

FRONTLINE

Preparing healthcare systems for shocks
from disasters to pandemics

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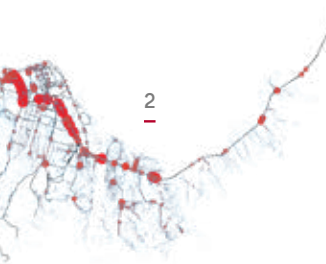
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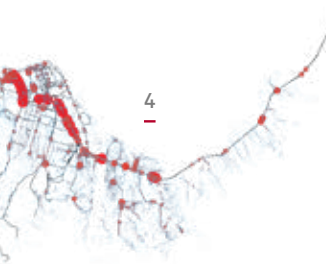
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Executive summary

Access to quality and affordable health care services is foundational to countries' long-term socioeconomic development prospects. Universal health coverage is of strategic importance for achieving sustained progress in ending extreme poverty and increasing shared prosperity. Yet, especially in developing countries, health care systems find themselves at the frontline, coping with pressures from disaster risks, climate change, pandemics, the growing burdens of noncommunicable diseases, and constrained resources and capacity. To deliver universal health coverage in the face of such pressures, countries need to take urgent action to improve the quality, coverage, and resilience of health care systems.

Even before the COVID-19 pandemic, many developing countries were struggling to meet the routine demand for effective health care services. Especially in low-income countries, significant shares of the population cannot access affordable, quality health care. A lack of equipment, skilled staff, and resources is aggravating capacity constraints. The needs that have emerged during the COVID-19 pandemic are highlighting and exacerbating existing capacity challenges. In addition, inefficient and unreliable infrastructure systems—including water, energy, and transport systems—are hampering effective health services delivery. Especially in many low- and middle-income countries, these vital infrastructure services experience severe disruptions during natural shocks. Such underlying shortfalls make it a challenge to meet routine demands and undermine the resilience of health care systems under emergency conditions, when their services are needed most.

Disasters, climate change, pandemics, and demographic changes will increase pressures on already strained health systems. Disasters create demand surges that can quickly overwhelm health care system capacities. As highlighted in the Sendai Framework for Disaster Risk Reduction, public and private sector investments are critical for saving lives and reducing disaster risks on health infrastructure, institutions, and systems. These challenges are compounded by climate change, which is already increasing the frequency of extreme weather shocks. Such events can have wide-ranging indirect impacts on people's health—for example, by spreading waterborne diseases after floods, or exacerbating food insecurity due to lost harvests. The increase in average temperatures is also expected to expand the risk areas for vector-borne diseases like malaria and dengue. The continued expansion of urban and agricultural land use is encroaching on natural habitats and risks the emergence of new zoonotic diseases. And demographic changes, including aging societies, pose new challenges to health care systems as service needs change. All these trends have major implications for the scale and type of routine health care services that need to be provided—but they also alter vulnerabilities to shocks such as disasters and pandemics.

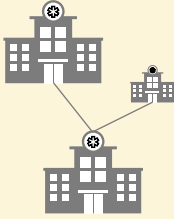


To strengthen the resilience of health care services to such shocks and pressures, this report highlights lessons from the disaster risk and emergency management practice. It outlines five principles that are crucial to enable health systems to offer more reliable and shock-resistant services:

- 1. Foundations: health systems that effectively manage routine demand are more resilient to shocks.** Building the capacity of health care systems to effectively meet routine demands is a prerequisite for increasing resilience to shocks. A wide range of enabling factors need to be strengthened, such as adequate equipment, financing, skilled staff, efficient management, and operational protocols. Ensuring that health systems are inclusive is key to boosting community resilience.
- 2. Individual health care facilities: managing demand, capacity, and readiness for shocks.** Health care facilities need to be prepared to meet the surge demand for health services due to shocks. Ex-ante contingency planning prepares the capacity, staff, equipment, and protocols needed for emergency contexts, thus ensuring resilience to shocks at the frontline of healthcare delivery. Health care facilities themselves must also be resilient to shocks, such as floods or earthquakes.
- 3. Health care systems: strategies to increase surge capacity and system-level coordination.** In complex health system delivery environments—especially when resources are limited—it is impossible to immediately equip every facility to the highest standard to provide its designated service. Organized systems planning and flexible solutions can meet surge demand through coordinated regional and system-level response. This includes evaluating and predicting resource and capacity constraints, and understanding the feasibility, role, and effectiveness of alternative service modalities and contingency plans for critical supply needs.
- 4. Integrated emergency response: coordination with disaster response and civil protection agencies.** Closely coordinating the emergency preparedness of health systems with the country's overall emergency management and disaster response systems—the military, civil protection, community groups, disaster risk financing, and so on—is vital. The need is most pronounced in postdisaster situations, when multisectoral issues have to be addressed simultaneously to meet basic needs such as food and shelter, and provide essential public services such as security, social safety nets, rescue, and health care.
- 5. Lifeline infrastructure for resilient health care services.** Quality infrastructure is essential for effective health care services—even more so during disasters and pandemics. Resilient water, electricity, transport, and communication and digital systems are crucial to ensure adequate treatment capacity, equitable access to health care, and functioning supply chains. The resilience of health care services depends on the interdependence of these lifelines.

Ensuring an effective pandemic response, while strengthening disaster response capacity. Strengthening health sector resilience and its interlinkages with emergency response systems and infrastructure planning is crucial for effective disaster risk management (DRM). As such, the framework outlined above is relevant beyond the current pandemic. The principles outlined in this report can directly inform health, infrastructure, and DRM operations; they can also contribute to emergency response systems that are better equipped to respond to a wide range of shocks, from seasonal demand surges to pandemics and disasters. Based on these principles, this report outlines five pillars of resilient health systems, and offers concrete action areas for governments, summarized in table **ES.1**.

Table ES.1 Five pillars of resilient health systems and respective priority actions

Pillars	Priority actions
 Foundations: health systems that can effectively manage routine demand	Ensure universal access to routine health care by: - Strengthening managerial and operational capacity, governance, and planning systems - Strengthening the technical and administrative capacities of the health workforce, including through specialized crisis trainings - Improving health information systems for identifying new risks, vulnerabilities, capacity bottlenecks, and information sharing - Ensuring the availability of essential medical supplies and equipment - Mobilizing and allocating the financial resources needed for routine operations and crisis response
 Resilient health facilities	Ensure adequate capacity and resilience of facilities by: - Upgrading structures to withstand shocks and ensure self-sufficiency - Enhancing staff capacity and training - Improving facility and inventory management to maximize utility of limited resources - Maintaining emergency stocks of essential medical supplies - Expanding capacity where possible based on needs (for example, number of intensive care unit beds) - Preparing crisis protocols for boosting capacity and ensuring basic level of care provision (for example, business contingency plans)
 Resilient health systems	Integrate individual health facilities into a coordinated network and improve cooperation during crises by: - Using data-driven approaches to identify surge demands early and distribute loads to health facilities and service modalities more effectively - Improving communication and cooperation between entities in the health system to manage surge demand during disasters - Leveraging solutions for delivering health care services outside health facilities, including community centers, telemedicine, pharmacies - Deploying mobile clinics to underserved and disaster-hit areas to boost the capacity of permanent health facilities
 Integrated emergency response	Integrate health care into DRM systems by: - Efficiently meeting wide-ranging critical needs during crises, including food, shelter, security, and health care - Coordinating with search and rescue agencies such as civil protection and the military to manage health service demand - Establishing interagency communication channels before disasters strike - Clearly defining roles and mandates for crisis response to mitigate capacity bottlenecks - Enhancing hydrological, meteorological, and early warning services and disseminating information to agencies and the public - Integrating health system needs in disaster risk finance strategies
 Resilient infrastructure	Ensure the resilience of critical infrastructure systems on which health facilities depend by: - Upgrading transport, water, electricity, and telecommunications assets in critical areas - Strengthening cyber resilience - Improving infrastructure maintenance regimes - Mandating risk-informed infrastructure planning, with higher standards for health system-relevant assets - Leveraging new technologies for service and supply delivery

Acronyms

ACH JHM	All Children's Hospital Johns Hopkins Medicine
BCP	business continuity plan
DEWS	Disease Early Warning System
DRM	disaster risk management
eIDEWS	electronic Integrated Disease Early Warning System
GFDRR	Global Facility for Disaster Reduction and Recovery
GDP	gross domestic product
HEPR	Health Emergency Preparedness and Response
ICU	intensive care unit
JJS	Japan Joint Staff
JMA	Japan Medical Association
JMAT	JMA disaster medical team
JSDF	Japan Self-Defense Forces
MHLW	Ministry of Health, Labor and Welfare
PAHO	Pan American Health Organization
RKI	Robert Koch Institute
SDG	Sustainable Development Goals
UNDP	United Nations Development Program
WHO	World Health Organization



1

Health care systems are crucial for managing shocks like pandemics or disasters

Building the resilience of health systems is an imperative for sustainable development.

Access to quality and affordable health care services is foundational to countries' long-term socioeconomic development prospects. Universal health coverage is of strategic importance for achieving sustained progress in ending extreme poverty and increasing shared prosperity. Yet, health care systems in developing countries are at the frontline, facing multiple pressures—not only from disaster risks, climate change, pandemics, and the growing burdens of noncommunicable diseases, but also constrained resources and capacity. In addition, demographic changes, including aging populations, are altering societies' vulnerability profiles. To deliver universal health coverage in the face of such pressures, countries need to take urgent actions to improve the quality, coverage, and resilience of their health care systems.¹

From flood-induced cholera outbreaks to earthquake casualties and zoonotic diseases, health care systems play a crucial role in mitigating the illnesses and deaths caused by emergencies. Countries' ability to provide reliable essential health care can also mitigate the severe, long-lasting, indirect effects of shocks. For example, estimates for the COVID-19 pandemic suggest that poor nutrition and interruptions in essential health services are drastically increasing maternal and child deaths—by 39 and 45 percent, respectively (Robertson et al. 2020). Children, particularly girls, are at heightened risk of lifelong consequences from shocks in their early development years. As health services are disrupted, immediate impacts include increases in the incidence of disease, hunger, and displacement; longer-term effects include disrupted livelihoods and education, and reduced labor market opportunities (UNDRR 2019). Poor households tend to be more vulnerable to such effects, exacerbating existing inequalities.

▲ Lunsar, Sierra Leone: A nurse and a medical worker preparing to enter an ebola treatment center to check on patients. Photo: Belen B Massieu / Shutterstock.com

Efficient health care systems are indispensable for managing systemic shocks like pandemics or disasters and mitigating the loss of life. To effectively serve patients during normal times, health care providers need adequate facilities, equipment, staff, medical supplies, food supply, information management capabilities, and reliable access to power and clean water. But what happens during shocks? To manage small and frequent shocks, health care facilities can take precautionary measures to bridge supply disruptions and demand surges—for example, through backup capacity planning that addresses the main causes of service gaps, such as loss of access to power or clean water, or disrupted supply lines. However, large-scale shocks like pandemics or severe disasters cause systemic spikes in demand, which require facilities to coordinate their capacity and capabilities to improve overall health system performance. Shocks can also reduce the capacity of health care facilities directly—for example, around 26 percent of health care facilities in coastal Vietnam are in flood zones (Rentschler et al. 2020).

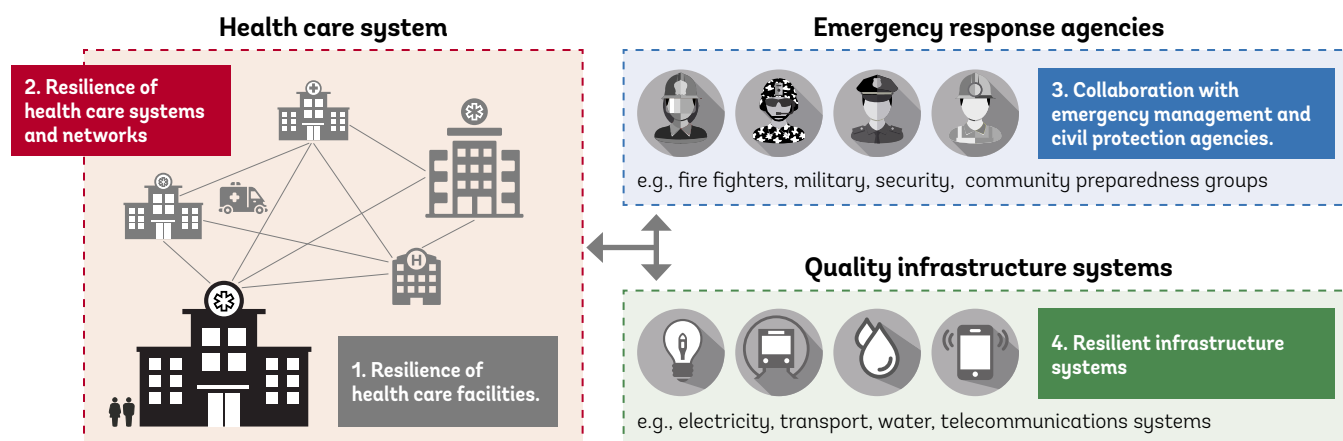
What are resilient health care systems?

The resilience of health care systems is the capacity of health sector agents and institutions to mitigate, reduce, manage, and rapidly recover from crises, including pandemics, disasters, and other major shocks. A resilient health system can maintain its core functions throughout a crisis and provide additional capacity to reduce the adverse impacts of the crisis. Health systems are resilient if they succeed in protecting human life and well-being during and in the aftermath of a crisis (Kruk et al. 2015) while also ensuring everyday quality health care.

Various detailed studies have already considered the resilience of health care systems in the context of specific crises. Kruk et al. (2015) discuss the implications of the Ebola outbreak and the factors of health system resilience. Ammar et al. (2016) analyze the Lebanese health system during the Syrian refugee crisis and its implications for resilience. The World Health Organization (WHO 2015a) analyze health systems' resilience to climate change and discuss the building blocks of a resilient health system in depth.

This report focuses on the intersection points between health care systems, emergency management, and quality infrastructure. It draws on insights from earlier studies to present a systematic overview of the intersection points between health systems and emergency management. It emphasizes that, far from being isolated systems, health systems are embedded in a wider network of emergency response systems (summarized in figure 1.1). As such, the resilience of health care systems is underpinned by the quality of infrastructure assets on which they depend. And according to the *G20 Principles for Quality Infrastructure Investments*, these should be built resilient to disasters and other risks (G20 2019). This report builds on the existing analysis of the resilience of health systems, adding the perspective of disaster risk management (DRM) and resilient infrastructure systems as important components of disaster-responsive health care provision.

Figure 1.1 Resilient health care systems depend on and interact with wider disaster management and lifeline infrastructure systems



Five principles of resilient health care systems

To strengthen the resilience of health care services to shocks and pressures, this report highlights lessons from disaster risk and emergency management practice. It outlines five principles that are crucial to enable health systems to offer more reliable and shock-resistant services:

- 1 Foundations: health systems that effectively manage routine demand are more resilient to shocks.** External shocks like disasters or pandemics cause surge demand for health services while placing pressures on the operating environment—for example, due to a shortage of supplies or effects on frontline health care providers, as experienced during the COVID-19 pandemic.² Thus, building a health care system's capacity to effectively manage routine demands is a prerequisite for increasing its resilience to shocks. A wide range of enabling factors need to be strengthened, such as adequate equipment, financing, skilled staff, efficient management, and operational protocols. Availability of digital information paves the path to estimating demand for various health services based on population and environmental characteristics to predict future demand shifts.
- 2 Individual health care facilities: managing demand, capacity, and readiness for shocks:** Frontline health service delivery points—such as primary care facilities or hospitals—need to understand demand trends and be prepared to meet surge demand for health services due to shocks. Ex-ante contingency planning can be key for preparing the capacity, staff, equipment, and protocols needed for emergency contexts. It is therefore important to consider compound risks, for example, as natural shocks may coincide with efforts to contain a pandemic or seasonal diseases such as the flu. Health care facilities need to be structurally resilient to shocks, such as floods or earthquakes, and investments in their capacity and resilience prioritized by identifying underserved regions and neighborhoods. Service resilience will also depend on delivery mode—for example, services provided through telemedicine might continue to function in the event of structural damage to a facility.
- 3 Health care systems: strategies to increase surge capacity and coordination:** In complex health system delivery environments—especially where resources are limited—it will not be possible to immediately equip every facility to the highest standard to ensure it can provide its

designated service. And as disasters are often regionally concentrated, orchestrated systems planning and flexible solutions to meet surge demand may be required. But many countries' health systems are not ready to function as part of a connected, coherent system. Data-driven approaches can help facilitate a coordinated service delivery and response at facility level and across service delivery modes to enable an effective regional and system-level response. This includes evaluating resource and capacity constraints for different services, selecting and quantifying the role of alternative interim or permanent service delivery modalities, designing contingency plans to prioritize and ensure critical supply needs, and identifying vital supply chains. A health system's capacity is more than the sum of its individual components.

- 4 Integrated emergency response: coordination with disaster response and civil protection agencies:** The emergency preparedness of health systems must also be closely coordinated with a country's overall emergency management and disaster response systems, including the military, civil protection, and community groups. The need is most pronounced in postdisaster situations when multisectoral issues have to be addressed simultaneously, from meeting basic needs such as food and shelter to providing essential public services such as security, social safety nets, rescue and health care. National disaster risk financing strategies can account for the specific needs of the health sector. A resilient health care system must therefore be embedded in a broader national DRM framework.
- 5 Lifeline infrastructure for resilient health care services:** Quality infrastructure is essential for effective health care services, particularly during disasters and pandemics. Without reliable water and electricity supply, treatment centers cannot function. Resilient transport systems are crucial for ensuring equitable access to health care for all—including for elderly or low-income households—and functioning supply chains. As health care systems increasingly rely on telemedicine and other digital technologies for service delivery, telecommunication infrastructure functionality and resilience to cyber threats becomes of central importance. To strengthen the resilience of health care services, health systems cannot be treated in isolation, as preparedness and response efforts rely on the interdependence of all infrastructure systems.

Stronger health care systems are crucial for safeguarding development progress and creating a robust basis for development.

Disasters and pandemics affect immediate supply and demand for essential care, as providers struggle to meet changing needs and patients forego routine and essential care. As a result, disruptions in routine service provision can result in increased morbidity and mortality rates, on top of any shock-induced increases in illnesses and deaths (see, for example, Jones et al. 2016; Wilhelm and Helleringer 2019). Past pandemics have shown that such indirect impacts can eventually cause greater harm than the disaster itself (Elston et al. 2017). WHO data for 80 countries show that around 1.4 million fewer people received necessary care for tuberculosis in 2020 compared with the previous year, because of COVID-19.³

The consequences of disaster can affect human development gains for decades, with their effects often rippling across populations and generations. Immediate impacts include reduced access to health care and increased incidence of disease, hunger, and displacement. Longer-term effects are felt through disruptions to livelihoods, education, and limited labor market opportunities (UNDRR 2019). Disadvantaged households tend to be more vulnerable to such effects, exacerbating existing inequalities—for example, an estimated 36 percent of the affected population fell below

the poverty line as a direct consequence of the 2010 floods in Pakistan (UNESCAP 2017). Actions to strengthen the resilience of health care systems are crucial for reducing and preventing the long-lasting impacts of health care disruptions and ensure a resilient recovery from COVID-19 alongside sustainable and inclusive development.

Endnotes for Chapter 1

1. The National Bureau of Economic Research Center of Excellence defines health systems according to three types of arrangement between two or more health care provider organizations: (1) organizations with common ownership, (2) contractually integrated organizations, such as accountable care organizations, and (3) informal care systems, such as common referral arrangements. In health care systems, organizations can be combined horizontally (for example, in a hospital system) or vertically (for example, in a multihospital system that also owns physician practices and post-acute care facilities). Based on the Agency for Healthcare Research and Quality, Rockville. <https://www.ahrq.gov/chsp/chsp-reports/resources-for-understanding-health-systems/defining-health-systems.html>
2. Frontline health care providers—mostly women (77 percent) and nurses (61 percent)—reported symptoms of depression (50 percent), anxiety (45 percent), insomnia (34 percent), and mental distress (72 percent) during the COVID-19 global crisis (Urdaneta, Stacey, and Sorbello 2020).
3. UN News. 22 March 2021. 1.4 million with tuberculosis, lost out on treatment during first year of COVID-19 <https://news.un.org/en/story/2021/03/1087962>.



◀ Disaster preparedness facilities by the Fiji Red Cross. Photo: chameleonseye.



2

Meeting future needs: today's shortcomings may be exacerbated by climatic and demographic changes

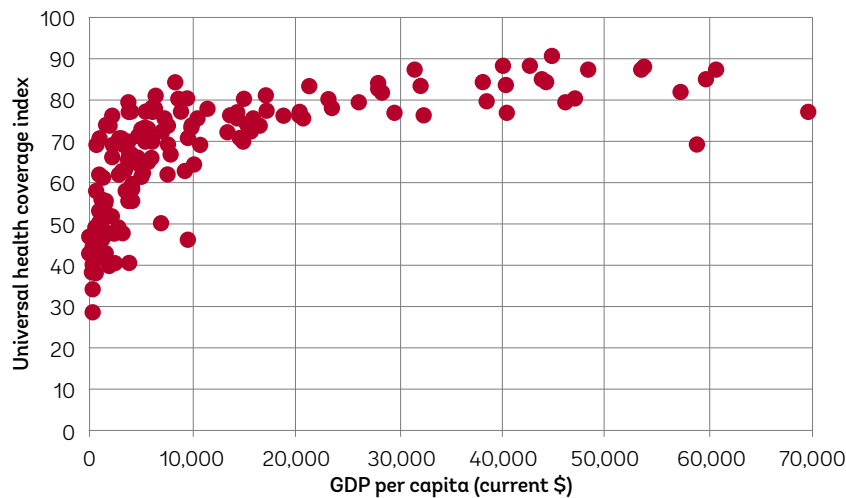
Even before the COVID-19 pandemic, health care systems in many low- and middle-income countries were struggling to meet routine needs.

By providing universal health coverage,¹ countries can ensure that people have access to the health care they need without suffering financial hardship. Yet, in low-income countries in particular, significant shares of the population still lack quality and affordable health care (figure 2.1; WHO, OECD and World Bank 2018). Low- and middle-income countries' primary health care is largely delivered at lower-level health facilities, such as health posts and health centers.

Worryingly, an analysis of 10 African countries showed that lower-level facilities tend to be poorly equipped to provide essential care compared with hospitals (World Bank, forthcoming). For example, the study finds that, while basic medicines² are available in 67 percent of hospitals, only 48 percent of health centers and 36 percent of health posts have them. Availability of basic equipment and infrastructure also greatly varies across facility types and geographic locations: in Tanzania, 87 percent of lower-level facilities have basic equipment—thermometers, stethoscopes, blood pressure cuffs, and weighing scales—compared to 100 percent of hospitals. In Niger, 85 percent of urban facilities have basic infrastructure—improved water and sanitation facilities, and electricity—against only 18 percent of rural facilities. Not only do such shortfalls make it a challenge to meet routine demands, they also undermine health care system resilience under emergency conditions.

▲ Johannesburg, South Africa: Mobile clinic for maternal health and dental treatment. Photo: Shutterstock.

Figure 2.1 Universal health coverage remains inadequate in many low-income countries



Source: World Development Indicators (2017 data)

Note: The Universal health coverage index measures people's access to quality and affordable health services and is reported on a scale of 0 to 100.

Shortcomings in health care systems are impeding effective pandemic and disaster response.

The needs that have emerged during the COVID-19 pandemic have highlighted and exacerbated existing challenges in health care systems—for example, a lack of capacity, situational awareness, coordination, or effective system planning. The World Bank's *Lifelines* report has also shown that the lack of resilient transport, energy and water systems can obstruct the effective delivery of essential health care services (Hallegatte, Rentschler, and Rozenberg 2019). This was evident during the 2021 cold wave in Texas, United States, when several hospitals lost their water and electricity supply, resulting in difficulties and delays for health services on top of the toll of the ongoing COVID-19 pandemic.³

Such experiences are common in low-income countries, where baseline shortfalls are more pronounced and systems more vulnerable. Low-income households tend to be affected harder by the effects of pandemics and disasters—and face more limited access to health care services—further aggravating these challenges. Data-driven approaches are key to assessing the scale and nature of these challenges, while also helping to inform and prioritize investments to build and strengthen the resilience of health care systems and their underlying infrastructure.

Disasters and climate change will increase pressures on health care systems.

Climate change is already increasing the frequency of extreme weather shocks, including cyclones, floods, droughts, and heat waves. Such events claim many casualties and add pressures on already strained health services. Disaster events not only cause destruction in their course but can have wide-ranging adverse impacts on people's health—for example, by spreading waterborne diseases after floods, or exacerbating food insecurity due to lost harvests. Different types of climatic shocks are likely to dominate in different regions. The *2020 Report of The Lancet Countdown on Climate Change and Health* finds that, over the past 20 years, there has already been a 54 percent increase in heat-related deaths, with Southeast and Central Asia being most affected (Watts et al. 2020).

Rapid urban and economic growth is contributing to increased disaster risk exposure and the spread of diseases. Urban growth is especially rapid in high-risk zones, not least because safe spaces have already been occupied and new settlements are increasingly occurring in flood zones or sensitive coastal stretches. In coastal Vietnam, high-growth areas are estimated to face twice the risk of flooding compared to low-growth areas (Rentschler et al. 2020). Such high-risk settlements are often home to low-income households, as they cannot afford property values in safer spaces (Patankar 2015). Informal and poorly planned neighborhoods thus often lack the infrastructure systems—such as drainage and sanitation systems—that could mitigate the impacts of floods, increasing the risk of waterborne diseases. Evidence from Dar es Salaam, Tanzania, shows that informal neighborhoods are particularly prone to suffer from outbreaks of cholera during flood events (Picarelli, Jaupart, and Chen 2017).

Disasters and compound shocks can have long-lasting impacts, especially on child development and health.

Children's health and development are strongly linked to their parents' income (Almond 2006). Inadequate nutrition and reduced well-being in pregnant women can cause their children to suffer permanent impairments to their cognitive and social development, and from chronic illnesses later in life (Almond and Currie 2011). Reduced parental income and access to care result in increased child mortality, malnutrition, and stunting. Children are also the most vulnerable to diarrheal disease and severe dengue (Watts et al. 2019). Children from disadvantaged backgrounds and especially girls are particularly affected by disruptions in access to education. At the height of the current pandemic, up to 1.6 billion children worldwide were out of school, leading to significant losses in the quality of learning (World Bank 2020a). As stunting and educational outcomes are closely interconnected, setbacks to a child's early health and education can have long-term implications for their development and productivity. Such consequences have the potential to reduce a country's productivity and growth prospect for decades, leaving today's children behind for the rest of their lives (World Bank 2020a). Actions to strengthen the resilience of health care systems are therefore an urgent imperative.

New diseases will emerge over time, and climate change may shift the types and burden of disease.

COVID-19 has been a sobering reminder of the risk of zoonotic diseases, but it is by no means the first zoonotic disease (following H1N1 and Ebola), and is unlikely to be the last. The rapid expansion of urban areas and agriculture is not only destroying natural habitats, but also increasing contact between wildlife and humans.⁴

Climate change is expected to cause large changes in infection rates from vector-borne diseases—including malaria and dengue—caused by changes in temperature, rainfall, and humidity levels. This is particularly so in tropical regions. Climate change is also expected to redistribute deaths from heat and cold exposure, reducing mortality in winter, especially in higher latitudes, and increasing mortality in summer, especially in lower latitudes. At this point, the overall effect of temperature changes on the total burden of disease remains uncertain. Climate change is expected to reduce the availability of staple foods, leading to an increase in the prevalence of stunting in children under 5. Although the global mortality rate from diarrhea has decreased, current trends show an improvement in the suitability of the climate to dengue and diarrheal disease transmission, to which children under 15 are most vulnerable (Watts et al. 2019). These trends are expected to vary significantly across regions (WHO 2014).

SPOTLIGHT GHANA

The Ghanaian government is strengthening institutional and technical capacities to tackle increased risk from climate change and disasters in the health sector (WHO 2015b). This includes measures like an early warning system for climate-sensitive health risks in the Integrated Disease Surveillance and Response system (WHO 2015b). Three pilot projects were established in 2010 in the districts Keta, Gomaa West/Apam, and Bongo, where public health agencies assessed climate hazards, installed health screening tools, established community emergency centers to respond to climate hazards like flooding, and trained over 750 health workers and volunteers on how to respond during climate and other emergencies (Tye and Waslander 2021). To collect essential data, the Ministry of Health, Ghana Meteorological Agency, and Noguchi Memorial Institute for Medical Research conducted a health vulnerability adaptation assessment in 2015 and 2016. The goal was to determine a baseline vulnerability assessment and to better understand the connection between climate variables and disease outbreaks (Tye and Waslander 2021). Results showed positive correlation between rainfall and malaria outbreaks and poverty and malaria outbreaks, thus enabling targeted policy measures.

Demographic trends, including aging societies, pose new challenges to health care systems.

The UN estimate that by 2050, 1 in 6 people in the world will be over the age of 65, up from 1 in 11 in 2019. High-income countries have experienced slowing birth rates and aging societies for several decades. Such demographic changes have major implications for the scale and type of routine health services that need to be provided; they also alter vulnerabilities to shocks such as disasters and pandemics. Aging societies tend to require added capacities to treat complex and chronic diseases and longer hospital stays. Demographic change also creates imbalances in the financing structure of health systems, as shrinking working populations reduce fiscal revenues.

More recently, similar trends have emerged in many middle-income countries. It is estimated that, by 2050, more than 80 percent of people over the age of 60 will be living in low- and middle-income countries (UNDESA 2020).⁵ Health systems in Pacific island states already face pressure from aging societies (Anderson and Irava 2017). The fastest increase in older populations is expected to happen in low-income countries, whose elderly population (aged 65 and older) will grow 225 percent from 37 million in 2019 to 120 million by 2050 (UNDESA 2020). As the life expectancy of the world's population increases, so does the disease burden of noncommunicable diseases.

Box 2.1. Managing the opportunities and risks of digitalization

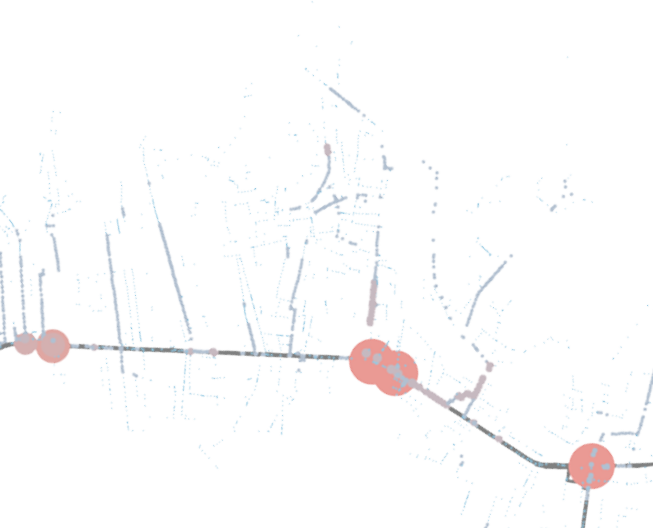
Digitalization offers a wide range of opportunities for health systems. It can secure vital medical consultations, maintain educational services, and enable more effective assessment of resource needs. Smart data usage can help detect outbreaks of contagious diseases faster, as shown in Ontario's real-time surveillance system for respiratory diseases (Moore, Edgar, and McGuinness 2007; van Dijk et al. 2009). It can also help analyze outbreak patterns and increase the availability of health care services.

Digital solutions in the health sector include information and communication technologies (eHealth)⁶ and mobile health (mHealth) (WHO 2011). While mHealth has the power to spread access to health systems in areas with low health care coverage that have mobile cellular networks, eHealth has a broader application involving smart solutions and data approaches. A powerful combination of factors is driving such digital solutions, including fast improvements in mobile technologies and applications, and advances in the coverage of mobile cellular networks and internet access (WHO 2011). According to the International Telecommunication Union, in 2020, more than 90 percent of the world's population was covered by a mobile network and more than 4 billion people had access to the internet, compared to around 1 billion in 2005 (ITU 2020).

However, these advances in digitalization and increased application of smart technologies also make health systems vulnerable to cyber threats. According to Jalali and Kaiser (2018), "cybersecurity incidents are a growing threat to the health care industry in general and hospitals in particular. The health care industry has lagged behind other industries in protecting patients, and now hospitals must invest considerable capital and effort in protecting their systems" (Jalali and Kaiser 2018, 1). Not only can cyberattacks disrupt the availability of health services, they can also compromise sensitive patient data. For example, a cyberattack on a German hospital in 2020 caused the death of a woman who could not be admitted to the hospital after the servers had been encrypted in a ransom scam.⁷ This is just one example that highlights the vulnerability of digital health networks to cyberattacks, indicating that cyber security will be a crucial consideration in the resilience of health care systems in the 21st century.

Endnotes for Chapter 2

1. The WHO defines universal health coverage as "the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population." <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/4834>. Accessed February 25, 2021.
2. Medicine availability is calculated as the percent of 14 medicines available and in stock at the time of the survey. The list of medicines is based on a subset of the WHO *Essential Medicines List*. More detailed information is available in World Bank (forthcoming).
3. Brooks, B. 2021. "Cold, lack of water overwhelm Texas hospitals more than COVID-19 did." *Reuters*, February 20. <https://www.reuters.com/article/usa-weather-hospitals/cold-lack-of-water-overwhelm-texas-hospitals-more-than-covid-19-did-idINL8N2KP6KM>.
4. WHO. 2020. "Zoonoses". Newsroom fact sheets, July 29. <https://www.who.int/news-room/fact-sheets/detail/zoonoses> accessed on February 16, 2020.
5. WHO. 2018. "Ageing and health", Newsroom fact sheets, February 5. <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>. Please note that the United Nations refers to less developed countries as "countries and areas of Africa, Asia (excluding Japan), Latin America and the Caribbean, and Oceania (excluding Australia and New Zealand)"; and that Least Developed Countries correspond to "47 countries, located in sub-Saharan Africa (32), Northern Africa and Western Asia (2), Central and Southern Asia (4), Eastern and South-Eastern Asia (4), Latin America and the Caribbean (1), and Oceania (4)." Further information is available at <http://unohrls.org/about-lDCs/>.
6. WHO. eHealth at WHO. <https://www.who.int/ehealth/about/en/>.
7. Kerkmann, C and Nagel, L-M. 2020. "Todesfall nach Hackerangriff auf Uni-Klinik Düsseldorf." *Handelsblatt*, 18 September. <https://www.handelsblatt.com/technik/sicherheit-im-netz/cyberkriminalitaet-todesfall-nach-hackerangriff-auf-uni-klinik-duesseldorf/26198688.html?ticket=ST-10457570-sHoBdG1eQODdUbp12CxY-ap1> (in German).



3

Building the resilience of health care systems

To strengthen the resilience of health care services to shocks and pressures, this report highlights lessons from disaster risk and emergency management practice. It outlines five principles that are crucial to enable health systems to offer more reliable and shock-resistant services:

- 1 Basic foundations for widespread, affordable and adequate health care provisions are essential. A system that cannot meet routine demands will not perform effectively during emergencies.
- 2 The resilience of individual health facilities must be strengthened by upgrading buildings, equipment, capacity, protocols, and through staff training.
- 3 Improved coordination and systems planning within health care networks can help systems flexibly respond to surge demand.
- 4 Clear coordination channels and protocols are needed to align health systems with the country's overall emergency response strategy, including through the military, civil protection, and community groups.
- 5 Health care provision depends on reliable lifeline infrastructure systems, including water, energy, and transport. For health care systems to be resilient, their underlying infrastructure systems must be resilient, too.



▲ Sulawesi, Indonesia: Devastation following the 2018 earthquake and tsunami. Photo: iStockphoto.com

3.1 Foundations: health systems that effectively manage routine demand are more resilient to shocks

To be resilient to shocks, health care systems must be able to effectively manage routine demand.

External shocks like disasters and pandemics cause surge demand for health services at the frontline and place pressures on the operating environment—for example, due to a shortage of supplies. Thus, building a health care system's capacity of to effectively manage routine demands is a prerequisite for increasing its resilience to shocks. Effective routine demand management requires a wide range of enabling factors—including adequate equipment, skilled staff, efficient management, and operational protocols—which are also essential for ensuring resilient health services during emergencies.

This means that continued investment in and policy support for strengthening health services and expanding health care coverage are an essential foundation for resilience. But it does not mean that countries need to build a strong routine health care system before they can take measures to build resilience. Rather, they should integrate such measures into their overall health system planning to ensure that systems are resilient by design.

A large body of experience and evidence highlights the building blocks of effective health care systems. The WHO emphasizes that effective health care systems rely on the following six essential building blocks (WHO 2010), which also incorporate climate resilience (figure 3.1.1):

- **Leadership and governance:** Strategic considerations to manage any current and future shocks and stresses, including policy planning and institutional rule and framework development
- **Health workforce:** Developing and strengthening health workers' technical and administrative capacities through training and ensuring there are sufficient financial and human resources—for example, specialized training and contingency plans for personnel deployment
- **Health information systems:** Assessing vulnerabilities and capacities and collecting data to enable informed decisions, by using early warning systems, identifying risk factors, and through further research to close knowledge gaps
- **Essential medical products and technologies:** Having the required hardware—from surgical equipment to medication and vaccines—and deploying new technologies, especially information technologies, to access and share relevant information more effectively and efficiently
- **Service delivery:** Deploying quality and affordable health services, by investing in other sectors if necessary (for example, to improve transport, water infrastructure, or garbage disposal), identifying emerging health threats and delivery challenges, and putting disaster management and business contingency plans in place
- **Financing:** Identifying financial needs and providing adequate financial resources, assessing health service resource needs by budgeting the interventions of the other building blocks. Planning and management must account for both routine operations and measures to increase surge capacity and resilience to shocks.

Figure 3.1.1 Building blocks of effective health care systems



Source: WHO 2015a

Large investment needs remain to ensure universal coverage with affordable and quality health care and meeting the Sustainable Development Goals (SDGs). The World Bank and WHO (2020) show that countries must increase spending on primary health care by at least 1 percent of their gross domestic product (GDP) if the world is to close glaring coverage gaps and meet the health targets agreed under the SDGs of ensuring healthy lives and promoting well-being at all ages.¹ There can be no universal health care without affordable, quality primary care. The research also warns that, if current trends continue, up to 5 billion people will still be unable to access health care in 2030.

Effective routine health care provision can help build disaster resilience.

Targeted investments and policy reforms in the above areas can help countries strengthen the effectiveness and coverage of routine health care provision. These activities are in line with Priority 3 of the Sendai Framework for Disaster Risk Reduction 2015–2030, which calls for support to enhance the disaster resilience of national health systems by, among other things, integrating DRM and health care services, developing the capacity of health workers in understanding disaster risk, and applying and implementing disaster risk reduction approaches in health work (UNISDR 2015).

The rest of this chapter outlines further steps that countries can take to strengthen the shock resilience of health systems to ensure adequate care service during emergencies. Such actions can, in turn, help improve operations under baseline conditions. For example, infrastructure systems that are resilient to disasters are also more reliable under baseline conditions—so, strengthening the resilience of infrastructure systems on which health care depends can also help address overall disruptions and inefficiencies.

Box 3.1.1. Learning from COVID-19

The COVID-19 pandemic has presented a monumental test case for health system preparedness, and documenting the lessons learnt will be crucial. The challenges countries have encountered while containing, responding to, and treating the pandemic have highlighted several areas in which governments can strengthen the resilience and preparedness of their health systems. Documenting experiences and lessons learnt will be crucial for identifying priority actions to enhance health system resilience in terms of preparedness, response, risk mitigation, and prevention. Several issues merit in-depth analytical assessments, including:

- Identifying and mapping population flows to hospitals and pharmacies
- Assessing hospitalization patterns and accessibility of facilities
- Forecasting contagion hotspots within urban zones
- Monitoring for compliance with 'stay at home orders', and
- Understanding and anticipating medical resource needs and impact on health care providers.

Significant resources, including from the World Bank Group, have been dedicated to supporting COVID-19 response and recovery and establishing pandemic early warning systems. Evaluating and documenting their effectiveness can be crucial to offer guidance during future emergencies—for example, with respect to investments in:

- Procuring and using testing and treatment equipment, medical supplies, and infrastructure facilities (including temporary field health facilities)
- Integrated disease surveillance and response systems to detect pathogens, and primary health systems' ability to diagnose emergency pathogens, and
- Developing emergency operations centers and strengthening emergency response communications.

Documenting these lessons is an important step toward strengthening the preparedness of governments and resilience of health care systems. To support this process, the World Bank, through the Global Facility for Disaster Reduction and Recovery (GFDRR) and the Health Emergency Preparedness and Response (HEPR) Trust Fund, are conducting an operational stocktake of government responses to COVID-19 across the South Asia region. This study is assessing how governments leveraged existing policies, institutional frameworks, and systems for disasters and pandemics for COVID-19 and will define entry points to increase response efficacy for future events.

Box 3.1.2. Governance and trust: a foundation for health service delivery

Governance and trust are critical for service delivery at all levels of health care systems. The lack of trust can undermine health services, especially during crises. In 2019, the WHO listed vaccine hesitancy as one of the top 10 threats to global health. Vaccine hesitancy is “the reluctance or refusal to vaccinate despite the availability of vaccines”, and can be driven by complacency, lack of trust in health care providers and institutions, and inconvenient access.² Surveys document large variation across countries in people’s willingness to get a COVID-19 vaccine, with the average willingness ranging from about 32 percent in France to 69 percent in the United Kingdom.³ Yet the uptake of vaccines is critical for countries to achieve the level of herd immunity required to overcome the pandemic.

Health providers are key to building trust, and attitudes towards health care can shift over time. During the 2014–15 Ebola crisis in Sierra Leone, mistrust in treatment centers was initially widespread. A later assessment was not only more positive but also showed that interactions between patients and social and health care workers were instrumental in reshaping their perceptions and increasing their trust, despite persisting skepticism among the public (Richards et al. 2019).

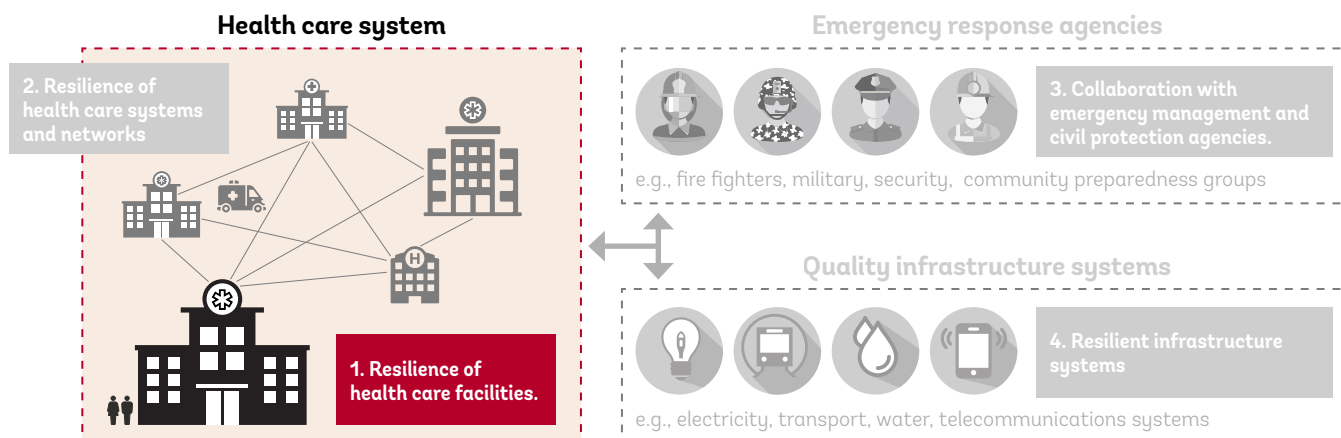
Trust and governance also matter in enabling better policy making. Advances in technology have made it possible for health care providers to collect data to improve care delivery. For example, the digitalization of health care has paved the way for linking data sources across facilities and over time, optimizing care pathways, diagnostics, treatments, and follow-up performance. Yet the safe use of private data remains a major concern for most countries. Strong governance frameworks are thus key to enabling the safe use of health data to improve the quality of health care delivery and minimize risks to patients’ privacy, while strengthening public trust in health care providers and governments (OECD 2015).



◀ Mataram, Lombok, Indonesia: Doctors of a non-profit organization taking notes and treating patients after an earthquake. Photo: Light Perspectives / Shutterstock.com.

3.2 Individual health care facilities: managing demand, capacity, and readiness for shocks

Health care facilities play a central role as the point of care. Resilient care facilities can withstand or quickly recover from shocks, while maintaining capacity to continue providing essential care during emergencies.



Seasonal demand surges—for example, due to flu—are testcases for effective capacity scaling during extreme events.

While demand surges during disasters are extreme cases, health care systems can plan and account for seasonal surge capacity in their regular scheduling. If done effectively, this can reduce stress on health system capacity and increase the quality of patient care. By accounting for additional demand during regular seasonal outbreaks, the health system is also more flexible in its ability to respond to additional shocks that might occur during the seasonal surge demand. Efficient use and management of available medical and human resources and staff training is at the heart of capacity building for these circumstances. Planning for seasonal outbreaks can help mitigate the shocks that infectious diseases have on people and lessen the economic harm they can cause.

SPOTLIGHT TAIWAN, CHINA

In many tropical and subtropical countries, dengue outbreaks trigger surge demands for health services. Luh et al. (2018) estimate that, each year between 1998 and 2014, Taiwan, China, lost an average of 115.6 years of full health per million inhabitants due to dengue (measured in disability-adjusted-life-years). They find the effects to be 12.3 times higher in pandemic years compared to normal years, highlighting capacity constraints during demand surges. Dengue has an incubation period of three to eight days and can show a variety of symptoms, often with unpredictable clinical outcome. Appropriate clinical interventions can significantly reduce the fatality rate to less than 1 percent of severe cases. It is not clear what factors contribute to patients developing severe symptoms, yet early diagnosis and immediate supportive treatment can drastically lower the risks of complications and death.

Countries that are prepared to manage seasonal demand surges are also better prepared to respond to more extreme emergencies. More than 100 countries are affected by dengue outbreaks. Rathnayake, Clarke and Jayasooriya (2019) analyze 18 case studies for a mix of high-, middle-, and low- income countries and how they deal with surge capacities of dengue to better understand what impacts effective planning. They find that countries where dengue is endemic typically have seasonal surge capacities built into their health systems at hospital level. Affected areas often prepare for seasonal outbreaks by incorporating them into emergency plans, planning in additional staff, and providing specific staff trainings. In doing so, the hospitals were able to better respond to the seasonal dengue surge demand, increasing quality of care for all patients. This shows that planning for seasonal surge capacity helps build health system resilience and can lessen the need to rely on ex-post emergency response approaches.

SPOTLIGHT PHILIPPINES

As one of the countries most exposed to natural hazards, the Philippines frequently experiences volcanic eruptions, floods, earthquakes, and typhoons. Dayrit et al. (2018) find that the frequency of disasters heavily impacts public health provision. In 2018, the government undertook ambitious actions to improve the quality and resilience of health services, upgrading or building 4,920 local health facilities and starting work on improvements at another 4,000 local government unit facilities. These works were complemented by the deployment of 23,800 health professionals and the mobilization of over 50,000 community health teams. The government also upgraded public hospitals and distributed critical equipment in local government units. These investments have increased health service coverage and outpatient and inpatient care capacity. Targeting vulnerable communities, the Department of Health also subsidized health insurance premiums of poor families, supported structural upgrades of facilities in poorer neighborhoods, and deployed trained staff and medicines in underserved communities (Dayrit et al. 2018).

During disasters—such as tropical cyclones, flooding, or earthquakes—or during infectious disease outbreaks, health care facilities will face surging patient numbers. If hospitals and primary care units are unprepared for these unexpected emergencies, patient care will be harder, if not impossible. Data-driven analyses can help estimate potential demand for both routine health services and surge demand. By identifying underserved regions and neighborhoods, such analyses are essential for prioritizing investments in the capacity and resilience of health care facilities. For example, the Pan American Health Organization (PAHO) periodically surveys health care facilities in the Caribbean and Latin America for hurricane, earthquake, tsunami, flooding, and other disaster risks.⁴ The PAHO surveys include a section about the emergency capacity of critical systems such as electrics, water, telecommunications, fuel storage, and medical supplies. Such exercises are an important first step for identifying needs and service gaps, and prioritizing investments in health care capacity and preparedness.

Staff, stuff, space, and systems are four essential components to ensure surge capacity.

In 2006, an interdisciplinary expert group, comprising academic and community emergency physicians, economists, hospital administrators, and mathematical modelers, identified three important determinants of surge capacity to respond to emergencies (Kaji, Koenig, and Bey 2006). A fourth was added later (Downar and Seccareccia 2010) to complete the following four essential components to ensure surge capacity:

- **Staff:** availability of trained health care professionals
- **Stuff:** essential medical supplies, from drugs to surgical instruments
- **Space:** availability of physical structures and spaces to care for patients
- **Systems:** leadership and governance, such as frameworks, guidelines, and disaster management.

All four components are necessary at frontline facility level for delivering health services during catastrophic events. Indeed, experience from previous disaster responses has shown that the number of “patients who can be cared for in a hospital depends not only on the facility’s resources, but also on how its limited resources are managed, staff are assigned, and the hospital’s space is used. Efficient use of the staff, resources, and space may lead to greater capacity than simply adding more of any category. A hospital can take action to increase its capacity and capability substantially (up to 500 percent, Ghayoomi et al. 2021) by repurposing space and beds, redeploying personnel across hospital units, implementing crisis standards of care, turning patients toward alternative health care facilities, or managing demand” (Miller-Hooks and Tariverdi, forthcoming).

Disasters and emergencies typically have short or no lead times, making ex-ante preparation of “staff, stuff, space, and systems” crucial for rapid and effective emergency response. Maintaining critical inventories can be crucial for ensuring continuous care provision in early emergency stages, including basic medicines,⁵ equipment, and infrastructure backup capacities, such as water tanks and generators. Rapid mobilization of spare capacity also requires ex-ante planning to ensure, for example, health care professional availability—through contingency personnel management, caseload distribution, minimizing absenteeism, and so on—and capacity to absorb and reallocate additional beds for inpatient care. Maintaining large spare capacity and inventories of supplies and equipment may not always be logistically feasible or affordable, but preparedness measures can alleviate some pressures of emergencies. Clearly predefined roles and accountabilities and preagreed procurement arrangements can help significantly speed up the increase of surge capacity in the early stages of disaster or pandemic response. Predefined operational protocols for emergency treatments can be based on contingency plans that shift the focus from day-to-day operations for optimizing the outcomes of single patients to optimizing outcomes for a whole population.

Health care facilities need to be protected from shocks.

Like all critical public infrastructure systems, health care facilities are exposed to a wide range of external shocks, including natural hazards such as floods and earthquakes. Ensuring the disaster resilience of staff, buildings, equipment, and medical supply chains is crucial to ensure continued care provision during disasters. In Vietnam, a recent risk assessment estimated that 26 percent of health care facilities in coastal provinces are located in high-risk flood zones (Rentschler et al. 2020). Earthquakes can pose particularly high risks for hospital buildings—for example, when a 6.2-magnitude earthquake struck in January 2021 on the Indonesian island of Sulawesi, hospital buildings collapsed and severely obstructed treatment and relief efforts.⁶

Through stronger building standards and systematic risk assessments, such risks to critical facilities can be reduced. The Global Program for Safer Schools offers an example for such action. Funded by the GFDRR through the Japan-World Bank Program for Mainstreaming DRM, it aims to boost investments in the safety and resilience of school infrastructure at risk from natural hazards and enhance the quality of learning environments for children.

SPOTLIGHT IRAN

The devastating 2003 earthquake in Bam, Iran, killed over 26,000 people. In the aftermath, local health systems experienced a functional collapse, due to structural damage to critical infrastructure and hospitals (Ardalan et al. 2009). To improve resilience of the health system and ensure better functionality, a 10-year mitigation plan was put in place. The rebuilding process was used to upgrade hospitals, strengthen their seismic resilience, and increase the overall number of facilities in the city, thus increasing overall resilience in the health system. Similar hospital safety pilot programs were initiated in the cities of Gorgan and Kerman, with support from the national government and the United Nations Development Program (UNDP). A study on the disaster preparedness of the Iranian health sector finds that these structural programs, disaster preparedness plans, and staff trainings have significantly improved health care quality and resilience in Iran, and recommends further resilience measures, especially concerning communication and information sharing in case of disasters (Ardalan et al. 2009).

Preparedness standards and self-sufficiency measures can bridge the continuity of care during emergencies.

Formulating concrete emergency standards can help facility managers take necessary preparedness measures, if their design takes into account capacity and resource constraints. In Japan, buildings that provide essential services—such as retirement homes, hospitals, or large residential buildings—need to meet heightened seismic resilience standards. For the United States, Brands et al. (2013) propose key measures for expanding self-sufficiency of hospitals in addition to existing regulations, including:

- Ensuring emergency power generation capability, a national standard requires at least 96 hours of generator fuel supply at critical facilities⁷
- Storing or ensuring medical supplies are accessible in off-site warehouses
- Ensuring the structural integrity of buildings—in flood and hurricane risk areas, this includes ensuring critical equipment is located above flood levels and in the heart of buildings, away from hazards
- Ensuring vital day-to-day functions, such as plumbing, air quality and temperature, water supply and sewage disposal, are disaster proof
- Building redundancy in all essential hospital systems, including patient databases
- Developing and training specific disaster response plans
- Creating a resilient transportation system in case of a disaster to safely and effectively relocate patients.

Self-sufficient hospital buildings can have economic and environmental co-benefits. Off-grid power solutions, such as solar electricity panels not only enable self-sufficiency in case of power outages but can also result in cost savings and reduce environmental externalities. By one estimate, an average hospital in the United States could save up to \$400,000 over 20 years by investing in solar power and smart grids, while simultaneously increasing their resilience to power outages (Lagrange et al. 2020). Mizuno et al. (2017) present a model for optimal installation capacity of a solar power and battery system to complement diesel-powered generators. They find that the additional power created increases fuel efficiency and independence from power grids in case of blackouts, and therefore resilience.

SPOTLIGHT UNITED STATES

Florida is particularly exposed to natural hazards and has been hit by twice as many Category 5 hurricanes as any other U.S. state over the last century (Brands et al. 2013). After Hurricane Katrina hit New Orleans in 2005, resulting in 1,833 fatalities and \$125 billion in damages, the planning commission for the All Children's Hospital Johns Hopkins Medicine (ACH JHM) set out to build a disaster-resilient hospital. The new hospital has self-sufficient power supply for up to 21 days, windows and building structure designed to withstand flying debris and winds up to 130 mph, and an on-site disaster locker with all necessary supplies. It has built in communications system redundancy by adding various technologies, such as shortwave and two-way radios and its own distributed antenna system to maintain cell service in case of larger outages. This allows the hospital to communicate with other emergency response services during a disaster. Learning from transportation problems during Hurricane Katrina, the helipads of ACH JHM were built to sustain the weight and size of military-grade helicopters. It has also installed water supply and treatment solutions, enabling the hospital to maintain plumbing and waste disposal functions in case of disruption to the local sanitation infrastructure.

Skills, capacity, and institutions are crucial to ensure smooth operations.

The importance of the availability of human capital in underpinning resilience goes beyond mainstreaming disaster risk reduction and capacity building across and within institutions. Vulnerabilities to disaster and climate change stem from a variety of socioeconomic and institutional factors. Yet, addressing these vulnerabilities requires strong governance structures and specialized skills, which are a bottleneck in many countries with high risks (Holloway and Fortune 2019).⁸ A study of 15 Pacific island countries revealed that reduced capacity and expertise in disaster response often results from a lack of adequate, accredited, and high-quality tertiary-level training programs specific to disaster risk reduction and climate adaptation (Hemstock et al. 2016). Additionally, countries with weak governance structures may struggle to provide basic services, including health care, during crises.

Providing essential care under surge demand therefore also requires capacity building at institutional level, where strong governance and the availability of adequately skilled experts are needed to inform system-level decisions. Planning and preparedness are crucial: the UNDRR (2011) recommends that countries assess their capacity assets and needs by engaging all stakeholders, and formulate, implement, and evaluate their capacity development plan, which should contain both institutional strengthening and knowledge enhancing measures.

SPOTLIGHT JAPAN

The Ministry of Health, Labor and Welfare (MHLW) promotes the education and training of health professionals at central level, while regional prefecture authorities oversee and build up subnational human resources.⁹ Specific training programs are designed to clarify role and protocols for medical personnel in the event of disasters, as well as triage and treatment technology for injuries and illnesses that frequently occur during disasters. The MHLW also oversees training programs for doctors and nurses who participate in disaster medical assistance teams, which can be dispatched promptly in the event of a disaster. Similar specialized training programs are offered to members of the Disaster Dispatch Psychiatric Medical Team¹⁰ and the Disaster Health Crisis Management Support Team, which consists of public health specialists and registered dietitians.

Business continuity plans (BCPs) can be effective in mainstreaming resilience standards and emergency protocols.

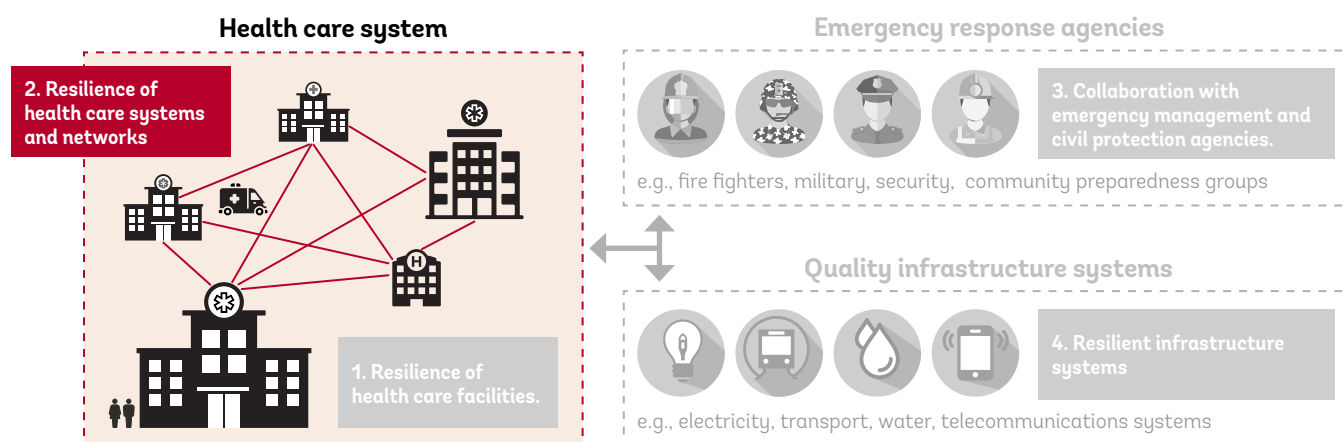
BCPs are common among private sector firms to define strategies for unexpected events or disasters, with the objective of ensuring or quickly recovering operations. In Japan, BCPs are widely used and subsidized by the government to ensure the continued functioning of businesses and supply chains during disaster events. This shows that BCPs are especially effective when the government provides concrete guidance on their contents and subsidizes their implementation.

SPOTLIGHT JAPAN

In March 2012, the MHLW instructed medical institutions to create disaster countermeasure manuals based on the concept of a BCP in hospitals.¹¹ Experiences from Typhoon Jebi and the Hokkaido Eastern Iburi earthquake in 2018 showed that long-term power and water outages could disrupt hospital treatment. To assess progress towards BCP formulations in hospitals, the MHLW conducted a survey among all the country's 8,372 hospitals. This showed that almost all 736 designated base hospitals for disaster response (*saigai kyoten byōin*) had developed their BCPs. Established in 1996, these base hospitals are designated facilities "for enhancing and strengthening the initial emergency medical system in the event of a disaster".¹² To be better prepared for crises, disaster base hospitals are required by law to meet predefined standards of capacity and readiness, including having: checklists for medical facilities and equipment; certified seismic resilience of medical facilities; private generators and fuel with capacity to provide about three days' power; secured water supply; on-site helicopter landing facilities; and vehicles to dispatch a disaster medical assistance team.¹³ As of 2019, the BCP development rate among regular hospitals was around 25 percent.¹⁴

3.3 Health care systems: strategies to increase surge capacity and coordination

Health systems are interconnected networks of many facilities providing a vast variety of services. Resilience can be built into the network itself to mitigate damage and disruptions in case a single facility loses functionality or is destroyed. This includes evaluating resource and capacity constraints, drawing up contingency plans for critical supply needs, and identifying of vital supply chains.



► Nigeria: Medical worker sharing information by mobile phone. Photo: Shutterstock.com



To ensure the best possible care during emergencies, system-level coordination is critical.

In case of pandemics or disasters, surge demand can exceed the capacity of single health facilities. Efficient management of available resources across different health service modalities and facilities and network-level cooperation can ease the burden on single facilities—for example, in heavily affected disaster zones. Data-driven approaches and digital technologies can help track medical supply stocks, and financial and human resources across these networks.

To ease the burden, a central coordination system can help with the efficient assignment of patients to health facilities and types of service. When individual health facilities are overwhelmed or out of resources to deliver certain services, a well-coordinated network of facilities can also help deliver necessary supplies and mobilize human resources to provide critical care where it is needed most. Modeling the effects of collaboration between hospitals when a facility suffers physical damage, Shahverdi, Tariverdi and Miller-Hooks (2020) show that distributing surge demand between hospitals in case of a shock can increase the quality of service delivery. They also find large potential for developing new strategies for resource sharing, transfers, and joint capacity enhancement, and conclude that a network approach increases the resilience of health systems. Similarly, Bonds and Rich (2018) find positive effects of increased quality of health services in Rwanda and Madagascar, after they implemented policies that “improved readiness (such as infrastructure, staffing, training, and supply chain) at each level of the system, and integrating clinical programmes” (Bond and Rich 2018, 2).

Sharing resources and capacities between facilities within a health networks can help distribute large demand in case of a shock, ensuring continuity of care services. To enable efficient responses during surge demand and disasters, health systems must prepare. Memorandums of understandings between entities for sharing information and resources, compatible digital health information systems where applicable, regional warehouses, prepositioning critical supplies, and evacuation contingency plans are examples of such actions.

SPOTLIGHT JAPAN

The Japan Medical Association¹⁵ (JMA) established a disaster medical team (JMAT) in 2010 (Ishii 2013). After the Great East Japan Earthquake on March 11, 2011, it was able to dispatch many disaster medical teams to the affected areas through a nationwide mobilization of doctors and medical professionals, thus decreasing stress on single facilities. During the current COVID-19 pandemic, JMAT assisted in distributing patient loads. Multiple hospitals started working together to effectively manage the increased demands from the pandemic and ensure patient care. In Kanagawa Prefecture, JMAT established an emergency load-sharing medical system by designating “advanced medical institutions” that accept critically ill patients; “priority medical institutions” that accept moderately ill patients; and “priority medical institution cooperation hospitals” that support priority medical institutions. Designed to divide surge capacity, the Kanagawa model enables a smooth delivery of health services. By dividing the patients according to symptoms and assigning enough support to institutions, it decreases the likelihood of a breakdown of the health system. Based on past experiences, the JMA plans to further promote disaster preparedness and management and implement disaster medical training to prepare for large-scale disasters across Japan (as of 23 December 2020).¹⁶

Communication between and coordination of health care system components and providers are crucial for managing and monitoring large outbreaks. Not only do they help distribute patient loads and mobilize scarce resources efficiently to enhance capacity, communication and coordination can also help uncover seasonal outbreaks and pandemics faster. In 2004, a two-year pilot project started in Ontario, Canada, to establish an emergency department chief complaint syndromic surveillance system. The project included multiple hospitals, as well as regional and national departments of health. In syndromic surveillance, health specialists use automated data acquisition and statistical alarms to monitor disease indicators in real time,¹⁷ enabling earlier detection of disease outbreaks, compared to traditional public health methods. For example, by linking infection data from multiple health facilities, the Ontario project has been shown to detect gastrointestinal or respiratory outbreaks faster than traditional reporting systems (Moore, Edgar, and McGuinness 2008). Early detection of outbreaks allows hospitals to adjust their resources and planning sooner.

Digitalization and data can improve the efficiency of coordination in crisis situations.

Established digital health information systems, inventory management, and supply chains help evaluate and coordinate capacities faster and more efficiently than analogue systems. They can also help track medical supply stocks, increasing communication efficiency throughout the health network. Tariverdi (forthcoming) finds that the availability of digitalized data on the health sector and supporting infrastructure, medical supplies, and global networks enables health care systems to plan for a wider range of risks, increase quality of care, and improve their impacts on health outcomes. New health sector data sources also facilitate better disease monitoring,

propagation, and prevalence predictions for real-time actions (or outbreak warning systems) and better long-term projections—for example, of noncommunicable diseases in a community (Tariverdi, forthcoming).

SPOTLIGHT YEMEN

The heavy rains in February 2019 that resulted in a cholera outbreak were typical of the natural shocks that frequently hit Yemen. To improve the country's response to outbreaks, the government implemented a national disease surveillance system, the electronic Integrated Disease Early Warning System (eIDEWS) in 2013.¹⁸ The system has improved the national health system's ability to detect infectious disease outbreaks and target interventions. With financing from the World Bank, eIDEWS was expanded in 2017 and now covers 1,991 locations across the country, including 22 governorates and all 333 districts, and another 450 sites are planned to be added in 2021 (World Bank 2021b). The eIDEWS, which collects data on 28 diseases from health facilities, including cholera, dengue, and malaria (World Bank 2021b), aims to reduce mortality and morbidity through early detection and a swift response to disease outbreaks. The system has enabled quick reporting on outbreaks and produces a weekly update. In 2017, 134,456 alerts were generated by eIDEWS, with 128,190 verified as valid alerts, detecting five disease outbreaks and indicating a positive predictive value of 95 percent (World Bank 2021b; Dureab et al. 2020). During the current COVID-19 pandemic and simultaneous cholera outbreaks, the eIDEWS has helped to keep Yemen's health system functioning by helping to quickly detect outbreak hot spots (World Bank 2021b).

Digitalization supports information sharing between public and private providers, which is essential for both routine services and in emergencies. Smith, Brugha, and Zwi (2001) find that private sector providers are the preferred point of contact for patients in many developing countries (Better physical accessibility and longer operational hours make private sector providers the first choice, provided affordability can be ensured. They are sometimes seen as more capable and more cost-effective than their public sector counterparts, so making full use of capacities and capabilities in private sector facilities in public emergencies is crucial. For example, during a Hepatitis A outbreak in San Diego, United States, public officials avoided delays and saved costs by working with private sector care providers to locate a significant number of vaccines for a mass vaccination campaign in private pharmacies. Private sector agility is particularly effective where private coordinating agencies can detect supply chain disruptions during emergencies and inform public sector of possible consequences.¹⁹

Mobile health technology can help to free up capacities and expand services to underserved areas.

Because they are widely used, mobile devices can increase the availability of health services, especially in areas where they would otherwise not be available or where physical health care facilities have limited capacity (Hao 2015; Hirsch-Moverman 2017). Combined with real-time data on outbreaks and disasters, it can be used to identify and facilitate communication with at-risk populations. WHO (2019) considers the role mHealth can play in communication between trained medical staff and patients in low- and middle-income countries. Stressing the importance of training health care providers in mHealth technology usage, it shows that the acceptance of mobile devices to communicate medical findings depends not only on medical staff training, but also on patients' technoliteracy. The WHO Guideline notes that, the more confident both sides are with mobile devices, the more effective the communication: "when health care providers

struggled using these technologies, they held negative perceptions about its usefulness. Those who struggled with techno-literacy were also anxious that this may result in additional errors, and not understanding the information generated by these technologies” (WHO 2019, 10). It also notes that mHealth technologies strengthen the interaction and flow of information vertically in health system between tertiary and regional facilities and community health centers.

SPOTLIGHT GHANA

Through pilot projects in Keta, Gomoe West/Apam, and Bongo, Ghana’s public health sector has supplied essential communication technology and training. A joint government-UNDP-Global Environment Facility initiative in the three pilot districts supplied doctors and nurses with mHealth technology to improve the quality of communication and to communicate and analyze health threats faster. The pilot also trained 180 disease surveillance volunteers. In Keta town, the program equipped 11 health centers and six community health facilities (Tye and Waslander 2021).

Well-developed digitized solutions and platforms can readily adopt to an emerging crisis. To support public agencies and government in response to COVID-19, for example, the Johns Hopkins University Global mHealth Initiative selected nine digital platforms that have an established presence in several low- and middle-income countries for case management and contact tracing needs, comparing their existing deployment, flexibility, and adaptability for COVID-19 use cases, their ability to support multiple languages, and stakeholder interest in how these applications can be leveraged in response to COVID-19 (Agarwal et al. 2020).

Mobile clinics can supplement health systems in underserved areas and during sudden demand surges.

Mobile clinics can offer a rapid and flexible approach to extending health care provision to areas with extremely low access to health services or where drastic surge demand occurs—for example, due to a disease outbreak or disaster. Mobile health clinics are found to be effective at reaching vulnerable populations that might otherwise not have access to health services, including those in remote locations (Yu et al. 2017).

The WHO and its partners have a long and successful track record of deploying mobile clinics to offer disaster relief.²⁰ Through them, critical health services can be provided where health systems break down due to shocks or are already vulnerable because of wars and conflicts. In the West Bank and Gaza, mobile clinics perform basic medical tasks like mammography for women who would otherwise not have access to such services.²¹ Mobile clinics can help increase resilience and provide basic health services after a shock or more generally to increase coverage and include vulnerable populations.

Certain health care services can be delivered outside of health facilities to free up capacity.

Diversifying health service delivery modalities and providing essential services closer to communities (as opposed to regionally concentrated services) are important steps in reaching a resilient and inclusive health system. This includes technological solutions like telemedicine, health promotions through community programs, and consultations with pharmacists. Telemedicine, widely used in the current COVID-19 outbreaks, has the potential to reduce demand “by permitting mildly ill patients to get the supportive care they need while minimizing their exposure to other acutely ill patients” (Portony, Waller and Elliott 2021, 1489). The use of telemedicine, which has

increased over recent years, could increase further through promotion and education about the upsides of remote consultations (Portony, Waller and Elliott 2021). Areas of telemedicine application will likely further grow with developments in the Internet of Things, sensors, artificial intelligence, and new hardware devices (Albahri et al. 2021).

Regular and surge demand for health facilities can be further decreased by using the expertise of other health professionals like pharmacists for consultations (Hedima, Adeyemi, and Ikunaiye 2021) and developing community programs for health promotion—for example, physical education or exercise programs (Sims-Gould et al. 2020). Community pharmacists are the most accessible health care professionals for many populations. During Nigeria's Ebola outbreak in 2014, they provided health education and helped prevent infection spread (Hedima, Adeyemi, and Ikunaiye 2021). During the current COVID-19 pandemic, community pharmacists have helped educate the public, mitigate supply shortages—of hand sanitizer and masks, for example—implement referral pathways for suspected cases (Cadogan and Hughes 2021), and with testing and vaccinations.²² Lower concentration of essential services in major facilities can also help minimize the disruption of routine services during crisis. For example, a regional hospital designating half of its resources to COVID-19 patients would lose 75 percent of elective services and surgeries and 25 percent of day-to-day emergency patients (Miller-Hooks and Tariverdi, forthcoming).

Box 3.3.1. Japan: coordinating disaster response and cooperating to supply equipment, staff and training

Japan's Disaster Prevention Basic Plan, the highest-level plan in the disaster prevention field prepared by the Central Disaster Prevention Council based on the Disaster Prevention Basic Law, forms the basis of disaster prevention measures in the country. Through this plan, the MHLW and prefecture governments establish a mutual support system for medical activities between neighboring prefectures. There is also support to improve or develop systems to coordinate emergency medical activities, provide a pediatric perinatal liaison, and dispatch the disaster medical assistance team. This is further complemented by operational guidelines for helicopter medical response teams to disasters.

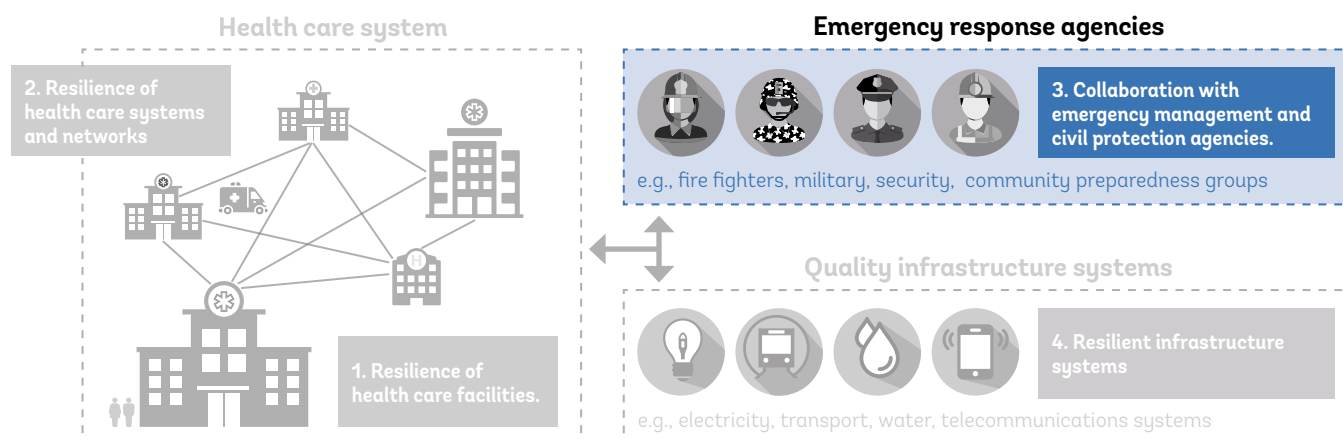
Under the plan, the MHLW, Ministry of Education, Culture, Sports, Science and Technology, Japanese Red Cross Society, National Hospital Organization (an independent administrative agency), Japan Community Health Care Organization, local governments, and airport managers make efforts to stockpile emergency medicine, medical equipment, and other requirements for situations when a large number of people are injured or when transportation is interrupted. Considerations are also made to improve the emergency medical system in the event of a disaster—for example, by designating base hospitals for disaster response as the main medical facility in the event of a disaster, according to the regional conditions. At these base hospitals, efforts are made to improve heliports and stockpile food, drinking water, medicines, fuel for emergency power, and so on.

Through these efforts, the MHLW, local governments, and medical institutions strive to develop a wide-area emergency medical information system and provide regular training on operations to enable a quick grasp of information such as medical care status of health care facilities in the event of a disaster.

Local governments impacted by a disaster can request additional support from private medical institutions to complement medical activities conducted within their own public medical institutions. Medical institutions in disaster-affected areas carry out procedures to restore damage to hospital buildings and medical equipment, and request lifeline operators for emergency restoration, as necessary. Further actions and dispatch support from the MHLW, local public organizations, and medical institutions are guided by medical care status of medical facilities in disaster areas through emergency medical information systems.

3.4 Integrated emergency response: coordination with disaster response and civil protection agencies

Countries also need to closely coordinate the emergency preparedness of health systems with their overall emergency management and disaster response systems. This need is most pronounced in postdisaster situations, when they must simultaneously address multisectoral issues, including essential public services such as food, shelter, security, social safety nets, rescue, and health care.



Interinstitutional coordination is crucial in the aftermath of disasters to meet urgent and multisectoral needs.

During emergencies, countries have to meet people's most urgent basic needs—such as food and shelter—while also providing essential public services such as security, social safety nets, rescue, and health care. To ensure this service provision is efficient and timely, emergency response efforts by a range of actors must be well coordinated. This means that the emergency preparedness of health systems needs to be closely coordinated with a country's overall emergency management and disaster response systems, including the military, civil protection, and community groups. Each agency's contribution is vital, so ensuring they have clear roles and capability in effective response is vital for saving lives and mitigating the long-term impacts of disasters.

Interinstitutional coordination is crucial for effectively managing and identifying surge capacities in case of disasters. DRM experience has shown that cooperation between different agencies should be established before a disaster through frameworks and disaster response plans. Furthermore, staff across agencies should be trained and accustomed to their role within the larger emergency response network to decrease frictions in communication and mandates. Disaster response training has shown to improve cooperation between trained professionals—including health professionals, firefighters, and others—in high-stress situations (Faraj and Xiao 2006). Response plans and cooperation frameworks should be updated regularly to address evolving and new risks and assimilate learning from past shocks. Experiences with earlier disasters and pandemics can serve as blueprints for future disaster response to avoid repeating past mistakes (Webster 2020).

SPOTLIGHT PHILIPPINES

The Disaster Act requires municipalities to establish local DRM offices, tasked with developing, implementing, and coordinating local emergency management programs. This includes conducting risk assessments, setting up a multihazard early warning system, training first responders, and coordinating response and recovery efforts (World Bank 2021b). During the COVID-19 pandemic, local governments quickly developed a multisectoral response by taking advantage of the emergency response systems designed for natural and climate-related disasters. The Disaster Act also mandates the establishment of local DRM councils, which convene representatives from local government bodies, police, fire protection, military, health services, communities, and the private sector (World Bank 2021b). This meant communication and cooperation between different agencies had already been established before the pandemic, and it was also possible to quickly reassign funding from disaster preparedness budgets to fight the pandemic.

SPOTLIGHT JAPAN

The Japan Joint Staff (JJS) under the Ministry of Defense established common protocols to deal with the COVID-19 pandemic. The JJS expanded the mandate of the Japan Self-Defense Forces (JSDF) to assist with the country's response to the COVID-19 pandemic. Once a predefined threshold of 10,000 infection cases was exceeded, the government declared a state of emergency for all prefectures. This authorized the JSDF to help transport civilians and patients, provide basic assistance at residences, and support quarantine measures. JJS also provides training for local government and private company staff. Although the JSDF had not previously responded to such a largescale infectious disease outbreak, its extensive training and operational protocols for biochemical agent protection and other emergency scenarios proved essential in launching a coordinated response. The JJS is documenting all missions and lessons learned from the ongoing COVID-19 response, to ensure the event is used to further improve protocols and emergency preparedness.²³

National disaster response agencies can help to rapidly mobilize critical supplies in emergencies.

In many countries, disaster response agencies are already defining postdisaster roles and responsibilities for various actors to speed up reconstruction and recovery. For example, measures that can significantly speed up postdisaster debris removal, if they have been prepared in advance, include (Jha et al. 2010):

- Pre-identifying available public resources to assist with debris removal
- Pre-identifying contractors with suitable equipment, such as bulldozers and dump trucks, and skills
- Prequalifying firms, prearranging contracts, and predefining contract scope, terms and prices
- Analyzing available financial resources and developing a procurement plan, which may include dedicated taxes, user fees, donations, and public.

The COVID-19 pandemic has illustrated that preparedness can also be vital for securing the supply of essential medical supplies, including PPE and vaccines. COVAX—or COVID-19 Vaccines Global Access, a global initiative led by UNICEF, Gavi, the Vaccine Alliance, the WHO, and others—aims to ensure equitable access to COVID-19 vaccines through prepurchase and distribution

agreements. It prioritizes districts in a country for vaccination based on vulnerability factors, travel time from potential distribution sites, and COVID-19 case counts.

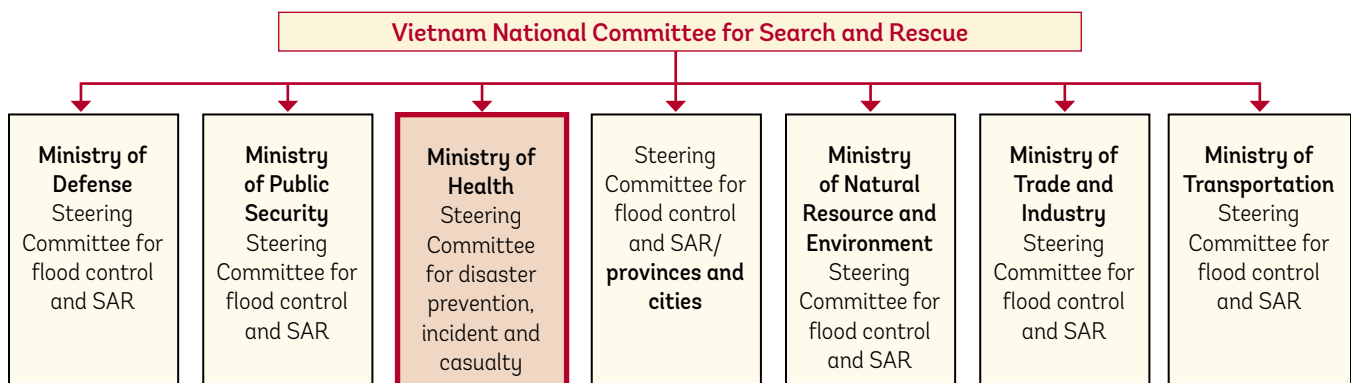
Effective communication channels can mitigate capacity bottlenecks and distribute critical resources.

If communication between emergency services and health systems is lacking or disrupted during a natural shock, this poses serious challenges to essential service provision. It is therefore important to build up communication strategies and divide responsibilities before a disaster happens. Assigning responsibilities and clarifying mandates helps prepare for disaster response and reduces frictions, thereby minimizing casualties (Aldrich 2019). A metastudy of disaster responses and the role of communication during responses reveals that poor planning and inefficient logistical infrastructure are associated with a higher likelihood of friction between disaster response stakeholders (Aldrich 2019). Another study finds that a mix of top-down and bottom-up communication during a disaster is helpful in coordinating response efforts more efficiently (Boin and Bynander 2015)—on its own, a central coordination hierarchy is inefficient in the chaotic aftermath of a disaster. The study also highlights the importance of training the challenges of coordination, to decrease chaos and friction in communications. Communication with other emergency response services also helps improve preparedness by incorporating early warning mechanisms.

SPOTLIGHT VIETNAM

The National Center for Hydro-meteorological Forecasting routinely communicates forecasts to stakeholders and public agencies, and has a warning system for monitoring and forecasting climatic hazards. It can issue warnings about potentially hazardous weather, climate, hydrology, water resources, or marine weather, and gives updates during emergencies. This information is also provided to the provincial people's committees, to enable regional planning and disaster preparedness (CFE-DMHA 2018). With the help of monitoring services and a prearranged preparedness plan, the Vietnamese government was able to reduce the number of casualties during five consecutive periods of flooding during the 2016 monsoon season (CFE-DMHA 2018). To secure the functionality of communication technologies during disasters, the Vietnamese military's Search and Rescue Unit plays a crucial role in humanitarian assistance and disaster relief. The Ministry of Health, through its central ministry and provincial subsidiaries, is embedded in the national disaster management framework, and has an active role in the Vietnam National Committee for Search and Rescue.

Figure 3.4.1 Cross-agency collaboration through the Vietnam National Committee for Search and Rescue



Source: CFE-DMHA (2018)

Note: SAR = search and rescue

Hydromet and early warning systems are critical for the disaster preparedness of countries, including in their health care systems.

Hydrological and meteorological (hydromet) services can predict variability, seasonal change, or extreme events, allowing people and emergency services to prepare for changes and events—for example, by scaling up treatment capacity, adjusting staff management and trainings, or through evacuations (World Bank 2020b). The WHO identified the importance of including climate information into disease surveillance and early warning systems in health information systems (WHO 2015a). By using hydromet services, health services can identify and prepare better for seasonal outbreaks, like dengue, or outbreaks that are connected to extreme weather patterns, like cholera. To be effective, hydromet systems must be connected to health systems through established communication channels and information sharing.

The WHO also highlights the importance of further research on the vulnerability of health systems to climate risks and the “expected future capacity of the system to respond, and identification of adaptations” (WHO 2015a, 11). Furthermore, it is important to share information with the public to increase transparency and protect people from risk, while simultaneously decreasing surge demand, as seen in Vietnam’s disaster warning system via text and public information channels, like radio and TV (Rentschler et al. 2020).

Coordination between different emergency sectors can improve the efficiency of health systems, even in the absence of large-scale disasters.

Investing in disaster preparedness measures and strengthening interagency coordination can yield immediate and tangible benefits for health service quality. More resilient infrastructure, facilities, staffing, and equipment not only facilitate the response to disasters, but can increase the efficiency with which counties manage smaller shocks, regular disruptions, or accidents. Improved communication channels between health care facilities and authorities are conducive to strengthening public health planning.

SPOTLIGHT UNITED STATES

The 9/11 terror attacks in 2001 resulted in heightened attention to bioterrorism threats, leading to the development of detailed response plans and infrastructure investments. Emergency response plans were not only structured around hospitals, but also included emergency response agencies and government units, and the military (Katz, Staiti, and McKenzie 2006). One benefit of the associated investments was the overall improvement of public health systems. The emergency response agencies invested in new communication tools—such as radio systems, new computer equipment, and online alert networks—which are essential in emergency situations and help coordinate surge capacity between emergency agencies and individual hospitals, even in the absence of disasters or large-scale shocks. For example, the Ohio Health Department invested in a direct cable line to communicate with local health authorities in case of any health threats, thus vastly increasing the efficiency of communication between health facilities and authorities. Health departments also used bioterrorism preparedness funding to recruit risk communicators, preparedness coordinators, and epidemiologists to address bioterrorism threats (Katz, Staiti, and McKenzie 2006), whose expertise has been instrumental in increasing preparedness for non-terrorism-related health emergencies.

International cooperation of health services can help countries manage surge capacity in case of large disasters. If a disaster is too large for national emergency response agencies, international collaboration can increase the resilience of health systems in a cost-effective way. For example,

health networks can effectively collaborate with facilities across state borders. During the COVID-19 pandemic, several European countries established international cooperation. In April 2020, the German military flew patients from French and Italian hot spot areas to German clinics that had spare capacity.²⁴ This was made possible through the close coordination and monitoring of COVID-19 case numbers in all three countries. From April 2020, all German hospitals were required to report free intensive care unit (ICU) bed numbers to a national registry (the *Intensivregister*,²⁵ managed by the Robert Koch Institute (RKI), a government agency), to ensure better and more effective management of surge capacities during the pandemic. This helped identify ICU capacity to care for French and Italian patients. The registry is coordinated by the RKI, not the hospitals. This national coordination of emergency services enabled the international collaboration to meet the high surge demands in neighboring countries' hotspot areas. Most of these protocols, however, were not readily available and were developed during the crisis.

Integrating health systems with a range of sectoral agencies and stakeholder groups.

The risk profiles of different population groups depend on a wide range of factors, including the resilience of food and agriculture systems, and of essential services, such as education, social protection, finance, transport, water, and energy. Ensuring that health systems are not overwhelmed during emergency situations also requires strengthening resilience in these sectors and integrating emergency preparedness measures. This process involves sectoral government agencies, but also community organizations and private sector actors. Vietnam's multisectoral National Committee for Search and Rescue illustrates how a wide range of sectoral groups and stakeholders can be convened to coordinate actions to build resilience (figure 3.4.1). Successful and innovative approaches to mobilizing financing for rapid response and to increase pandemic preparedness have also been documented by the International Working Group on Financing Preparedness (2017) and in the World Bank assessment of the Ebola response in West Africa (World Bank 2019).

Box 3.4.1. Indonesia: risk financing to strengthen resilience to disasters, climate risks, and health shocks

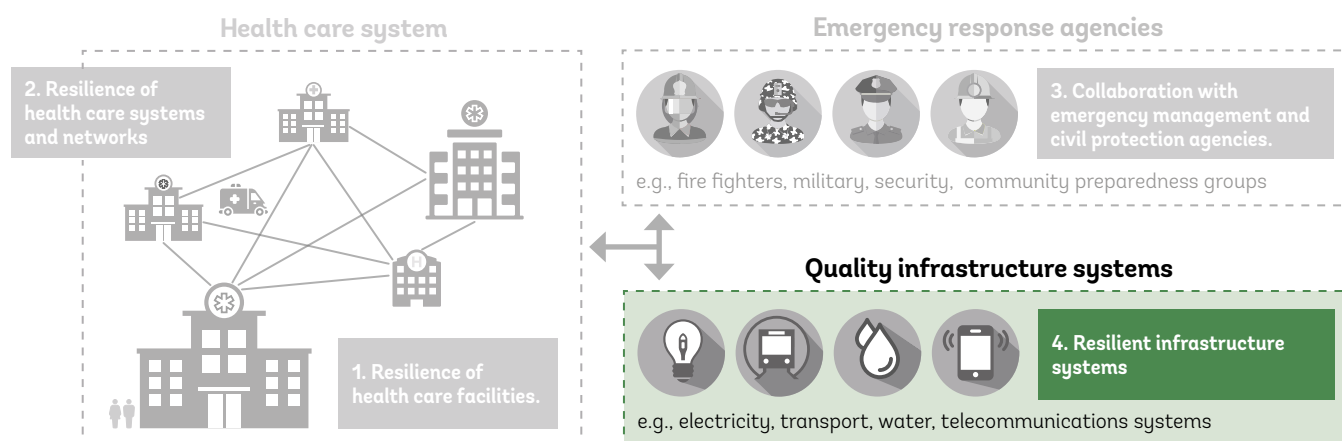
For an effective disaster response, financial resources must be made available at a scale and speed that correspond to the needs. These resources need to be channeled efficiently to the agencies and regions that are at the forefront of crisis response. Preparing these mechanisms in advance of the next emergency is essential for ensuring that resources reach the right disaster response agencies—including local civil protection, search and rescue, or health care providers—in a coordinated and timely manner.

A new World Bank project in Indonesia will support the Government's National Disaster Risk Finance and Insurance Strategy by strengthening fiscal and financial resilience through a Pooling Fund for Disasters.²⁶ This fund, which will become the central mechanism for postdisaster finance flows, will leverage domestic and international insurance markets to provide financial backstop capacity. The project will also help ensure effective and transparent flow of funds to relevant government agencies, including budget tracking on disaster-related expenditures, faster social assistance payments for victims of disasters, and improved preparedness planning for health shocks. Central and local government agencies will receive additional, faster, and more effective financial support after a disaster.

The COVID-19 pandemic has demonstrated the importance of financial planning for health shocks in Indonesia. Building on the lessons of the pandemic, the Pooling Fund for Disasters and Ministry of Finance will collaborate with the Ministry of Health to implement a program for health sector preparedness and response financing. This includes more efficient interagency collaboration with the health sector and establishing transparent funding flow mechanisms, while improving both vertical (national and subnational governments) and horizontal (interagency/interministry) integration. Overall, this initiative demonstrates how disaster risk finance strategies can support emergency preparedness, contingency planning, early warning mechanisms, and disaster relief—all in a way that also helps strengthen the resilience of health systems.

3.5 Lifeline infrastructure for resilient health care services

Quality infrastructure is essential for effective health care services, particularly during disasters and pandemics. Resilient water, electricity, transport, and communication and digital systems are crucial to ensure efficient and inclusive access to health care and functioning supply chains. The resilience of health care services depends on the resilience of these systems.



Disasters disrupt critical infrastructure, obstructing the effective provision of health care.

Health care provision depends on a range of critical infrastructure services (Figure 3.5.1). To operate effectively, essential health services rely on safe water supply, reliable electricity, efficient transport systems, and telecommunication infrastructure. These systems do not only underpin treatment, but also health care workers' and patients' access to facilities, functioning medical supply chains, staff and patient safety, and effective coordination and planning. Thus, a lack of resilient quality infrastructure can severely affect both operating capability and quality of care. For example, when the 2003 earthquake struck Bam, Iran, the whole health system broke down.

► Kumamoto, Japan:
A road damaged by
an earthquake. Photo:
Shutterstock.com

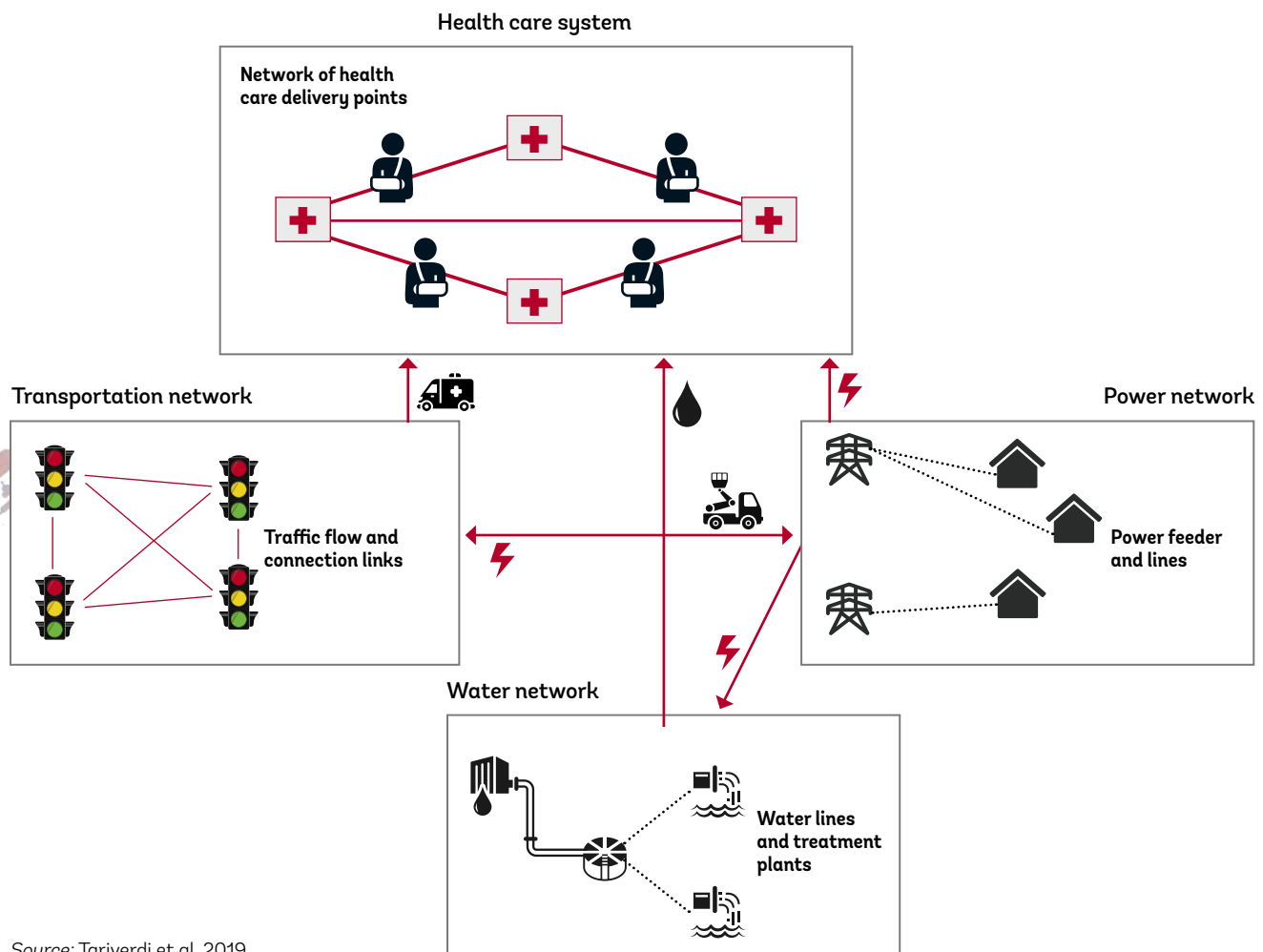


This was due to damage not only to health facilities, but also to infrastructure, as disruptions to power, water, and transport complicated medical care provision for victims or made it impossible (Ardalan et al. 2009). Similarly, disruptions to critical infrastructure after Hurricane Katrina played a role in its devastating effects (Rodríguez and Aguirre 2006). Investing in and planning for resilient and high-quality infrastructure networks can mitigate service disruptions due to disasters, ensuring a higher quality of health services.

SPOTLIGHT UNITED STATES

In February 2021, a blizzard caused extensive electricity and water outages in hospitals in large parts of Texas. The power outages were caused by equipment failures, including at gas and nuclear power plants.²⁷ As heating was disrupted, freezing pipes caused water supply disruptions. While U.S. hospitals are required to have emergency power generators, the water outages were harder to mitigate. Dialysis machines do not work without water, surgery equipment cannot be sterilized, and hands cannot be washed—all basic functions that were heavily hindered during the blizzard. Dangerous road conditions also obstructed ambulances, leaving some neighborhoods in Houston without access to emergency medical services.²⁸ As well as complicating health service provision, failures in other sectors and infrastructure due to the cold weather also increased demand for health services.

Figure 3.5.1 Health care systems rely on interdependent supporting critical lifelines



Source: Tariverdi et al. 2019

SPOTLIGHT ZIMBABWE

In 2019, low water levels in Lake Kariba, the main power source of the state-owned Zimbabwe Electricity Supply Authority meant the country's power supply—which is heavily dependent on hydropower—became highly unstable. This led to disruptions in health service provision as electricity supply to many health facilities could not be ensured.²⁹ These disruptions were most common in rural and suburban centers and disproportionately affected households that could not afford private hospitals. Many hospitals affected by power outages were also unable to provide basic medical services.

Network effects create affordable opportunities to increase the resilience of infrastructure services and users.

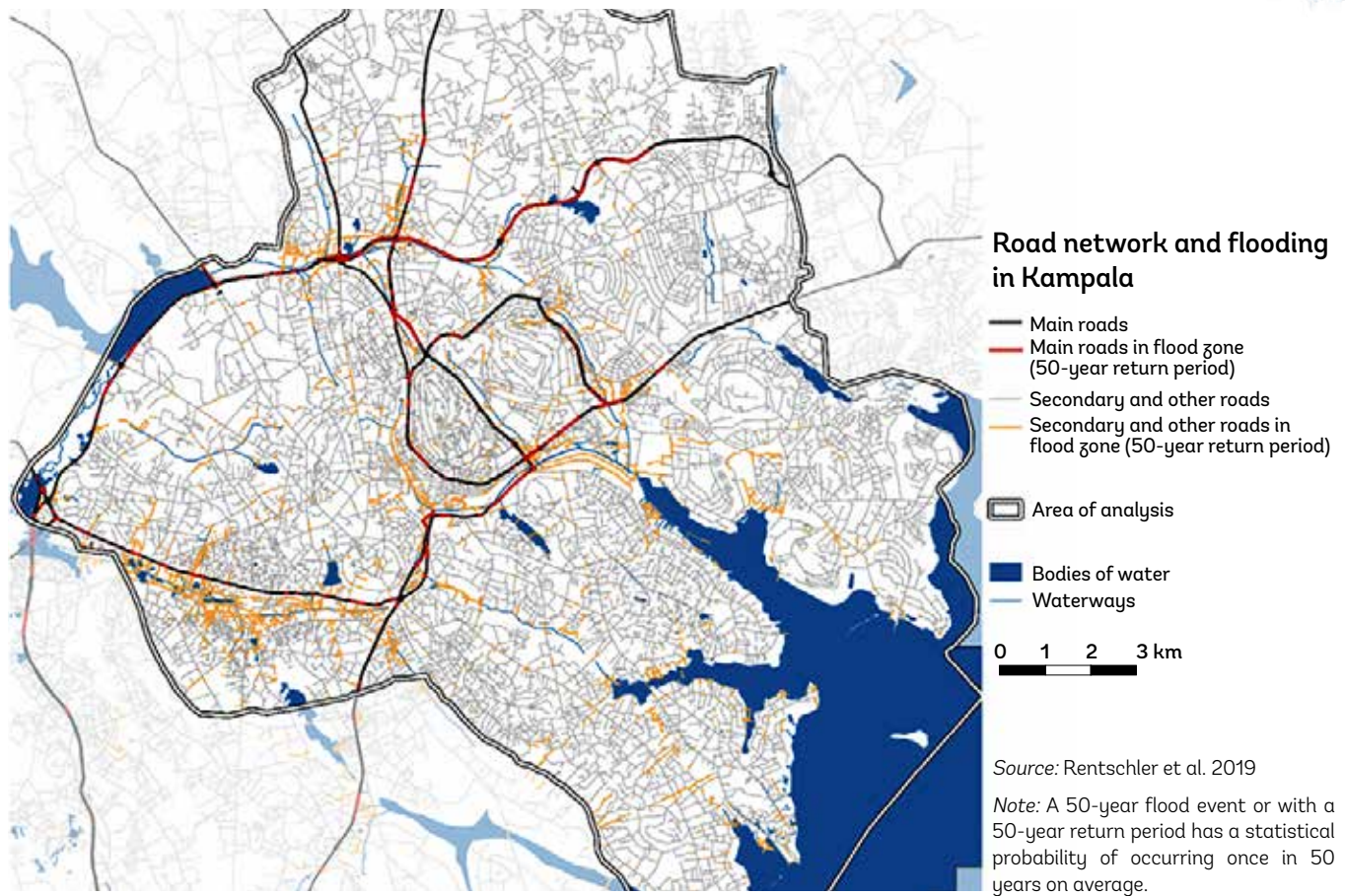
Criticality analyses can help prioritize investments for strengthening critical assets and identify options for building in redundancy at choke points (Hallegatte, Rentschler, and Rogenberg 2019). For transport infrastructure, this can be done by systematically simulating disruptions to the road and rail network and measuring the resulting loss of functionality. This can help to identify and prioritize targeted investments in transport resilience, rather than upgrading all roads to maintain a necessary level of functionality. In its Lifelines report, the World Bank's GFDRR has developed a framework for assessing the basic functionality of infrastructure systems and guidelines on how to increase resilience of infrastructure networks (Hallegatte, Rentschler and Rogenberg 2019). Building resilience into the infrastructure system that a health facility is embedded in can also decrease the need for them to be self-sufficient, thus creating cost saving opportunities. It also improves the reliability of out-of-facility care deliveries, a benefit to both health care facilities and patients.

Reliable transport infrastructure enhances access to critical health services, particularly for poor communities and during a disaster.

Especially in low- and middle-income countries, public infrastructure and transportation services are crucial for ensuring access to health care facilities. A World Bank (2021a) report finds that well-functioning public transportation has the ability not only to lift people out of poverty, but also to ensure basic human rights, such as access to education and health care. Disruptions to infrastructure (and transport in particular) hit poor people most, as they are less likely to afford any other means of transportation, such as private cars or taxis. Transport infrastructure solutions need to be tailored to the needs of each individual city and population, to effectively improve access to health care.

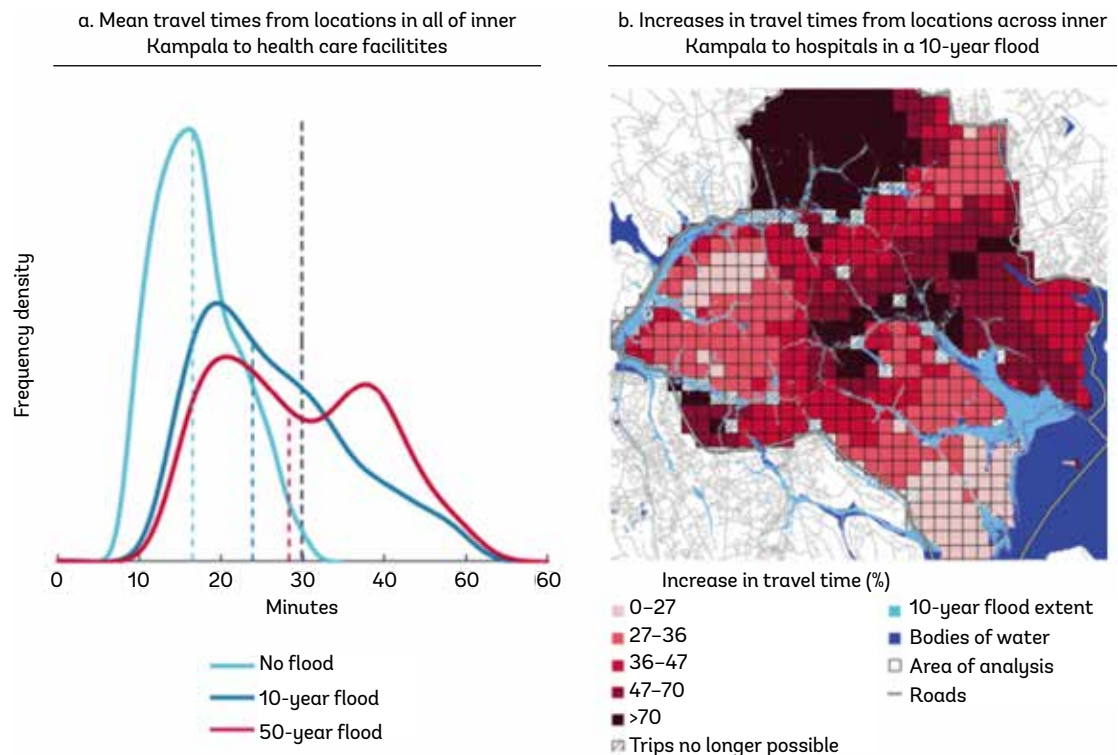
Natural hazards, such as storms and flooding, can severely restrict access to health care. An assessment of Kinshasa, Democratic Republic of Congo, demonstrates that urban flooding can significantly reduce urban mobility (He et al. 2020). Public transportation services become less reliable, travel speeds are reduced, and critical road segments are blocked, all of which contribute to people being unable to reach jobs and public services. The experience with cyclones in Mozambique (see *Spotlight* below) further highlights the importance infrastructure systems play for access to health services (Hierink et al. 2020). An assessment for Kampala, Uganda (Rentschler et al. 2019), shows that 8 percent of main roads are at risk from flooding (figure 3.5.2), and the resulting disruptions substantially increase travel times to health care facilities (figure 3.5.3a) for most residents. Certain neighborhoods are cut off almost completely from health services during heavy floods (figure 3.5.3b). Targeted interventions to upgrade the resilience of critical road segments can substantially increase access to health services, and the World Bank is actively using such prioritization methods to inform its projects.

Figure 3.5.2 Road segments in inner Kampala at risk of flooding during a 1-in-50-year flood event



◀ Small examination Room in a hospital in Jinka, Ethiopia. Photo: arnitorfasen.

Figure 3.5.3 Floods in Kampala severely restrict people's access to health facilities



Source: Rentschler et al. 2019

Note: a) shows average travel time compared to travel times during a 10- and 50- year return flood; b) shows geographical distribution and increase of travel time to health facilities during a 10-year return flood event.

SPOTLIGHT MOZAMBIQUE

After Cyclones Idai and Kenneth in 2019, people's access to functional health facilities was heavily reduced. A study by Hierink et al. (2020) showed that reduced travel speeds, obstructions in transport infrastructure, and damages to health facilities decreased accessibility coverage in cyclone-affected districts. In the areas affected by Cyclone Idai, health system accessibility coverage decreased from 79 to 53 percent. The most affected villages saw an increase in travel time from 1.3 hours pre-cyclone to 63.6 hours directly after the cyclone, making lifesaving health services were practically inaccessible. In areas affected by Cyclone Kenneth, accessibility coverage decreased from 82 to 72 percent. The study concludes that, in the aftermath of both cyclones, damage to transport networks and low travel speeds played a more substantial role in accessibility coverage losses than direct damage to health facilities. Thus, investing in the resilience of transport systems could substantially strengthen health service accessibility and provision during emergencies.

Poor infrastructure exacerbates health risks.

Unreliable and vulnerable infrastructure not only affect quality of care for routine or emergency services; they can also exacerbate health risks in the population. Inefficient transport systems increase traffic congestion, leading to higher levels of harmful air pollution and associated respiratory diseases. The lack of safe water supply and sanitation infrastructure spreads diseases

and affects people's ability to perform basic hygiene routines. Inadequate flood control and drainage systems can increase flood risks and aggravate the risk of waterborne diseases, such as cholera (Picarelli, Jaupart, and Chen 2017). Electricity outages increase the use of polluting alternative power sources—such as diesel generators, charcoal, or firewood—which increase indoor air pollution and associated respiratory diseases (Hallegatte, Rentschler, and Rogenberg 2019). Actions to strengthen infrastructure resilience can therefore contribute to more effective health risk management and demand for health services.

SPOTLIGHT TANZANIA

Cholera outbreaks in Dar es Salaam tend to occur during rainy seasons and periods of flooding, as documented by Picarelli, Jaupart, and Chen (2017). Outbreaks are especially concentrated in communities with poor drainage, water supply and sanitation systems, where “the inundation of drains, water systems, and pit latrines enhances the risk of exposure to contaminated water and food” (Picarelli, Jaupart, and Chen 2017, 2). Such low-quality infrastructure is most commonly found in informal, low-income settlements. The study finds that on average a 10-millimeter increase in weekly accumulated precipitation led to 1.5–3.5 percent higher numbers of weekly recorded cholera cases. After extremely heavy rainfall (>75th percentile), the effect on cholera infections in flood-prone areas was on average 20 percent higher than in non-flood-prone areas (all other things equal). Such outbreaks can already cause surge demand and can coincide with increased demand during flood and storm events. Accounting for rain periods when planning for seasonal surge demand would therefore increase health systems' ability to manage additional stress factors.

New technologies can help identify and mitigate supply chain vulnerabilities and bottlenecks.

While it is not feasible to predict all potential shocks that could hit a complex supply chain—such as production shortages in personal protective equipment during the COVID-19 pandemic—considering alternative solutions where possible for service or supply deliveries provides a redundancy in the networks. One example is using drone technologies for medical supply deliveries like blood and vaccines to ensure timely delivery and to minimize wastage. During emergencies, such solutions are vital where infrastructure is not well developed—for example, if rural accessibility is poor or there are cold chain or cold storage issues—and where lower initial stock makes the disruptions even more devastating. In Ghana, about 5 million COVID-19 vaccine doses are expected to be delivered to rural health facilities using drones in 2021.

SPOTLIGHT KENYA

Rescue.co,³⁰ known as “Flare” among ambulance companies, and dubbed “the Uber for ambulances” by patients, is a newly launched private app that aims to cut patient waiting time. It provides situational awareness and information to public and private hospitals and to the general population. To fleet managers, it provides insights on how to position ambulances and how to ask for additional resources. As a single point of contact for hospitals, the public, and trained personnel, it improves coordination and has saved lives in past events. In response to COVID-19, Flare provided a vital role in safely transporting patients to hospitals, a key step in containing the virus.

Having the capability to anticipate supply chain disruptions or spikes in demand is key for gaining a head start in crisis response, and emerging technologies are becoming available that could help improve disease surveillance and early warning systems. The Disease Early Warning System

(DEWS), introduced in Pakistan in the immediate aftermath of the 2005 earthquake, is one such system (Rahim et al. 2010). DEWS generates alerts that prompt the dispatching of specialists to facilities, enabling the timely identification of disease outbreaks and epidemic control. The DEWS network was successfully used during a range of flood and earthquake-related shocks and internally displaced persons' crises. The effectiveness of surveillance infrastructure and its ability to rapidly respond with clinical and laboratory care depend on data collection and analysis structures, and the way responses are reported and implemented at various levels. Open source software—such as District Health Information Software 2—shows how data from multiple sources can be applied in low- and middle-income countries to support data analysis and response functions.³¹

Digitalization exposes health systems and the infrastructure they depend on to cyber risks.

Health systems are directly and indirectly exposed to cyberattacks. Direct attacks can be aimed at personal patient data, or core health facility or network management and administration systems. Such attacks have increased over the past decade, as health care has become increasingly dependent on information systems, digital technologies, and data (Jalali and Kaiser 2018; Gordon, Fairhall, and Landman 2017). For example, in March 2020, Brno University, Children's, and Maternity Hospitals in the Czech Republic suffered a ransomware attack, causing a complete computer shutdown amid the ongoing COVID-19 pandemic. The hospital had to cancel operations and could neither admit new patients nor upload laboratory results to its patient database (Mohammadi et al., forthcoming).³² The WHO predicts that the uptake and relevance of digital technologies will increase substantially in coming years.³³ With this growth, the risk of cyberattacks or technology failure will magnify the risk of disruption in the health sector.

Critical infrastructure systems—water supply, electricity networks, traffic management, and telecommunications systems—are also increasingly vulnerable to cyber threats, indirectly exposing the health care sector (Sandhu and Raja 2019). Targeted actions to increase resilience to cyber risks will be essential for increasing the resilience of health service provision.

Box 3.5.1. Strategies for mitigating cyber risks

Based on the increase in cyberattacks on health facilities over the last decade, Bhuyan et al. (2020) recommend measures to reform cyber security systems, making them proactive, rather than reactive: “Cybersecurity issues threaten access, quality, and cost in health care. Technology offers hopeful alternatives for each of these goals, but in order to realize the benefits of these technologies, cybersecurity issues must be resolved.” (Bhuyan et al. 2020, 98).

Cyber resilience strategies must recognize that cyber risks are constantly evolving and reflect threats at all levels: from national, to economic or infrastructure sector, to individual facility and system levels, including public health care program databases. Rather than rely on ad hoc approaches that respond to threats as they emerge, health facilities can strategically increase their resilience through systematic cyber stress testing. Cyber resilience is particularly crucial to health facility IT infrastructure, treatment devices, patient data, and staff training (Bhuyan et al. 2020). Cybersecurity considerations also need to be included in health system strategic planning, administration, and budgeting.

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4

A way forward

Resilient health care services require collaboration across disaster risk management, health, and infrastructure sectors.

The framework outlined in this report is relevant far beyond the COVID-19 pandemic—strengthening health sector resilience and its interlinkages with emergency response systems and infrastructure planning are crucial for more effective disaster risk management. The framework provides recommendations for governments to take actions in five areas (summarized in table 4.1) that are crucial for enabling health care reliability and shock-resistant services. These are:

- **Foundations:** Health systems that can effectively manage routine demand are more resilient to shocks. Such health systems are structured around the WHO's six essential building blocks for building climate-resilient health systems: leadership and governance; health workforce; health information systems; essential medical products and technologies; service delivery; and financing (figure 3.2.1). Continued investments and policy actions are essential to ensure that health systems can offer inclusive, affordable, and quality services.
- **Individual health care facilities:** Planning for seasonal surge capacity for flu and other common outbreaks has shown to reduce stress on affected health system entities and improve quality of care. While surge planning for disasters is less common, data-driven analysis can help estimate potential demand for health services, based on the frequency of recurring events and disaster risk profiles. Risk assessments for the health sector can help decision makers understand the natural hazards faced by health care providers, informing appropriate health service modalities and targeted interventions to reduce exposure and vulnerabilities to reach an inclusive and accessible care.
- **Health care systems:** Pandemics and disasters can trigger health care demand surges that can overburden a single health care facility, especially during extreme but regionally concentrated shocks. Horizontal and vertical coordination at the network level can support the redistribution of surge demands across health facilities and service modalities, mobilizing health care workers and medical supplies to predefined treatment centers or mobile clinics.

▲ Photo: smshoot.

Coordinated and flexible solutions are especially important for taking cost-effective action to strengthen health systems' ability to manage demand surges.

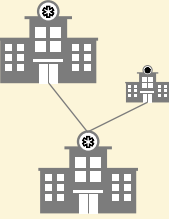
- **Integrated response and civil protection agencies:** Interinstitutional coordination is crucial for effectively managing urgent and diverse needs in the aftermath of disasters. DRM and emergency preparedness and response plans offer a blueprint for establishing communication strategies and defining responsibilities before a disaster or pandemic happens. Preparedness plans will enhance disaster response capacities and reduce frictions of communication and mandates that challenge the provision of essential services. DRM and risk financing strategies can also be designed to meet the requirements of the health sector's emergency and crisis response.
- **Lifeline infrastructure for resilient health services:** The resilience of health care services is underpinned by the functionality and reliability of quality infrastructure systems, which enable not only the provision of care, but also access to facilities, functioning medical supply chains, and staff and patient safety. By investing in resilient infrastructure systems, governments strengthen the resilience not only of health systems, but also of business continuity, urban mobility, and people's livelihoods.

Country diagnostics are essential for identifying implementation priorities.

In this report, we outline general areas of intervention that can strengthen the resilience of health systems (see table 4.1). While this can serve as a basis for designing country-level programs, implementation priorities will depend entirely on each country's most urgent needs and constraints. Risk profiles and pre-existing challenges in health systems differ significantly across countries, which makes it necessary to conduct tailored, country-specific assessments to identify priority interventions.

In addition to health sector diagnostics, cross-sectoral assessments of DRM systems and climate change impacts can highlight the interdependence of health care and broader drivers of development. The World Bank has conducted several climate resilience assessments—for example, for Vietnam (Rentschler et al. 2020) and Fiji (World Bank 2017)—that illustrate cross-sectoral resilience strategies. The World Bank will further expand such approaches to more countries as part of an effort to develop comprehensive climate resilience strategies. Developing operationally relevant diagnostics and solutions is also crucial in small island states and fragile and conflict-affected countries, where disasters and pandemics exacerbate existing conditions of vulnerability.

Table 4.1 Five pillars of resilient health systems and respective priority actions

Pillars	Priority actions
 Foundations: health systems that can effectively manage routine demand	Ensure universal access to routine health care by: - Strengthening managerial and operational capacity, governance, and planning systems - Strengthening the technical and administrative capacities of the health workforce, including through specialized crisis trainings - Improving health information systems for identifying new risks, vulnerabilities, capacity bottlenecks, and information sharing - Ensuring the availability of essential medical supplies and equipment - Mobilizing and allocating the financial resources needed for routine operations and crisis response
 Resilient health facilities	Ensure adequate capacity and resilience of facilities by: - Upgrading structures to withstand shocks and ensure self-sufficiency - Enhancing staff capacity and training - Improving facility and inventory management to maximize utility of limited resources - Maintaining emergency stocks of essential medical supplies - Expanding capacity where possible based on needs (for example, number of intensive care unit beds) - Preparing crisis protocols for boosting capacity and ensuring basic level of care provision (for example, business contingency plans)
 Resilient health systems	Integrate individual health facilities into a coordinated network and improve cooperation during crises by: - Using data-driven approaches to identify surge demands early and distribute loads to health facilities and service modalities more effectively - Improving communication and cooperation between entities in the health system to manage surge demand during disasters - Leveraging solutions for delivering health care services outside health facilities, including community centers, telemedicine, pharmacies - Deploying mobile clinics to underserved and disaster-hit areas to boost the capacity of permanent health facilities
 Integrated emergency response	Integrate health care into DRM systems by: - Efficiently meeting wide-ranging critical needs during crises, including food, shelter, security, and health care - Coordinating with search and rescue agencies such as civil protection and the military to manage health service demand - Establishing interagency communication channels before disasters strike - Clearly defining roles and mandates for crisis response to mitigate capacity bottlenecks - Enhancing hydrological, meteorological, and early warning services and disseminating information to agencies and the public - Integrating health system needs in disaster risk finance strategies
 Resilient infrastructure	Ensure the resilience of critical infrastructure systems on which health facilities depend by: - Upgrading transport, water, electricity, and telecommunications assets in critical areas - Strengthening cyber resilience - Improving infrastructure maintenance regimes - Mandating risk-informed infrastructure planning, with higher standards for health system-relevant assets - Leveraging new technologies for service and supply delivery

Box 4.1. World Bank support for strengthening disaster and pandemic preparedness in client countries' health care systems

An innovative emergency preparedness program, building on experience and active engagements: The World Bank Group has long-standing experience of supporting client countries to expand affordable and quality health care coverage and safeguard development in the face of disaster risks. Building on ongoing projects in these fields, GFDRR and the World Bank's Health Practice are also developing a suite of operational approaches to further strengthen the way in which projects support health care system resilience. For this purpose, new analytical tools are under development to identify investment priorities to strengthen health sector resilience—for example, by analyzing transport networks and people's access to health care in emergency situations. In a timely and multisectoral collaboration, these tools will be deployed to increase the cost-effectiveness of World Bank financing operations.

Collaboration between DRM and HEPR programs: In implementing action, health sector and DRM practitioners and policy makers can benefit from significant synergies. The newly established World Bank HEPR Program supports eligible countries and territories to improve their capacities to prepare for, prevent, respond to, and mitigate the impact of epidemics on their populations. GFDRR is working with the HEPR Program to apply lessons from previous disasters and strengthen coordination with DRM institutions to enhance preparedness and response systems, procedures, and institutional capacities during public health emergencies. This includes the ongoing operational stocktaking of COVID-19 responses in South Asia to consolidate lessons learnt and develop a framework that defines common touchpoints and opportunities for leveraging DRM knowledge in future health response and preparedness activities.

Technical assistance and financing for targeted measures to strengthen health system resilience: Building on ongoing engagements and these new programs, the World Bank supports countries to develop and finance strategies that combine responses to health emergencies and natural hazard-related preparedness. It is offering technical assistance to client countries in the following areas:¹

1. Guidance and joint retrospective assessments to develop a holistic strategy for resilience
2. Action plans to integrate DRM and public health strategies, and to establish legal and institutional frameworks
3. Information sharing and joint approaches for planning, modeling, monitoring, and evaluating to empower governments to respond quickly and effectively to crises.

The priorities identified through such technical assistance activities can inform the World Bank's financing support to governments, which ranges from infrastructure investments to policy and regulatory reforms. Public-private partnership models can also be effective in mobilizing financial resources for the actions recommended in this report; experiences from public-private engagements to finance hydromet systems can offer guidance on aligning the interests of different stakeholders (World Bank 2020b).

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Reliable access to adequate and affordable health care services is foundational to countries' long-term socio-economic development prospects. Yet, even before the COVID-19 pandemic, many countries were struggling to meet routine demands for health care. Climate change, disasters, pandemics, and demographic changes will increase pressures on already strained health systems.

To strengthen the resilience of health systems to shocks and pressures, this report outlines five principles and priority areas for action. (1) Foundations: Building the capacity of health systems to effectively manage routine demands is a prerequisite for increasing its resilience to shocks. (2) Health care facilities: To be resilient, facilities must be prepared to meet surge demand during emergencies and protected against shocks, such as earthquakes or floods. (3) Health care systems: Systems planning and flexible solutions can be key for meeting surge demand through coordinated regional and system-level response. (4) National emergency management: Crisis response by health systems must be coordinated with all emergency management agencies and systems, including the military and civil protection. (5) Quality infrastructure: Resilient water, electricity, transport, and digital systems are essential for effective health services.

Healthcare systems are at the frontline of delivering critical care during emergencies. The principles presented in this report can help to better prepare health systems to respond to a wide range of shocks, from seasonal demand surges, to pandemics, climate change, and disasters.