

Enhancing the sustainability and climate resiliency of health care facilities: a comparison of initiatives and toolkits

John Balbus,¹ Peter Berry,² Meagan Brettle,³ Shalini Jagnarine-Azan,⁴ Agnes Soares,⁵ Ciro Ugarte,⁶ Linda Varangu,⁷ and Elena Villalobos Prats⁸

Suggested citation

Balbus J, Berry P, Brettle M, Jagnarine S, Soares A, Ugarte C, et al. Enhancing the sustainability and climate resiliency of health care facilities: a comparison of initiatives and toolkits. *Rev Panam Salud Publica*. 2016;40(3):174–80.

ABSTRACT

Extreme weather events have revealed the vulnerability of health care facilities and the extent of devastation to the community when they fail. With climate change anticipated to increase extreme weather and its impacts worldwide—severe droughts, floods, heat waves, and related vector-borne diseases—health care officials need to understand and address the vulnerabilities of their health care systems and take action to improve resiliency in ways that also meet sustainability goals. Generally, the health sector is among a country's largest consumers of energy and a significant source of greenhouse gas emissions. Now it has the opportunity lead climate mitigation, while reducing energy, water, and other costs.

This Special Report summarizes several initiatives and compares three toolkits for implementing sustainability and resiliency measures for health care facilities: the Canadian Health Care Facility Climate Change Resiliency Toolkit, the U.S. Sustainable and Climate Resilient Health Care Facilities Toolkit, and the PAHO SMART Hospitals Toolkit of the World Health Organization/Pan American Health Organization. These tools and the lessons learned can provide a critical starting point for any health system in the Americas.

Keywords

Climate change; climate effects; prevention and mitigation; disaster preparedness; health care facilities; sustainable development; Americas.

Climate change is anticipated to worsen extreme weather threats. Changes in precipitation, more heat waves and fewer frost days, higher hurricane intensity, and other changes will increase vulnerability

throughout the Americas. Serious health system failures in the United States in the past decade, including Hurricane Katrina in 2005 and Superstorm Sandy in 2013, have demonstrated the vulnerability of

that nation's health care facilities. Super Typhoon Haiyan of 2013 and other super typhoons in the Pacific have left similar destruction and health tragedies in their wake (1). In the coming century, the intensity of typhoons, which are among the most devastating natural hazards on Earth, is expected to further increase due to climate change (2).

Increasing instances of prolonged and severe extreme weather events (e.g., temperature extremes, drought, and flooding) and infectious disease outbreaks

¹ National Institute of Environmental Health Sciences, Bethesda, Maryland, United States of America. Send correspondence to John Balbus, email: john.balbus@nih.gov

² Health Canada, Climate Change and Health Office, Ottawa, Ontario, Canada.

³ Health Canada, Ottawa, Ontario, Canada.

⁴ Pan American Health Organization (PAHO), Washington, DC, United States.

⁵ PAHO, Special Program of Sustainable Development and Health Equity, Washington, DC, United States.

⁶ PAHO, Department on Emergency Preparedness and Disaster Relief, Washington, DC, United States.

⁷ Canadian Coalition for Green Health Care, Branchton, Ontario, Canada.

⁸ World Health Organization (WHO), Geneva, Switzerland.

(e.g., water-, food-, vector-, and rodent-borne) attributable to climate change pose significant risks to human health and health care facilities (3 – 5). In light of the uncertainty surrounding the magnitude, pace, and character of future climate change, there is an urgent need for health care facilities to build the capacity to cope with and adapt to current and projected impacts.

In response, health care officials can identify current and future climate risks and use evidence-based guidance to improve health care facility operations and infrastructure and develop emergency preparedness plans (3, 5). While emergency preparedness measures are imperative and must be in place, there are also aspects of climate change mitigation that involve health care facilities and the health care sector in general. Health services are large consumers of energy and are significant greenhouse gas emitters. Based on estimates from the United States and the United Kingdom (6, 7), the contribution of health care facilities can range from 3% – 8% of the national emissions. Although the global accuracy of these estimates requires more information from developing countries, it is nevertheless important to find ways to reduce emissions. Improving the energy efficiency of health care facilities not only reduces energy costs during normal operations, it also improves resiliency by helping to ensure continuity of operations when extreme weather cuts off external electrical power or fuel access.

The World Health Organization (WHO) has developed the Operational Framework for Building Climate Resilient Health Systems in which such a system is defined as “one that is capable to anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stress, so as to bring sustained improvements in population health, despite an unstable climate” (8). This framework provides a systematic approach for health systems, health care facilities, and public health programming to strengthen their capacity to effectively respond to the increased health risks posed by climate change.

To further assist in implementing the principles highlighted in the WHO framework document (8), several countries and health care organizations have developed resiliency tools that identify vulnerabilities, improve sustainability, and increase resiliency. The Canadian Coalition for Green Health Care (Branchton,

Ontario, Canada), the United States Department of Health and Human Services (Washington DC, United States), and WHO and its Regional Office for the Americas, PAHO, have produced tools (9 – 11) that align with the WHO Framework to help health care facilities prepare for and mitigate the impacts of climate change.

In addition, PAHO collaborated with Health Canada (Ottawa, Ontario, Canada), the National Institute of Environmental Health Sciences (Research Triangle Park, North Carolina, United States), the Canadian Coalition for Green Health Care, the National Institute of Public Health (*Institut national de santé publique*, Québec City, Québec, Canada; INSPQ) and Synergie Santé Environment (Montreal, Québec, Canada) to convene international experts for a workshop on “Health Care Facility Climate Change Resiliency,” held in Montréal, Québec, Canada, on 8 September 2015. This Special Report contextualizes and summarizes the topics discussed at the workshop that brought together 33 experts from eight countries to:

- (i) Share information on existing climate change resiliency tools for health care facilities in the Americas;
- (ii) Share examples of tool implementation, best practices for application, challenges encountered, and suggestions for effective use; and
- (iii) Discuss opportunities for future collaboration in efforts to enhance health care resiliency to climate change impacts.

THREATS TO HEALTH FACILITIES FROM CLIMATE-RELATED PHENOMENA

The Intergovernmental Panel on Climate Change (IPCC) summarized key risks from climate change for North, Central, and South America, including the following (12):

- Human illness and death, property loss, and damage to ecosystems from more extensive wild fires;
- Heat-related human mortality;
- Floods and landslides associated with extreme precipitation, resulting in property and infrastructure damage, water quality impairment, health impacts, and supply chain, ecosystem, and social system disruption;
- Decreased water availability in semi-arid and glacier-melt-dependent areas and Central America;

- Decreased food production and food quality; and
- Spread of vector-borne diseases to higher altitudes and latitudes.

Each of these climate change associated hazards can pose significant threats to the operation of health care facilities. For example, in August 2015, Tropical Storm Erika struck the Leeward Islands in the Caribbean, causing at least 31 deaths in Dominica and making it the deadliest event on this island since Hurricane David in 1979. During Erika, at least 15 inches (380 mm) of rain fell at the Canefield Airport, resulting in extensive mudslides and flooding. A total of 890 homes were deemed uninhabitable, leaving more than 14 000 people homeless, and 80% of the island lost power (13). Damage to the island was estimated at US\$ 482.8 million (2015), setting back development in the country by at least two decades. Health services in Dominica were significantly impacted and had enormous difficulty responding to the emergency. Almost 2 weeks after the storm, 10 of 53 health facilities were still without clean water and 14 did not have solid waste collection. Water supply remained an urgent need in specific health facilities and a focus of disaster response efforts (13). The vulnerability attributes of health care facilities related to climate change hazards are presented in Table 1.

COMPARISON OF THREE TOOLKITS

Health care facility officials need information about climate change risks to their facilities and operations in order to take effective measures to increase sustainability and climate resiliency. The section that follows and Table 2 compare the individual toolkits presented at the September workshop and help illuminate the strengths and gaps of each.

Canadian Health Care Facility Climate Change Resiliency Toolkit

In order to help Canadian health care facilities increase their resiliency to climate change, the Canadian Coalition for Green Health Care, with support from Health Canada and the Nova Scotia Department of Environment (Halifax, Nova Scotia, Canada), developed the “Health Care Facility Climate Change Resiliency Toolkit” (9). This toolkit can be used to

TABLE 1. Climate hazards and vulnerability attributes of health care facilities and examples of risks/impacts, United States of America, 2015

Hazard	Vulnerability attributes and impacts
Temperature extremes: heat and cold waves	<ul style="list-style-type: none"> • During heat waves, health care service volumes surge as residents in the area present to emergency departments, urgent care centers, and physician practices. At the same time, the urban energy infrastructure is over-stressed; the electrical grid is challenged to provide sufficient energy to meet residential and commercial cooling demands. As a result, rolling electrical blackouts often accompany extended heat waves, which can compromise health care delivery. Urban hospitals, as large electricity consumers, are often asked to shift to emergency power generation in order to free grid resources during peak demand periods. • Corresponding elevations in humidity can overwhelm cooling tower and chiller capacities. This is a particular concern in operating rooms where ventilation is essential to prevent patient infection via airborne pathogens. • Many hospitals do not have their cooling systems on their emergency power generation systems; when blackouts occur, hospitals are required to continue to operate their basic ventilation systems but may lose portions of their space cooling systems. For the most part, hospitals are sealed buildings; i.e. they do not incorporate operable windows due to infection control and pressurization requirements. • A cold wave can cause poorly insulated water supply pipes and mains to freeze. It may impact building water supply piping, if not buried deeply enough underground. • Cold waves accompanied by precipitation often produce ice storms, resulting in massive transportation disruptions, electrical grid interruptions, and increased emergency service activities as auto accidents and slip-and-fall injuries peak. Like heat waves, cold waves have greater effects on the poor and elderly.
Tropical cyclones and hurricanes, storm surges, and riverine flooding	<ul style="list-style-type: none"> • Many hospitals constructed in 100-year and 500-year floodplains are now being required to meet current construction code standards for flood-resistant construction. This is a complex requirement, as many hospitals that were constructed under much earlier floodplain maps were not required to meet this level of construction when they were built. • There is growing awareness that hospital campuses must be capable of “island” operation—that is, able to maintain operational capability even when losing municipal electricity, thermal energy, water and sewage utility systems for extended periods of time. Because on-site generators may fail when used at full loads for an extended period of time, coastal hospitals and nursing home facilities are increasingly required to have an electrical pre-connection for external mobile generators. • Two major storm systems deluged the Mississippi River watershed in 2011 with record rainfalls. Seventeen hospitals and 11 nursing homes were considered at high risk of flooding and four health care facilities were evacuated.
Tornadoes and extreme wind	<ul style="list-style-type: none"> • Many U.S. Critical Access Hospitals in tornado-prone areas were built in the 1950s and 1960s, prior to contemporary codes and standards. • Hospitals in the U.S. have faced catastrophic damage from extreme wind events. Some facilities have required total reconstruction, while others have suffered severe damage from flying objects, broken glass, and damaged generator systems placed in vulnerable locations.
Drought	<ul style="list-style-type: none"> • Hospitals are generally among the top 10 potable water consumers in their communities. Residential and ambulatory facilities consume far less water than hospitals, but also require potable water supplies to operate. • While droughts have not, to date, caused severe disruptions to health care services, a range of other weather related water supply disruptions have led to significant service disruptions.
Wildfires	<ul style="list-style-type: none"> • Hospitals may have to evacuate when wildfires encroach. Hospital ventilation systems require an outdoor fresh air supply to maintain indoor air quality and pressurization; if the outdoor air quality is severely compromised by smoke, it may be impossible to safely house patients and staff in the building. • Forest fires have caused a number of planned, limited duration evacuations in the U.S., most recently in 2013 at Camp Pendleton Naval Hospital in California and St. Luke’s Wood River Valley Medical Center in Idaho.
Landslides, liquefaction, and avalanches	<ul style="list-style-type: none"> • Buildings whose foundations bear directly on sand that liquefies will experience a sudden loss of support, resulting in drastic and irregular settlement of the building causing structural damage, or may leave the structure unserviceable afterwards, even without structural damage. • A small ancillary office structure at the University of Minnesota Medical Center was partially evacuated in June 2014 when a 100-meter section of embankment directly adjacent to the hospital campus gave way following 8-15 cms of rainfall in a single day, the worst single rainfall event since 1871 and the culmination of the wettest June on record.
Melting permafrost	<ul style="list-style-type: none"> • Permafrost temperatures have continued to increase over the last century in much of the Arctic. • The Beaufort Delta Hospital in Inuvik, Northwest Territories, Canada, was built with thermosyphon technology to aid in preventing permafrost degradation that could result in damage to building infrastructure.

Source: Adapted by the authors from 2014 data provided by the United States Department of Health and Human Services (14).

increase awareness of climate change impacts to health care facilities, assess facility resiliency to climate change, and identify adaptations that help facilities become more resilient. It includes a facilitator presentation, an online resiliency questionnaire, and resources for adaptation. Facilities can obtain a score of their resiliency and make notes online on specific issues or concerns. The 78 questions are divided into three sections: (i) risk assessment (including risk reduction strategies and assessment of risks to infrastructure); (ii) risk management (including procurement, monitoring, clinical risk management, infrastructure

systems, and energy supply and use); and (iii) building capacity (sustainable health care and climate change mitigation). Six facilities in Nova Scotia, Ontario and Manitoba have piloted the toolkit. The first facility to undertake the assessment was the University Health Network (Toronto, Canada).

The “Health Care Facility Climate Change Resiliency Toolkit” will help the health sector in Canada plan for the challenges posed by climate change. The facilities that have used the toolkit have become important agents of change for reducing fossil fuel emissions, improving resiliency to extreme weather events,

and advocating for public understanding of climate change and health.

U.S. Sustainable and Climate Resilient Health Care Facilities Toolkit

The “U.S. Sustainable and Climate Resilient Health Care Facilities Toolkit” (10) was created as an initial component of the 2013 President’s Climate Action Plan and the “Enhancing Health Care Resilience for a Changing Climate” effort (14). This toolkit helps health sector officials prepare for climate change impacts based on a 5-elements: (i) climate risks

TABLE 2. Overview of the main features of three toolkits for health care facility climate change resiliency

Category	Health Care Facility Climate Change Resiliency Toolkit (Canada)	Sustainable and Climate Resilient Health Care Facilities Toolkit (United States)	PAHO SMART Hospitals Toolkit
Type of facility	<ul style="list-style-type: none"> Small, medium, and large hospitals 	<ul style="list-style-type: none"> Hospitals, residential health care (rehabilitation/long-term care), ambulatory care (dialysis, drug treatment, and chemotherapy), retail (pharmacies), and home care settings 	<ul style="list-style-type: none"> Hospitals with 200+ beds Small and medium-sized health facilities that form part of the health network. Among these are primary care facilities that offer certain specialized services (obstetrics and gynecology, pediatrics, internal medicine, and general surgery) and often have ≤ 20 beds
Hazards addressed	<ul style="list-style-type: none"> Extreme weather events, water- and food-borne contamination, infectious diseases, air quality 	<ul style="list-style-type: none"> Extreme weather events 	<ul style="list-style-type: none"> Geological phenomena (e.g., earthquakes, volcanic eruptions), hydro-meteorological phenomena, social phenomena, environmental phenomena (e.g., epidemics, infestations, contamination), chemical and/or technological phenomena, geotechnical properties of the soil
Areas of resiliency focus	<ul style="list-style-type: none"> Emergency management Sustainability Infrastructure 	<ul style="list-style-type: none"> Infrastructure (institution level infrastructure: physical buildings and campus infrastructure as well as mobile technologies) Critical services and personnel, supply chain, sustainability/energy and water efficiency, and enhancing ecosystem services 	<ul style="list-style-type: none"> Sustainability Infrastructure
Format	<ul style="list-style-type: none"> Facilitators Guide Online Resiliency Assessment Checklist (78 questions) Resiliency scoring provided Resources guide Case studies 	<ul style="list-style-type: none"> Best Practices Document 5 Element Framework Detailed checklists for each checklist linked to resources Case studies 	<ul style="list-style-type: none"> Hospital Safety Index Baseline Assessment Tool The Green Checklist and Discussion Guide Cost Benefit Analysis Methodology Training aids Lessons learned from the SMART Hospitals Initiative
End-user	<ul style="list-style-type: none"> Hospital administrators, emergency management coordinators, health care services managers, food services managers, health facility designers, engineers, and maintenance personnel 	<ul style="list-style-type: none"> Sectors and disciplines engaged in health care facility climate resiliency activities including health care providers, design professionals, policymakers, and institution-level decisionmakers 	<ul style="list-style-type: none"> Hospital administrators, health disaster coordinators, health facility designers, engineers, maintenance personnel, architects, health staff, and hospital directors associated with the overall management and operations of health care facilities.
Number of health care facilities that have used the toolkit	<ul style="list-style-type: none"> 6 health care facilities in Canada piloted the toolkit in 2013. 1 health care facility in Ontario completed assessment on own. 	<ul style="list-style-type: none"> 0 (toolkit is still under development) 	<ul style="list-style-type: none"> In the Caribbean, the Hospital Safety Index was applied in 45 hospitals and 59 small facilities in Anguilla, Barbados, Dominica, Grenada, Montserrat, St. Kitts and Nevis, and St. Vincent and the Grenadines. Based on the results and recommendations from the evaluation team, 15 facilities have begun to make needed improvements.

Source: Produced by the authors from the study data and adapted from References 9, 10, 11, and 14.

and community vulnerability assessments; (ii) land use, building design, and regulatory context; (iii) infrastructure protection and resiliency planning; (iv) essential clinical care service delivery; and (v) environmental protection and ecosystem adaptation. Checklists and searchable case studies linked to the framework elements are included to further assist health care facility officials assess site and infrastructure vulnerabilities and identify needed adaptations. The Toolkit, along with an accompanying guide, are being disseminated, pilot tested, and evaluated from September 2015 – September 2016.

PAHO SMART Hospitals Toolkit

PAHO considers a health care facility “smart” when its structural and operational safety during normal and emergency/disaster operations are linked

with green interventions, at a reasonable cost-to-benefit ratio. To encourage the development of SMART hospitals, PAHO launched the SMART Hospitals Toolkit (11). The online toolkit includes all its tools and guidance documents, as well training materials, case studies, and lessons learned. A key element in the progress towards achieving safe hospitals has been the application of the Hospital Safety Index (HSI)—a rapid and low-cost diagnostic tool for assessing the probability that a hospital will remain operational during an emergency/disaster. The evaluation provides information about a hospital’s strengths and vulnerabilities, and suggests actions required to improve its safety, emergency, and disaster management capacity.

In addition to the HSI, the Toolkit contains a Baseline Assessment Tool, a Green Checklist, a Cost Benefit Analysis Tool, and a Sustainability Construction Guide

Annex. Users are able to mitigate the impact of climate change by reducing greenhouse gas (GHG) emissions and lowering operating costs through reduced water and energy consumption, while enhancing patient/staff comfort through improved indoor environmental quality and occupant conditions.

In Phase 1 of the project, the pilot facilities—Georgetown Hospital (St. Vincent and the Grenadines) and Pogson Hospital (St. Kitts)—applied the toolkit and retrofitted their facilities with great success. They achieved a 50%+ reduction in electrical power consumption and an increase in patients use of the facilities (11). With the continued support of the UK Department for International Development (London, United Kingdom), Phase II will expand to Grenada, Saint Lucia, St. Vincent and the Grenadines, and Dominica. The Toolkit’s cost-to-benefit analysis component is considered a

useful tool for advocacy for action and for ensuring the accountability of the planned interventions. It has been applied in Saint Kitts and Nevis and in Saint Vincent and the Grenadines (15).

DISCUSSION

A number of factors critical to the sustainability and resiliency enhancements have been identified by the three toolkits. As climate change threats and opportunities for the health care sector become more apparent over coming years, continued attention to these critical factors could transform the sector, achieving GHG mitigation and adaptation goals.

Availability of cost benefit analyses and business case statements

Because health care systems and facilities around the world generally operate on public funds or thin economic margins, being able to make a cogent business case for investing in sustainability and resiliency measures is critical to gaining the support of policy makers and corporate managers and boards. Case studies in the toolkits provide some examples of costs and benefits; in some cases, they demonstrate that taking actions to build resiliency have been wise investments in risk reduction; in others, they show how savings from investments in energy efficiency or other sustainability measures can help to recover the costs of combined sustainability and resiliency actions. The PAHO toolkit is the only one to provide a guide to cost-benefit analysis explicitly (15); all toolkits should develop resources and examples to help users make the business case for sustainability and climate resiliency in their own contexts and localities.

The importance of the process

A common theme at the Workshop was the need to actively engage a wide range of partners with adequate knowledge and expertise when undertaking health care facility resiliency initiatives. The toolkits can provide a convening focus for multiple stakeholders to undertake the actual assessments. By helping diverse groups focus on climate change and risks to health facilities, the toolkits help build the consensus needed for developing effective reduction plans. Given the complexity of risks from climate change

to health facilities, it is important to take a multi-disciplinary approach. The toolkits describe the various aspects of health care systems that should be taken into account when planning, and assist users in identifying the specific disciplines and expertise required to carry out their goals. Past users of the toolkits have indicated that the process of determining who to include in the discussions and raising awareness of those involved was extremely valuable as an end to itself (15).

Ensuring a skilled health care workforce

Health care staff require training and education opportunities to effectively use the resiliency tools discussed at the Workshop. Even with a robust adaptation plan at a facility, significant challenges arise if workers are not trained on protocols and procedures for reducing health risks and impacts on infrastructures. In one example provided by a Workshop participant, hospital staff did not know how to operate the equipment installed to limit damage during a flooding emergency.

PAHO is currently developing training guidance for health care workers in the Caribbean so they will be better prepared for emergency events (e.g., proper use of back-up generators). Training of workers should be done periodically given high turnover rates and continuous upgrades and improvements to health care services and infrastructure that can quickly outdate prior skills. Health facility maintenance guides and health care worker training can help officials and staff remain knowledgeable about information, services, and equipment. Workshop participants noted that all the tools would benefit from additional emphasis on health staff training and support. If empowered and properly trained, workers can help raise awareness of climate change and health risks more broadly, advocating for adaptation measures among facility leaders and within the broader community (15).

Ensuring toolkits appropriate for local needs

To ensure wide and sustained use, health care facility resiliency toolkits should be tailored to the needs of users at the local level. Workshop participants agreed that it is key to consider variables, such as the size and scale of the health

care facilities, what resources are available to health officials, and the state of existing sustainability and emergency planning initiatives. Actions can range from local projects revising codes, standards, and regulations, to implementing broad initiatives, such as a national health facility climate change resiliency accreditation process. Innovative approaches can help achieve the flexibility needed to meet different local circumstances. In addition, health care resiliency toolkits must have the right size tools for the facility, with shorter or easier to complete versions for smaller or lower-resourced facilities (15).

Incorporating sustainability into disaster preparedness

Sustainability and resiliency actions should be viewed as overlapping components of the same adaptation process. The economic and quality of life benefits of sustainability are significant. Examples include reductions in costs to facilities, increased energy and water conservation, reductions in greenhouse gas emissions, improved air quality, and healthier patients, staff, and communities. Therefore, resource conservation at health care facilities offers numerous opportunities for synergistic outcomes, ultimately lowering the cost of the resiliency and sustainability improvements that allow facilities to continue providing services to the community during adverse events.

Measures to enhance resource conservation can complement actions to increase resiliency. For example, in addition to constructing a new, high efficiency district energy plant (co-generation of power and thermal energy) after Tropical Storm Allison in 2001, the Texas Medical Center (Houston, Texas, United States) elevated essential infrastructure (e.g., a set of bridge walkways between buildings), removed parking lots, established groundwater recharge systems (to handle extreme rain better), and advocated for and participated in a marsh restoration project upstream from the health center campus (15). A number of these measures acted as redundant initiatives and proved to increase resiliency when the system suffered little to no damage from the 2014 Houston floods. The US health care facility toolkit provides information about these important linkages (10).

In addition, there are many low-technology, proven sustainability actions

incorporated by hospitals across the Americas from which hospitals in more developed nations can learn. These actions include building facilities with windows that open, incorporating more daylighting and passive heating options, taking advantage of natural ventilation, and purchasing local foods.

Health care facilities as community refuges in disasters

In addition to operating through the course of extreme weather events and climate-related disasters, health facilities also need to consider their function as providers of energy, shelter, water, and food for displaced community members. Experiences from the Americas show that facilities can increase resiliency by taking an “island” approach to energy needs, that is, by developing on-site energy sources that are can function independent from the main power utility grid. In Mexico, 3 000 rural medical units and 12 rural hospitals use solar panels (15). In the United States, Gundersen

Hospital (La Crosse, Wisconsin, United States) was the first to obtain 100% of its energy from renewable resources. Distributed energy systems also greatly enhance resiliency to climate change impacts (10). Following Superstorm Sandy on the East Coast of the United States, several facilities disengaged from the public electric power grid and generated their own power using on-site co-generation capabilities (14).

CONCLUSIONS

Climate change threatens to exacerbate the multiple challenges facing health care systems and facilities around the world. By combining measures that produce more sustainable health care operations with infrastructure initiatives that create more resilient facilities, systems, and communities, the health sector can simultaneously reduce costs and ensure continuity of operations during extreme weather hazards. Despite the urgency of addressing both sustainability and resiliency, awareness of the available

improvement measures is low among the health sector. The toolkits and initiatives described here can provide a critical starting point for further health sector awareness raising, training, and implementation of sustainability and resiliency initiatives.

Conflict of interests: None declared.

Disclaimer. Authors hold sole responsibility for the views expressed in the manuscript, which may not necessarily reflect the opinion or policy of the *RPSP/PAJPH* and/or PAHO.

This article is the work product of an employee or group of employees of the National Institutes of Health (NIH), however, the statements, opinions or conclusions contained therein do not necessarily represent the statements, opinions, or conclusions of the NIH, its component Institutes and Centers, or the United States Government. The authors declare they have no actual or potential competing financial interests.

REFERENCES

1. Singer M. 2013 state of the climate: record-breaking super typhoon Haiyan. Available from: www.climate.gov/news-features/understanding-climate/2013-state-climate-record-breaking-super-typhoon-haiyan Accessed on 10 November 2015.
2. Mei W, Xie S, Primeau F, McWilliams J, Pasquero C. Northwestern Pacific typhoon intensity controlled by changes in ocean temperatures. *Sci Adv.* 2015;1(4).
3. Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W, et al. Health and climate change: policy responses to protect public health. *Lancet.* 2015;7;386(10006):1861–914. doi: 10.1016/S0140-6736(15)60854-6.
4. Smith KR, Woodward A, Campbell-Lendrum D, Chadee DD, Honda Y, Liu Q, et al. Human health: impacts, adaptation, and co-benefits. In: *Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral Aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change.* Cambridge: Cambridge University Press; 709–54.
5. Paterson J, Berry P, Ebi K, Varangu L. Health care facilities resilient to climate change impacts. *Int J Environ Res Public Health.* 2014;11(12):13097–116. doi:10.3390/ijerph111213097.
6. National Health Service Sustainable Development Unit. NHS England carbon footprinting report. Cambridge: NHS Sustainable Development Unit; 2012.
7. Chung J, Meltzer D. Estimate of the carbon footprint of the US health care sector. *JAMA.* 2009;302(18):1970.
8. World Health Organization. Operational framework for building climate resilient health systems. Geneva: WHO; 2015. Available from: http://apps.who.int/iris/bitstream/10665/189951/1/9789241565073_eng.pdf?ua=1 Access on 1 February 2015.
9. The Canadian Coalition for Green Health Care. Climate change resiliency for health care. Available from: www.greenhealthcare.ca/resiliency/ Accessed on 6 May 2016.
10. National Oceanic and Atmospheric Administration. U.S. climate resilience toolkit. Available from: <https://toolkit.climate.gov/topics/human-health/building-climate-resilience-health-sector> Accessed on 6 May 2016.
11. Pan American Health Organization, World Health Organization. SMART hospitals toolkit. Available from: www.paho.org/disasters/index.php?option=com_content&view=article&id=1742%3Asmart-hospitals-toolkit&Itemid=911&lang=en Accessed on 6 May 2016.
12. Intergovernmental Panel on Climate Change. Climate change 2014: synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the IPCC. Geneva: IPCC; 2014.
13. Government of Commonwealth of Dominica. Rapid damage and impact assessment Tropical Storm Erika - August 27, 2015. ACP-EU Natural Disaster Risk Reduction program; 2015. Available from: www.drrinacp.org/sites/drrinacp.org/files/publication/Commonwealth%20of%20Dominica%20-%20Rapid%20Damage%20and%20Needs%20Assessment%20Final%20Report%20.pdf Accessed on 6 May 2016.
14. United States Department of Health and Human Services. Primary protection: enhancing health care resilience for a changing climate. Washington DC: HHS; 2014. Available from: <https://toolkit.climate.gov/sites/default/files/SCRHCFI%20Best%20Practices%20Report%20final2%202014%20Web.pdf> Accessed on 6 May 2016.
15. Pan American Health Organization. Health care facility climate change resiliency workshop report. Washington, DC: Health Canada/PAHO; 2016. Available from: www.paho.org/hq/index.php?option=com_docman&task=doc_view&Itemid=270&gid=32440&lang=en Accessed on 1 February 2016.

Manuscript received on 1 February 2016. Revised version accepted for publication on 24 May 2016.

RESUMEN

Mejora de la sostenibilidad y la resistencia de las instalaciones de atención sanitaria ante el cambio climático: iniciativas y recursos

Los sucesos climáticos extremos han puesto de manifiesto la vulnerabilidad de las instalaciones de atención sanitaria y el grado de devastación infligido a la comunidad cuando estas fallan. Ante un cambio climático que preanuncia un aumento de los sucesos climáticos extremos y sus respectivos impactos en todo el mundo (sequías, inundaciones y olas de calor intensas, así como enfermedades relacionadas transmitidas por vectores) los profesionales sanitarios deben comprender y hacer frente a las vulnerabilidades de sus sistemas de atención de salud, y emprender acciones que apunten a mejorar su resistencia de manera sostenible. Por lo general, el sector salud es uno de los mayores consumidores de energía de un país y una fuente significativa de emisión de gases de efecto invernadero. En la actualidad tiene la oportunidad de liderar las acciones de mitigación frente al cambio climático, y a la vez de reducir los costos de energía y agua, entre otros.

En este informe especial se resumen varias iniciativas y se comparan tres recursos dirigidos a implementar medidas de sostenibilidad y resistencia para instalaciones de atención sanitaria: la Herramienta de Resistencia ante el Cambio Climático para Instalaciones de Atención Sanitaria (Canadá), la Herramienta de Resistencia ante el Cambio Climático para Instalaciones de Atención Sanitaria (Estados Unidos) y la Herramienta Hospitales Inteligentes de la Organización Panamericana de la Salud/Organización Mundial de la Salud. Estas herramientas y las lecciones aprendidas a través de ellas proporcionan un punto de partida crucial para todos los sistemas de salud de la Región de las Américas.

Palabras clave

Cambio climático; efectos del clima; prevención y mitigación; planificación en desastres; instituciones de salud; desarrollo sostenible; Américas.
