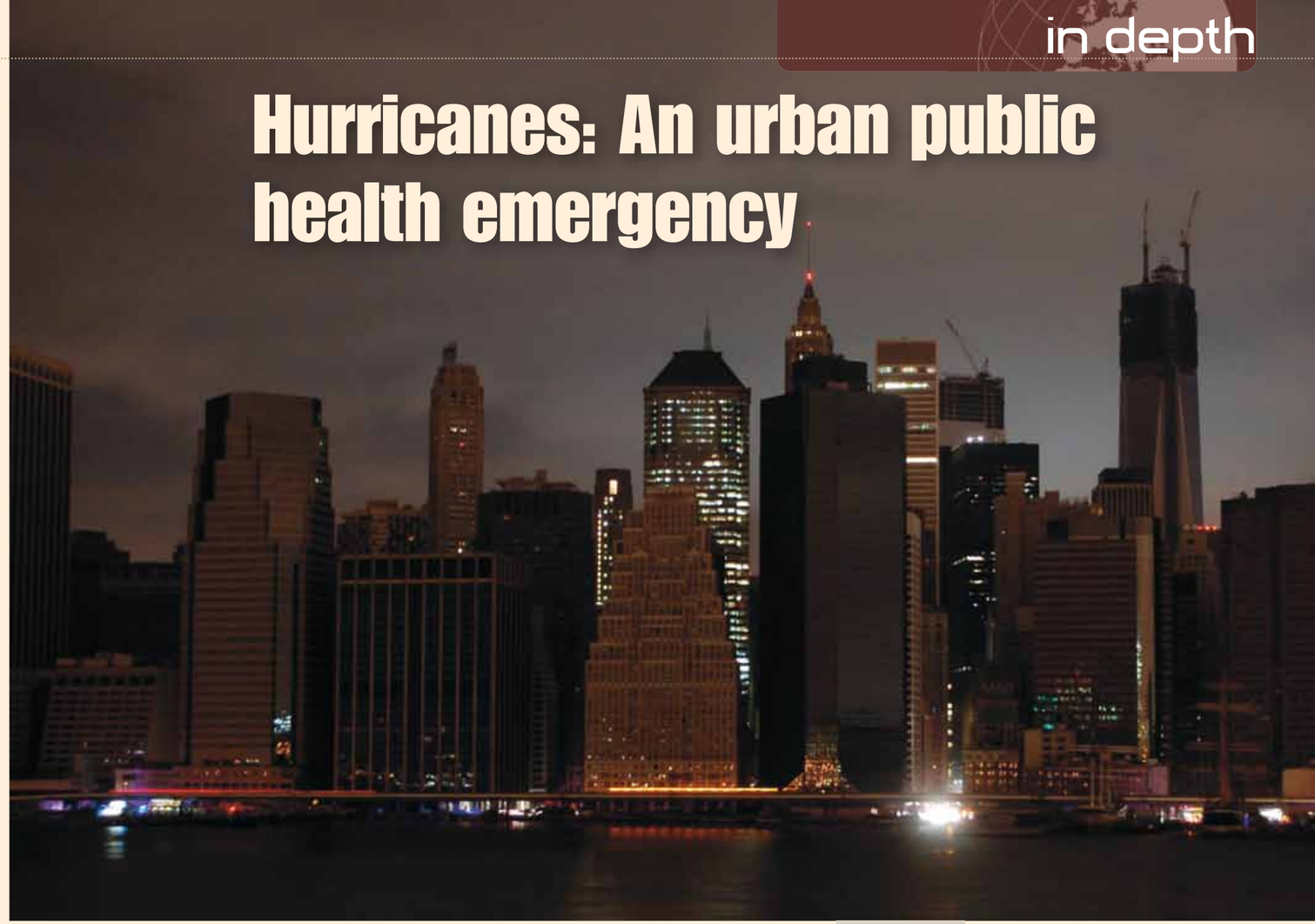
Hurricanes: An urban public health emergency



Continuing this series examining the effects of major adverse climate events upon urban environments, the authors focus upon the urban response to hurricanes and floods, using November 2012's Hurricane Sandy as an example

WITHIN A SPAN OF FIVE DAYS Hurricane Sandy – a late-season post-tropical super storm – devastated the Caribbean and the East Coast of the US (see *CRJ* 8:4). The storm left over 10 million people without power, more than 200 dead and an estimated US$71 (€54.3) billion dollars in damage. Seven New York City Subway stations were completely flooded, there were 24 major (storm related) fires reported in New York City (NYC), and 71,000 homes and businesses were lost in New Jersey. In addition, hospitals had to be evacuated – including four of NYC's largest hospitals – and patients and staff relocated.

This article, the second in the series examining Major Adverse Climate Events (MACE), looks at super storm Sandy and the New York metropolitan area in order to understand how critical infrastructure was affected.

One of the immediate issues that the storm and its consequent inundations highlighted is that flood-zoning maps are outdated. Although it is impossible to achieve absolute flood protection, effective flood risk assessment and management are essential to minimise the risk of flooding.

The US National Flood Insurance Program (NFIP) values flood insurance for New York State at US$31.6 (€24) billion, with approximately US$8 (€6.11) billion of this figure being earmarked for NYC.

On a national level, the Federal Emergency Management Agency (FEMA) achieves flood risk reduction through the NFIP. It does this by identifying flood hazard areas and establishing flood insurance premiums that are based on flood risks by formulating flood insurance rate maps (FIRMs). These, in turn, are the backbone of design standards for constructions in floodplains, including building codes. Designated spaces with an expected flood rate probability of one per cent per year are known as special flood hazard areas or 1/100 flood zones.

It is estimated that there are 1.54 million people at risk living in the 1/100 flood zone in NYC. But flood risk maps do not take into account climate change or social, economical or ecological risks. This makes NFIP flood zones arbitrary and inherently inaccurate, because there are areas of significant size and population density that are exposed to flooding, but which are located outside of the areas designated as 1/100 flood zones.

Improvements must, therefore, be made to the NFIP to optimise flood protection. Flood risk assessment and flood insurance rate maps need to be adjusted to incorporate climatic, environmental, social and ecological risk factors. This would lead to more accurate flood insurance rate maps, and insurance premiums – although likely to be increased – would be a more exact reflection of the true risk. In addition, public education about the levels of flood risk and the promotion of appropriate risk mitigation, could effectively reduce potential damages from MACE and weather-related risks.

Dynamic data

Hurricane strikes are indiscriminate, and when they hit urban areas they cause damage to property, movement is greatly restricted and, in worst-case scenarios, lives are lost. First responders – law enforcement, firefighters, emergency medical services, healthcare workers and disaster response agencies and teams – are not immune from the effects of MACEs.

Disaster management involves four fundamentally overlapping phases – preparation, response, recovery and mitigation – with each phase requiring accurate and current real-time disaster data. Effective and undisturbed communication channels are the main source of this real-time data dissemination. Dynamic data, such as the severity of the disaster and the number of people affected, is continually changing.

In order to co-ordinate appropriate disaster response operations, alleviate confusion and maintain order across distressed populations, governments and relief agencies must analyse and disseminate critical and emerging information effectively. A clear division of authority and a culture of trust are essential.

In NYC, the Metropolitan Transportation Authority (MTA) adopted social media to keep passengers informed about changes in service. The MTA website, along with its Facebook and Twitter pages, were frequently updated in the aftermath of Sandy. This multi-dimensional approach to information dissemination was essential in providing updates to a large population of the tri-state metropolitan area left without television, cell phone or Internet access.

These communication channels were critical for first responders who were trying to assess response needs during an eastern river blackout in NYC that engulfed most of downtown Manhattan. But reliance upon communication that utilises popular technology has severe limitations. Connecting to the Internet is virtually impossible during a power cut. Cellular tower outages make mobile devices useless. And high monthly broadband costs mean that one-third of New York's residents are still not connected to the Internet.

After the 9/11 attacks, major cellular phone companies in Washington, DC, and New York reported surges in cellular voice usage of up to 1,000 per cent. While cellular towers are capable of withstanding significant peaks in demand, the sheer number of calls being made rendered them useless. Similar outages have been reported during Hurricanes Katrina and Rita, where short messaging services (SMS) became a reliable method to send and receive communication, as long as cellular towers were still functioning.

Harold Feld, senior vice president of Public Knowledge, remarked: "An emergency communication system that fails us when we need it most is worse than no emergency communication system at all."

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Unfortunately, as we saw with super storm Sandy, power outages mean that people cannot call or send SMS to emergency workers. This leads to wasted resources, unstructured response and *ad-hoc* communication channels; these could put lives at risk.

Furthermore, citizen-to-authority emergency calling is a crucial part of public safety and emergency response. The emergency 911 and Enhanced 911 (E911) services automatically provide public safety and emergency response personnel with most essential information and geo-location data to deliver assistance effectively. But there are widespread limitations in the E911 technology, which supports voice calls, but not the most obvious – and increasingly popular methods of communication – such as SMS or Tweets. By utilising this ubiquitous technology, an E911 service that could process SMS or Tweets would benefit public safety in general, as well as enhancing accessibility to people with hearing and speech disabilities or across medically vulnerable populations.

Currently the Federal Communication Commission is proposing to introduce the Next Generation 911 (NG911) service, which would be based on an internet protocol network. This new service's goal is to enable the transmission of voice, video, data, text messages, and images captured by cellular phones in emergency communications to enhance emergency response efficiency and public safety.

Sandy also raised issues as regards the vulnerabilities of critical infrastructure in urban areas during climate-related events, the first being the loss of electricity. Most problems that arise during and after MACEs are commonly related to power, or lack thereof. As technology advances in both telecommunications and in medical fields, so does reliance on sustainable energy sources. The New York metropolitan area has a sparse history of hurricanes but, over the last two years, Hurricanes Irene and Sandy have inflicted major damage to NYC's infrastructure.

Current climate disruption trends point to an increase in MACEs, meaning that local and national governments must seriously consider how to safeguard their electric power grids and invest in adequate back-up power systems. ConEd estimates that it will cost roughly US$450 (€344) million to repair damage caused by Sandy, but that the cost of fully protecting its electric grid system from MACES would be US$40 (€30.59) billion. The cost-benefit analyses that utility companies are performing point to an alarming trend of repairing MACE-related damages, rather than building-in measures to prevent them.

A safe drinking water supply is another essential component of public health protection. Natural disasters, however, may interfere with the normal operations of water utilities and government health departments. Thus emergency planning is necessary, with plans that set out the actions required before, during and after a natural disaster to provide for a timely and effective response and recovery, and to reduce the severity of damage.

A massive blackout after super storm Sandy left hundreds of thousands of people without power
dreamstime

Water systems affected by hurricanes may suffer major problems, including loss of power and pressure, damage to back-up generators and damage to treatment plants and water distribution systems.

When electrical power is lost, the consequent loss of pressure in water distribution systems enables contaminated floodwater and wastewater to enter damaged water mains, the water-table and drinking water wells. The possible consequences of such contamination – which could be aggravated by delays in issuing public health alerts – are manifold. These might include illness, drop in real estate prices, costs of investigation and repair, civil action suits, persistent public mistrust in the water supply, loss of credibility, and criminal convictions. Moreover, contaminated water could also be the source of an outbreak of infectious disease. Although latent in nature and somewhat limited, it is not uncommon for such outbreaks to occur after floodwater surges or hurricanes. Chlorine remains the most affordable, easily and commonly used disinfectant for drinking water, as it is highly effective against the majority of all water-borne pathogens.

On a national scale in an effort to respond to Hurricane Katrina, the federally-run Environmental Protection Agency (EPA) compiled a list of contaminants of concern which were: E. Coli; cholera; hepatitis A and B; tetanus; mould; lead; petroleum; and pesticides. Three vaccinations were given for hepatitis A and B, tetanus, and diphtheria. In addition, after Hurricanes Katrina and Rita, the load of fungal spores in flooded houses was significantly elevated, with Aspergillus Niger, Penicillium sp., Trichoderma, and Paecilomyces, all of which can cause either respiratory or dermatological disease, and immune-compromised individuals are the most vulnerable.

On a global scale, diarrhoeal episodes are a leading cause of morbidity and are the most reported diseases in post-disaster settings. Common pathogens include cholera, Giardia, E. coli, Shigella, Salmonella, and various viral illnesses such as rotavirus and norovirus.

Hospitals are part of the critical urban infrastructure, and those affected by MACEs may potentially be forced to function with limited resources, or mandated to evacuate, leading to a surge of patients at nearby facilities. In terms of hospital operations, surge capacity generally refers to the ability to manage a sudden and unexpected increase in patient volume that exceeds the present capacity of the facility.

Hospitals in vulnerable coastal areas tend to allocate significant time and resources towards planning for natural disasters or scenarios, but the reality of a disaster can be quite different to any drill that a medical centre may have planned and prepared for. The medical centres and treatment facilities throughout New York and New Jersey that most successfully anticipated the damage from super storm Sandy had taken extensive preparatory measures to ensure patients were informed, were prepared for the possible closure of the facility and/or referred the patients to other treatment facilities. This allowed for agencies like the American Red Cross, in co-ordination with FEMA, to establish and manage shelters, while providing assessment and care of the displaced population's disaster-related health needs, thus helping to decrease surge to local health care systems.

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Healthcare services must extend beyond the walls of a hospital structure. Manhattan finds itself home to 20 per cent of New Yorkers aged 60 and above, one fifth of whom are defined as 'medically vulnerable' patients. Super storm Sandy's tidal surge caused an explosion at a sub-station operated by Consolidated Edison (ConED), the main NYC utility corporation. This triggered a massive blackout across lower Manhattan, leaving 750,000 residents without power. Patients who are medically vulnerable rely on basic utilities for survival. Power failure stops oxygen machines from delivering oxygen to patients; electrical wheelchairs are rendered useless without adequate back-up battery supplies; prescriptions are not refilled when local pharmacies are inoperative; and patients living in high-rise buildings are trapped, unable to seek help from others.

Hospitals tend to be equipped with back-up generators and are staffed around-the-clock with healthcare professionals, although when an unprecedented disaster strikes, it is not uncommon to find both hospitals and medically vulnerable populations equally at risk of increased functional needs, including treatment, oncology services or pharmaceuticals. Super storm Sandy was a perfect example of the latter.

That leads us to an important final consideration – hospital manpower should never be taken for granted. As with first responders, the decision by healthcare professionals to work during a disaster may be influenced by their obligations and responsibilities to their families, as well as to the community and the organisation. Other underlying factors may include individual staff members' past experiences of disasters, the perceived importance of their role in the organisation versus family needs, their relationship with the organisation, and their understanding of the role within that same hospital system. Critical employees – ie physicians, nurses, maintenance and engineering staff – are usually designated to stay in place in emergencies and, as such, understand their roles. But it is unrealistic to assume that personnel who have not been designated as 'critical' in emergency plans would be willing to work if faced with a major emergency or disaster.

Stressed and depleted

Detailed job descriptions and contingency plans for emergency situations may allow first responders to be adequately prepared prior to MACEs, allowing them to fulfil their duties once a natural disaster occurs.

To conclude, a shift in paradigm is needed to recognise climate change as a major factor when devising disaster relief plans. During the initial weeks of this storm, Manhattan was a tale of two cities: the lower east side and downtown Manhattan were left in the dark, while life was as normal for the rest of New York's largest borough. Residents walked or hitched rides to midtown to charge cell phones and to receive the latest recovery news. Staten Island and parts of Brooklyn began salvaging personal property, as many had been left homeless. Less than two weeks after Sandy, New York and New Jersey residents braced for another storm that caused power outages to an already depleted and stressed population.

Six months after Sandy, the East Coast is just beginning to recuperate. If anything is to be learnt, it is that urban responses to MACEs are a work in progress and somewhat flawed.

Disaster planning helps to prepare for and withstand the effects of natural disasters; but once a critical system crashes or a large population is affected, timely and adequate counter-measures need to be implemented. CRJ

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