Mitigating tropical cyclone risks and health consequences: urgencies and innovations

The devastation wrought by human population exposure to the 2017 Atlantic basin hurricanes and the protracted health and social consequences of these storms highlight the destructive potential of tropical cyclones.[1–3] Two factors are contributing to the progressively increasing risk for weather-related disasters throughout the 21st century.[4] First, as the oceans warm and the sea levels rise, prominent tropical cyclone hazards are quantifiably increasing over time, especially peak storm intensity, maximum precipitation rate, frequency of the most intense cyclones, and areal extent of storm surge flooding.[5–7] Second, vulnerabilities are worsening, driven by population growth, urbanisation combined with increasing population density (particularly in coastal cities bordering the world's tropical cyclone basins), the disproportionate risk for small island developing states (SIDS)—22 of 29 SIDS in the Caribbean region were affected by at least one 2017 storm,[3] damaged ecosystems, fragile and failing infrastructure, and increasing socioeconomic disparities. The public health consequences of tropical cyclones will commensurately increase unless solutions are found to mitigate and adapt to increasing risk.[3] The 2017 Atlantic storms brought these risk dynamics into clear view.

After a lull of several years with few land-falling hurricanes in the Atlantic, the 2017 season has re-energised the conversation around disaster risk reduction and management. Unless action is taken to mitigate hazards and invest in adaptive capacity, losses could increase sharply throughout the 21st century as stronger storms encounter populations residing in environments with marked areas of vulnerability.[4–6] Therefore, 2017 could be a harbinger of things to come that require innovative solutions on multiple levels to match the complexity of effectively governing tropical cyclone risks and consequences. With these hazard and vulnerability patterns in mind, confronting tropical cyclone risks globally will require a reformulation of the approach on several scales.

Important contributors to future tropical cyclone risk are people's vulnerability along with erosion of the ecosystem's natural buffer function. The 2015–30 Sendai Framework[8] and the UN Sustainable Development Goals[9] recognise the primacy of disaster risk reduction, which prioritises the upstream elements of prevention, protection, and preparedness over the downstream focus on rescue and response.[10] Disaster risk reduction partners smoothly with climate change adaptation by fully encompassing it.[10]

Effective macro-level planning will rely on collaborations between atmospheric and oceanographic scientists, hydrologists, structural engineers, urban planners, legal scholars, and social scientists in active partnership with medical, public health, and health-care professionals; all dovetailing their expertise with emergency managers and disaster response personnel.[6] Also at the macro level, fragile infrastructure must be redesigned and renovated. As observed repeatedly throughout the 2017 season, long electrical power outages decapitate the emergency response, and are thus life threatening. Also, regional satellite and communications capabilities must be dramatically upgraded.

Fortunately, some model programmes worthy of emulation exist. The Atlantic storms reinforced the importance of the Pan American Health Organization initiative to create disaster-proof, safe, and green hospitals throughout the western hemisphere. The US public health preparedness approach of creating regional health-care coordination could be adapted to provide care for island-based populations and coastal communities that sustain damage to the point at which local health-care delivery is hindered or inoperable.

At the community level, local emergency management plans will need to be updated on the basis of lessons learned and redeveloped to prioritise disaster risk reduction approaches.[10] Evacuation procedures must be revisited in light of previous experiences, including assuring adequate fuel supplies along the designated routes and creatively using public transport options.[1] Post-storm damage assessment data can usefully guide enforcement of tougher building codes. Community shelter systems should be expanded, retrofitted, and fortified to withstand stronger storms.

During 2017, the need for mutual aid became a forefront issue. One component is maintaining and replenishing community or regional stockpiles of essential supplies and

life-saving medications during tropical cyclones. Now is also the optimal time to plan better to ensure sufficient regional gas reserves, ample supplies of generators to maintain the viability of crucial infrastructure, and improve regional warning systems such that they reach everyone, including homeless people, and are not dependent on electrical power.[1,2]

For optimal disaster planning, attention should ideally reach down to the household level. Hazards interact with local human and social vulnerabilities, resulting in dramatically different effects across small areas. Behavioural and communication scientists might assist in devising strategies to achieve citizen engagement and empowerment in the areas of attending to warnings, acting on disaster information, updating and practising family disaster plans, stockpiling supplies, creating personalised go-kits, and volunteering on citizen emergency response teams. Targeted outreach must be done to ensure the welfare of all tenants in multifamily dwellings and those living on upper floors of high-rise buildings where tropical cyclone wind speeds are greater. Focus should be brought to citizens who have fewer social connections, such as homeless people, people with disabilities, prisoners, or undocumented migrants.[2] Attention to marginalised populations is important, particularly those who are unstably housed, who clearly represent the highest risk group for all disasters, including tropical cyclones.

Data systems are being developed that can comprehensively catalogue the vulnerability characteristics of each household (eg, accomplished by overlaying GIS datasets with socioeconomic ones) before a storm, provide impact-phase warnings and messages to citizens, record geocoded and quantified storm impacts sustained by each residential structure (eg, maximum wind speed, flooding, and rainfall), and assess damage after a storm. These household-level indicators can be supplemented with precision photographic imagery from satellite or drone-mounted cameras. Given the rapidly accelerating tropical cyclone risk to human populations, advancing these new technologies is essential.

As the storm-battered survivors of the 2017 Atlantic hurricanes navigate through the recovery and reconstruction phases, the importance of building back better and also building forward better is acutely apparent.[10] Tropical cyclone risks are increasing in complexity, a product of the interplay of worsening hazards and social–ecological vulnerability.[1,6,10] These patterns showcase the imperative to respond to the urgent need to mitigate harm and attendant public health consequences by prioritising an innovative, science-based, multidisciplinary, multiscaled approach to confronting tropical cyclone risks to human populations.[1]

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