient, with a particular focus on electrical power systems. Cuba, for instance, completely redesigned its electrical system, creating a decentralized

microgrid architecture that facilitated islandwide restoration of power less than 3 weeks after Irma's impact in 2017.

Second, the health care system will have to be undergirded to withstand stronger hurricanes in order to maintain access to lifesaving services and operability of life-sustaining treatments.³ Fortification of hospital facilities, auxiliary electrical power, and workforce protection for health care staff are priorities. Lessons learned from U.S. health care systems can be applied in island states.³

Third, enhancing warning systems, upgrading the structural integrity of hurricane shelters, and ensuring citizen compliance with evacuation protocols are lifesaving actions. Special attention must be paid to making these resources equitably available to marginalized populations.

Fourth, citizen engagement in disaster preparedness and response is generally lacking, although Cuba is an exception. Personal and family disaster planning and participation in community emergency-response teams, with opportunities for active practice, has been a vision in the United States — and a well-rehearsed reality in Cuba. Family preparedness is especially crucial for households with members who have special medical needs. The building of citizen cohesion and social connectedness is one of the hallmarks of community resilience that pays dividends in disaster situations.⁵

Fifth, health professionals can help increase collaborations among climate scientists, population health scientists, and clinicians to

better plan the health response to hurricane-affected communities. In particular, health professionals have an important voice and can use it to advance the public conversation about climate change and resulting disasters. Both individually and collectively, health professionals can advocate for policies that constrain carbon emissions and seek alternative energy sources that diminish population health risks.

Sea levels will not recede, average global temperatures will not decline, and hurricane hazards will not moderate. We need to prepare now for future Dorian-like scenarios in a manner that redresses environmental injustice.

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