CLIMATE CHANGE IS WIDELY recognised as a major emerging environmental challenge and its effects vary from an increased occurrence of extreme weather events, elevated temperatures, shifts in timing and intensity of precipitation, to rising sea levels. These affect urban environments in a variety of ways and, over time, are anticipated to result in environmental degradation, loss of biodiversity, increased infectious disease burden, water access and supply constraints, and threats to life and property in urban areas, particularly where people, resources, and infrastructure are concentrated.

The World Health Organization (WHO) projects that in the next 35 to 40 years the world's urban population is expected to increase by more than three billion people. The majority of this growth will occur in continents that are most commonly struck by hurricanes, tsunamis, tornadoes and droughts (ie, Asia, the Americas and Africa). The increased scale of urbanisation will be most extraordinary in such areas, where expanding of agricultural lands, deforestation, and impingement upon other natural resources will contribute to even more complex urban responses towards climate change related disasters.

Over the 12 months, the US has experienced the effects of multiple, significant Major Adverse Climate Events (MACEs).

In April 2012, New York firefighters battled five-alarm brush fires in Staten Island, an area with little history of such events. In early July in the mid-Atlantic, the Washington, DC metropolitan area was paralysed for days as it recovered from severe thunderstorms. Thousands were left powerless, and in some Virginia localities, the emergency 911 calling system was compromised for several days.

In Colorado and much of the western US, higher than normal summer temperatures sparked forest fires that caused havoc for citizens and first responders. While climate conditions (eg, cooler nights and precipitation) can assist in combating forest fires, higher than normal temperatures and minimal precipitation required firefighters to labour against two fronts: fire and climate.

Just a year after catastrophic storms spawned record tornado outbreaks culminating in the destruction in Joplin, Missouri (see *CRJ* 7:2) the summer brought the longest US drought in five decades. Shipping rates fell to a three-and-a-half year low in the Midwest, with the Mississippi River (which had flooded the prior year), limited to one-way traffic in some areas because of decreased water levels. As a direct result of the drought, it is anticipated that global grain exports will suffer.

Seven years after Hurricane Katrina, New Orleans was struck again as Hurricane Isaac tested local and federal protective measures.

Finally, one year after Hurricane Irene, Hurricane Sandy brought devastating flooding, surge, and destruction to the north-east (see page 22). Flooding unlike any experienced in the previous 100 years caused massive damage, which subsequently triggered utility, communications, transportation and other infrastructure failures. Healthcare facilities and commercial establishments were seriously (and some permanently) damaged. Multiple hospital evacuations forced hundreds of patient and staff relocations, leaving an ongoing gap in healthcare delivery and straining pre-hospital care.

> Disaster management must now expand its focus and bridge multiple disciplines, including administrative regulation and policy, engineering, forecasting, public health and medicine, if it is to confront the multiple emerging threats posed by climate change

Magnification

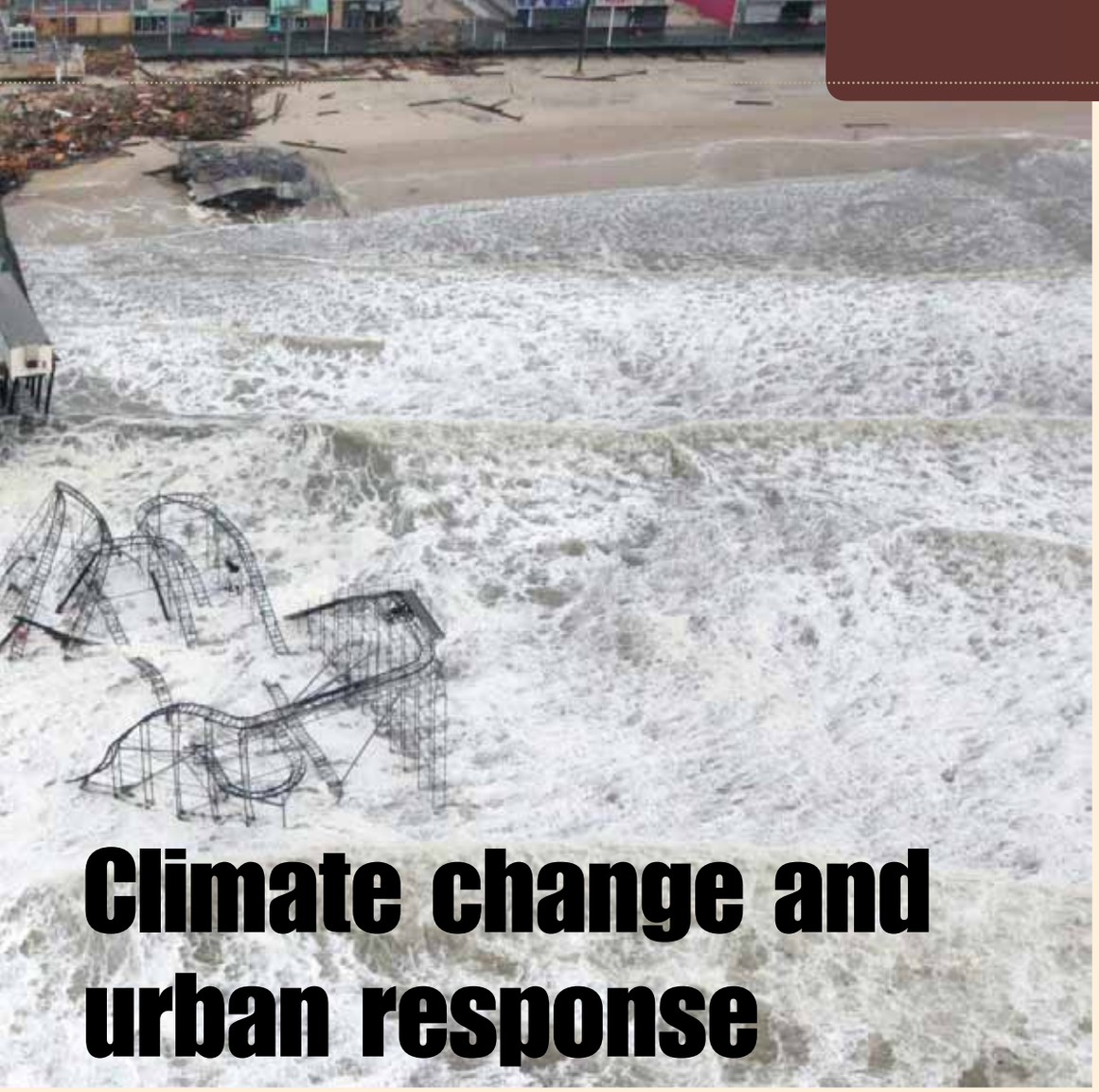
Despite impressive technological and organisational advances, the impact of climate change remains profound and complex. While countries with emerging economies are proportionally more prone to catastrophic infrastructure failures than industrialised ones, developed nations are clearly not immune. In a time of constrained resources, urban entities must now confront climate change directly. Population socioeconomic factors magnify the adverse effects of MACEs. Even before Hurricane Katrina devastated New Orleans, the city was one of the US's poorest and 54 per cent of its inhabitants lacked private transportation. This significant baseline poverty compromised residents' ability to stock up on food, water and medicine, and to evacuate via independent transportation. Buildings and shelters were not structurally sound enough to withstand the devastation of wind and water, a factor exacerbated by population density.

As this article was in preparation, Hurricane Sandy made its way across the Caribbean and north-eastern USA. This image provides emphasis – if any is needed – that although developing nations have their own particular vulnerabilities to climate-related disasters, the developed world is far from immune and weather can have devastating effects

US Air Force Photo / Master Sgt. Mark C Olsen

Previous experiences and lessons learnt, while important, may fail to address future events. Mindful of the 2003 summer, when 46,000 Europeans died in extreme heat-waves (*CRJ* 1:4) many countries now issue early mitigation measures and warnings (such as during France's longest drought in decades in 2011 and the asthma warnings issued during the 2012 London Olympics owing to temperature and city pollution). But in Japan, in 2011, a heat-wave killed 13 people and hospitalised 5,467 more.

Multifaceted and multidisciplinary tabletop drills, modelling, computer simulations, and spatial architectural and urban planning are increasingly playing an important role by developing scenarios for climate-based disasters; planning for energy efficient settlements and communities; and minimising risk for and during disasters. That said, it has



Climate change and urban response

This series will look at the effects of climate and weather-related disasters on urban environments, with the authors saying that we must re-evaluate city and critical infrastructure, and reassess communication and human response structures in the light of changing and more extreme weather events

been difficult to sustain education, curricula and manpower to develop standardised and evidence-based tactics for effective urban response, which cross the silos of institutions, businesses, and local and national agencies.

Disaster management must now expand its focus and bridge multiple disciplines, including administrative regulation and policy, engineering, forecasting, public health and medicine, if it is to confront the multiple emerging threats posed by climate change.

Effective co-ordinated urban response to changes in climate will be vital in curbing the potential rise of infectious disease by compromised water systems and increased arthropod burdens. For example, heavy rainfall in Ontario, Canada, in 2004 and the following year in Michigan, US, contributed to water contamination and deaths.

Climate change and the progressive urbanisation of coastal regions risk further degradation of existing water supplies, flooding, increased effluent pathogens in water and sewage treatment facilities, changes in watershed and littoral run-off, as well as adverse effects in marine food webs. The estimated cost of damages and preventive measures for coastal flooding in the Boston, metropolitan area alone was estimated in 2008 at US$6 – 94 (€4.4 – 69.4; £3.8 – 59.8) billion. The failure to address the devastating effects posed by rising seawater in littoral cities was clearly illustrated by the billions of dollars in damages inflicted by Hurricane Sandy.

European countries, such as the Netherlands and Italy, have started to invest in infrastructure development to address rising sea levels. Reviews of evacuation plans and transportation networks will need to be undertaken concurrently with engineering developments.

Neither are inland areas immune, as shown by Pakistan's deadly floods in 2010, which affected millions of people. Increased heat wave-triggered or exacerbated wildfires, as seen in Europe recently, may force the realignment or reallocation of resources.

Alongside a re-evaluation of city infrastructure and high value assets (utilities, public transportation, hospitals, commercial exchanges, etc), concurrent assessment of communication and human response structures is required. Will tomorrow's emergency personnel be appropriately trained and equipped with adequate technology to accommodate climate challenges? How will their own families' needs be addressed? Have redundant communication links between associated agencies responding to natural disasters matured?

MACEs which occur over large geographic footprints will require the increasing use of formal and informal co-operative agreements between diverse agencies. Co-ordinating information for scores of local, state, and federal agencies dispatched for large scale MACEs will remain an ongoing challenge. Are those involved in modelling and prediction integrated into existing operational or tactical organisational hierarchies?

These are some of the questions that our series will try to address, while debating and rationalising current public health and response trends in relationship to the efficacy of preparedness and management owing to climate change and its effects. CRJ

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