World Health Organization

MEASURING THE CLIMATE RESILIENCE OF HEALTH SYSTEMS

World Health Organization

MEASURING THE CLIMATE RESILIENCE OF HEALTH SYSTEMS

Measuring the climate resilience of health systems

ISBN 978-92-4-004810-2 (electronic version)
ISBN 978-92-4-004811-9 (print version)

Suggested citation. Measuring the climate resilience of health systems. Geneva: World Health Organization; 2022. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Design and layout by Inis Communication

CONTENTS

ACKNOWLEDGEMENTS

This document was written by Kristie Ebi (University of Washington, United States of America (USA)), Carlos Corvalan (University of Sydney, Australia; Elena Villalobos Prats (WHO), Peter Berry (Health Canada, Canada), and Diarmid Campbell-Lendrum (WHO). WHO thanks the following experts for their revision and contribution to this report: Kone Brama (WHO); Ariel Brunn (London School of Hygiene and Tropical Medicine, United Kingdom of Great Britain and Northern Ireland); Paddy Enright (University of Waterloo, Canada); Solip Ha (WHO); Guy Howard (University of Bristol, United Kingdom); Sari Kovats (London School of Hygiene and Tropical Medicine, United Kingdom); Robert Marten (WHO); Tara Neville (WHO); Aderita Sena (WHO); Linda Varangu (Canadian Coalition for Green Health Care, Canada); Salvatore Vinci (WHO); Sonam Yangchen (WHO).

LIST OF ABBREVIATIONS AND ACRONYMS

COVID-19	Coronavirus disease of 2019
EWARS	Early Warning and Reporting System
HNAPs	Health National Adaptation Plans
IHR	International Health Regulations
IPCC	Intergovernmental Panel on Climate Change
JEE	Joint External Evaluation
NAPs	National Adaptation Plans
NDCs	Nationally Determined Contributions
UHC	Universal health coverage
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations Statistical Division
SDGs	Sustainable Development Goals
V&A	Vulnerability and adaptation
WHO	World Health Organization

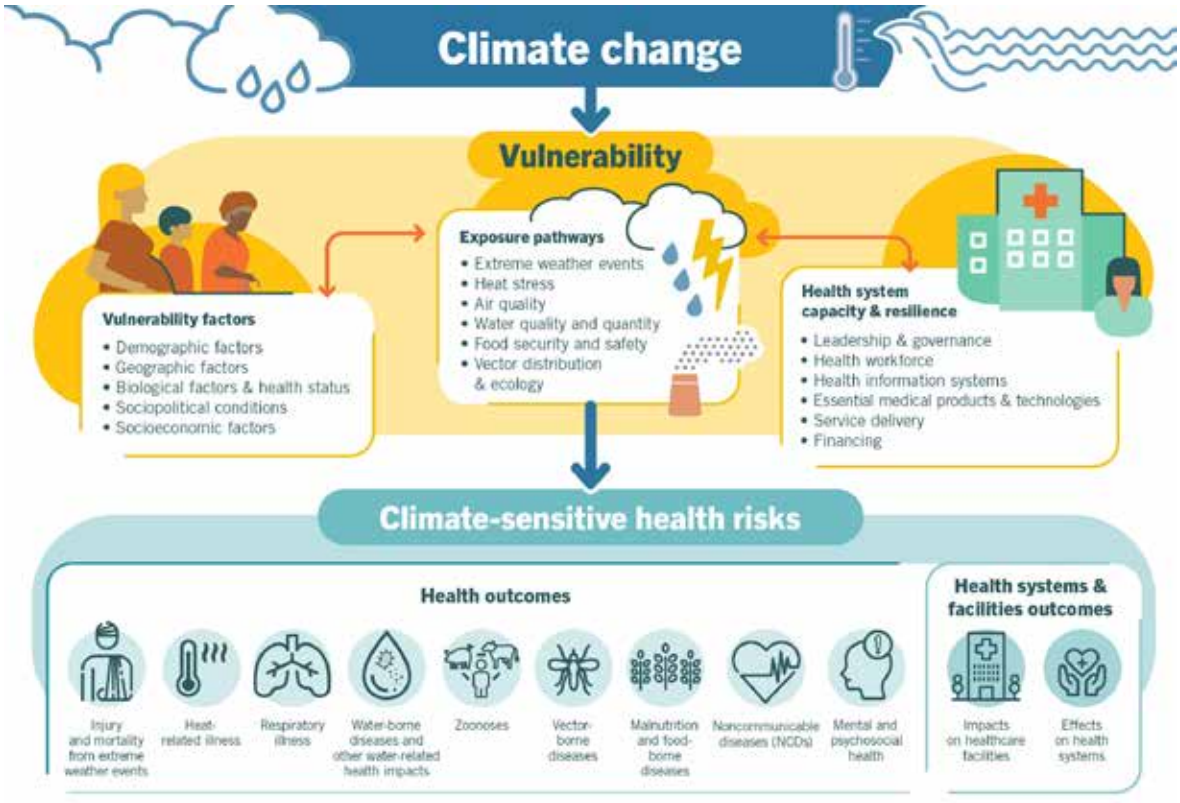
1 INTRODUCTION

Climate change adversely affects population health and health systems. Health systems include all organizations, people and actions whose primary intent is to promote, restore or maintain health *(1)*. By supporting the development and application of essential policies and programmes, in the context of a changing climate, this report seeks to promote the strengthening of health systems *(2)*.

Figure 1, highlights that climate change is altering hazards, exposures and vulnerabilities that can interact to increase or decrease risks to population health and health systems. Enhanced resilience decreases the likelihood that impacts will occur as well as the severity of the impacts that do occur. The COVID-19 pandemic has demonstrated how vulnerable health systems can be when confronted with a large hazard that stresses existing capacity to provide optimal health services.

Health decision-makers, health professionals and civil society organizations recognize the risks posed by climate change and the need for proactive measures to plan for the impacts. Over two decades of adapting to the health risks of climate change have demonstrated that evidence-based actions can protect vulnerable people and communities.

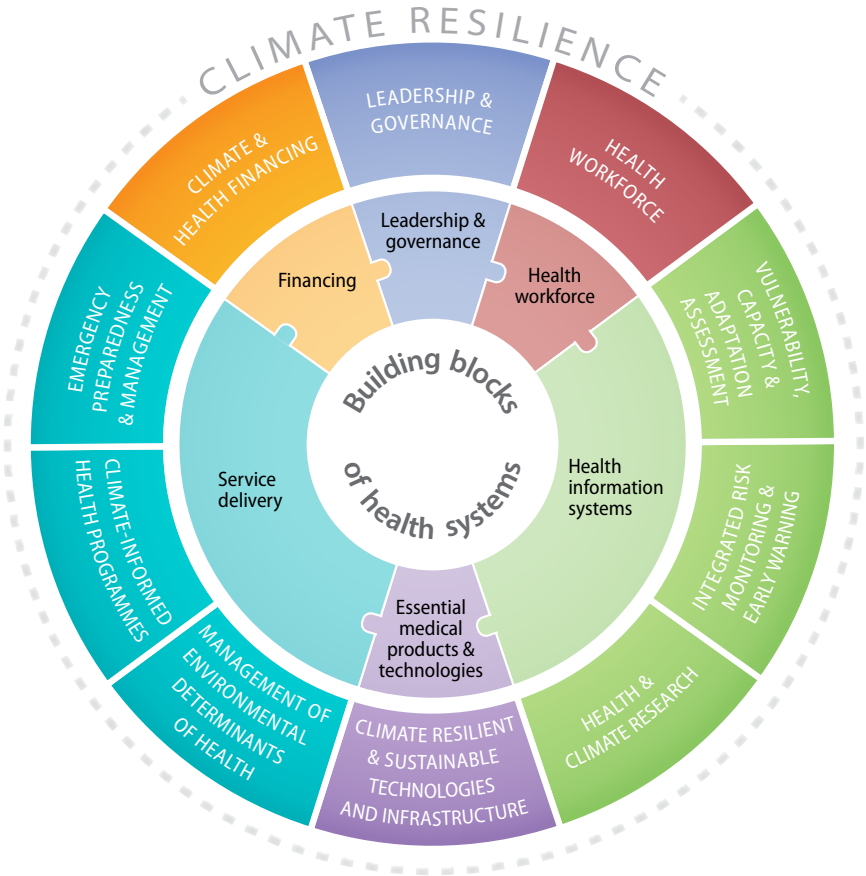
Figure 1: Climate-sensitive health risks *(9)*



For over 20 years, the World Health Organization (WHO) has been supporting efforts by health authorities to prepare for the challenges posed by climate change by implementing a risk management approach to strengthen health systems, learn from these efforts, and share information to support essential collaborations and partnerships. In 2015, WHO published the Operational Framework for Building Climate Resilient Health Systems *(3)* to guide users on conducting vulnerability and adaptation (V&A) assessments; developing comprehensive medium- and long-term adaptation plans (e.g., Health National Adaptation Plans (HNAPs)); and to design and implement interventions and programmes on climate change and health. Since then, the Operational Framework has been used to support countries' efforts to transition to a system-based approach to health adaptation. In 2020, WHO published guidance for climate resilient and environmentally sustainable health care *(4)*. That guidance aims to enhance the capacity of health care facilities to protect and improve the health of target communities in the context of a changing climate, and to empower environmentally sustainable health care facilities. Achieving these aims is an important component of universal health coverage (UHC).

The Operational Framework describes ten functions of health systems necessary to increase climate resilience, implemented around the six building blocks that support the delivery of UHC *(5)*, see Figure 2. Complementary and targeted guidance related to some of the key functions is presented in Box 1, such as undertaking V&A assessments, increasing the climate resilience of health facilities, assessing vulnerabilities in health care facilities in the context of climate change, and developing HNAPs.

Figure 2: WHO Operational Framework for Building Climate Resilient Health Systems



Box 1: WHO guidance to protect health from climate change

Recent guidance developed by WHO to help health authorities to prepare for the health risks of climate change include:

- Climate Change and Health – Vulnerability and Adaptation Assessment *(6)* – provides basic and flexible guidance on conducting a national or subnational assessment of current and future vulnerability to the health risks of climate change, and of policies and programmes that could increase resilience, taking into account the multiple determinants of climate-sensitive health outcomes.
- WHO Guidance for Developing Climate Resilient and Environmentally Sustainable Health Facilities *(4)* – provides health professionals and health care facility managers with key tools and interventions to build resilience and improve environmental sustainability in health care facilities. A companion report provides checklists to assess vulnerabilities in health care facilities in the context of climate change *(7)*.
- WHO Checklists to Assess Vulnerabilities in Health Care Facilities in the Context of Climate Change *(7)* – provides checklists to help health care facility managers and other health workers understand the climate risks that health care facilities may face, specifically in terms of existing vulnerabilities and possible impacts, and support them in taking appropriate action.
- WHO Guidance to Protect Health from Climate Change Through Health Adaptation Planning *(8)* – assists health authorities with identifying national strategic goals for building health resilience to climate change and developing a national plan with prioritized activities to achieve these goals, within a specific time period and given available resources.
- Quality Criteria for Health National Adaptation Plans (HNAPs) *(9)* – provides examples of good practice in HNAP development and assists countries in setting the foundation for establishing a long-term iterative HNAP process.

As countries continue to prepare health systems for additional climate change, and as risks to health continue to increase with the possibility of more severe impacts, information and guidance are needed to understand when a health system can be considered resilient. Information and guidance are similarly required to recognize when adaptation efforts are not having the intended results, and whether specific components of the Operational Framework should be prioritized for effectively strengthening climate resilience.

1.1 What is resilience?

Resilience, health system resilience and climate resilient health systems are related concepts. Although there are multiple definitions of these terms, they share key commonalities. The Intergovernmental Panel on Climate Change (IPCC) defines resilience, in the context of climate change, as "the capacity of social, economic, and environmental systems to cope with a hazardous event, trend, or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure while also maintaining the capacity for adaptation, learning, and transformation" *(10)*. Health system resilience, independent from climate change, can be understood as the capacity of health actors, institutions and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and reorganize if conditions require it *(11)*. Others build on this definition to suggest that resilience is the ability to prepare for, manage (absorb, adapt and transform) and learn from shocks *(12)*. Linking these two definitions, climate resilient health systems are those that are capable of anticipating, responding to, coping with, recovering from, and adapting to climate-related shocks and stresses, so as to bring about sustained improvements in population health, despite an unstable climate *(3)*.

This definition highlights that resilience is measured at the scale of a health system. Health systems are composed of multiple actors, infrastructure and activities, along with collaborations with other sectors and entities. This report provides insights into the routine monitoring of the climate-related shocks and stresses that will impact each of the ten functions of health systems identified in the Operational Framework, to identify weaknesses that need to be addressed to enhance preparedness for a changing climate *(13)*.

1.1.1 Climate-related shocks and stresses

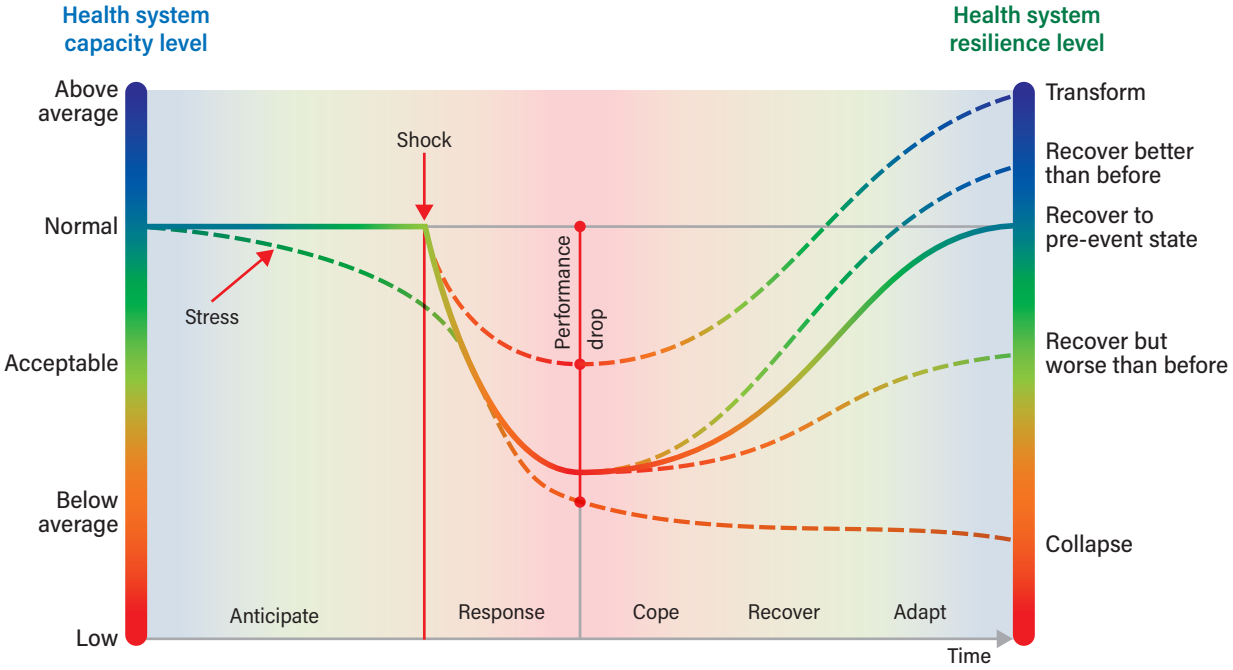
Figure 3 shows in a simplified form how a climate-related stress (a slow onset event such as a drought or sea-level rise) or a sudden shock (such as a tropical cyclone, or a heatwave) could impact a health system and its capacity to respond. The response should be proportionate to the magnitude of the hazard, the extent of the exposure of populations and health care facilities, the underlying vulnerabilities of people and communities, and the capacities of health systems. Depending on the capacity to respond, there are a range of possible outcomes: from health system collapse with severe impacts on the population; to recovery to the pre-event state; to system transformation where future threats, including those made worse by climate change, have less impact.

As a stress multiplier, climate change is increasing the probability of new and intensifying compound and cascading risks that stretch the capacity of health systems and leave less time between events for the systems to recover. It is increasingly likely that climate-related shocks and stresses will co-occur over short time periods. There will likely be increasing numbers of compound and cascading events that threaten people and health systems. The cessation of a stress may come in the form of a shock (such as heavy rains that end a drought, resulting in flooding). Risk factors (e.g., hazard, exposure and vulnerability) can also interact and compound, such as heatwaves interacting with dry conditions to increase wildfire hazard *(7)*. The upstream determinants of risk can similarly interact, such as when inequities within the population result in certain groups (e.g., low income, marginalized) living in areas with higher exposure to climate-related hazards and with limited capacity to cope with

them. These interactions can create cascading risks, with one event or trend triggering another thus increasing their impact, particularly where a population's vulnerabilities are higher.

This implies that the resilience of health systems is dynamic, with no assurance that resilience today will provide adequate health protection tomorrow. This may be because the magnitude of hazards may increase, or unanticipated hazards may occur, or because health systems may be resilient to individual hazards but not to multiple hazards occurring in close proximity. Failure to prepare for climate change now by bolstering the resilience of health systems increases the probability that hazards become disasters and complex emergencies that cause severe impacts to human health and communities.

Figure 3: Health system resilience



Source: (4)

1.1.2 Resilience requires monitoring and preparation for future risks

Understanding the resilience of each function of a health system does not provide sufficient information to understand how well the system works as a whole. The uneven effectiveness of individual components of a health system can decrease its overall resilience. Indicators are required that provide insights into how well the total system is functioning when faced with challenges from current and future climate change risks.

Addressing climate change risks to population health and improving health system resilience requires proactive efforts to avoid being caught in a cycle of responsive or forced adaptation when shocks and stresses challenge a health system's function. It also requires a focus on monitoring and managing future risks, including from more severe shocks and stresses to health systems or on previously unanticipated hazards, as well as thoughtful planning with decision-makers outside of the health sector. Inter-sectoral collaboration can help achieve large and immediate health co-benefits from adaptation and from measures to reduce greenhouse gas emissions, while increasing the resilience of health supporting systems (e.g., transport, food, water, etc.). These actions can, in turn, reduce impacts to health system operations including by lowering health care demand.

Measuring the climate resilience of a health system is most effectively done with information and indicators that are tailored to the needs of the health authority using it. This exercise should build upon, but not duplicate the results of existing national health surveillance and related monitoring systems, as well as regional and international monitoring and reporting initiatives such as the WHO Health and Climate Change Global Survey, the Lancet Countdown on Health and Climate Change, the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction. This guidance provides illustrative examples of the different types of indicators as well as the process of identifying them but it is not comprehensive. The guidance should be used to initiate discussions on which indicators are of the greatest relevance to the local or national health concerns about a changing climate.

1.2 Target audience

This report assists health authorities – from local to national levels – in their efforts to chart progress towards developing health systems that protect populations from current climate-related hazards and that are prepared for future climate shocks and stresses. Because many of the actions and indicators of progress are relevant for actions taken by decision-makers in other sectors, this report can also inform their adaptation activities. To this end, it provides a framework and suggested approach for measuring the climate resilience of health systems.

1.3 Guide to using this document

In Section 2, this document outlines a framework and method for measuring climate resilient health systems, discussing the linkages among upstream determinants of health, health system capacity and adaptation, and health outcomes in a changing climate. Section 3 then provides information on criteria for selecting indicators as well as tips on selecting the first set. Section 4 provides useful data sources health authorities can use to populate their indicators as part of V&A assessments or other studies. The final section discusses how the information from application of the indicators can be used to inform policy processes and programme development by health authorities to plan for climate change impacts.

2 FRAMEWORK FOR MEASURING THE CLIMATE RESILIENCE OF HEALTH SYSTEMS

Climate-related risks result from the interaction of the hazards created by a changing climate, the populations and regions exposed to those hazards, and the underlying vulnerabilities to exposures. Reducing greenhouse gas emissions will contribute to reducing future climate hazards. However, the inertia of the climate system means that reduced emissions will not affect the frequency and intensity of hazards in the short-term; many will continue to pose serious threats to health. Climate change is increasing the probability that thresholds are crossed in terms of health system response during disasters and public health emergencies, overwhelming the coping capacities of health systems, with catastrophic impacts to communities. For example, rapid and extensive sea-level rise with associated increases in the magnitude of storm surges may increase the likelihood of such thresholds being crossed in the future. This means the key areas of interventions for health systems should focus on managing current exposures and reducing current vulnerabilities to help reduce the possible impacts of potentially more severe impacts of climate change. Health system investments, particularly in fixed assets, should consider current vulnerabilities as well as projected future risks to foster long-term resilience.

The performance of key programmes and processes (e.g., health sector staff training, development of emergency management plans in health facilities, climate proofing health infrastructures, public education and outreach) can be monitored along with any population health and/or health system impacts to develop strategies for continuous improvements to build resilience to climate change. This includes a focus on strengthening the health system functions that are the weakest and focus on communities and populations that are particularly vulnerable.

2.1 Understanding linkages among upstream determinants of health, health system capacity, and adaptation and health system resilience outcomes in a changing climate

Figure 4 proposes a framework to identify methods and indicators to measure climate resilience and implement necessary health system adaptations. The Framework for Measuring the Climate Resilience of Health Systems starts with climate variability and change and illustrates the connection among three distinct parts that require measurement: i) upstream determinants of exposure and vulnerability; ii) climate resilience of health system functions; and iii) outcomes of health system resilience.

- **Upstream determinants of exposure and vulnerability:** the goal is to identify and measure environmental factors and trends as well as the exposure pathways that are important to health outcomes in a specific jurisdiction. It is also relevant to identify and measure key socioeconomic factors and trends, and the existing vulnerabilities and susceptibilities of broader systems.

- **Climate resilience of health systems functions:** the goal is to measure current health system capacity and adaptation efforts based upon the ten components of WHO's Operational Framework most relevant to a specific health authority area by accessing available data in collaboration with partners within and outside of the health sector.
- **Outcomes of health system resilience:** these are measured with two sets of indicators that focus on climate change-related health outcomes and health system outcomes, to measure progress towards resilience.

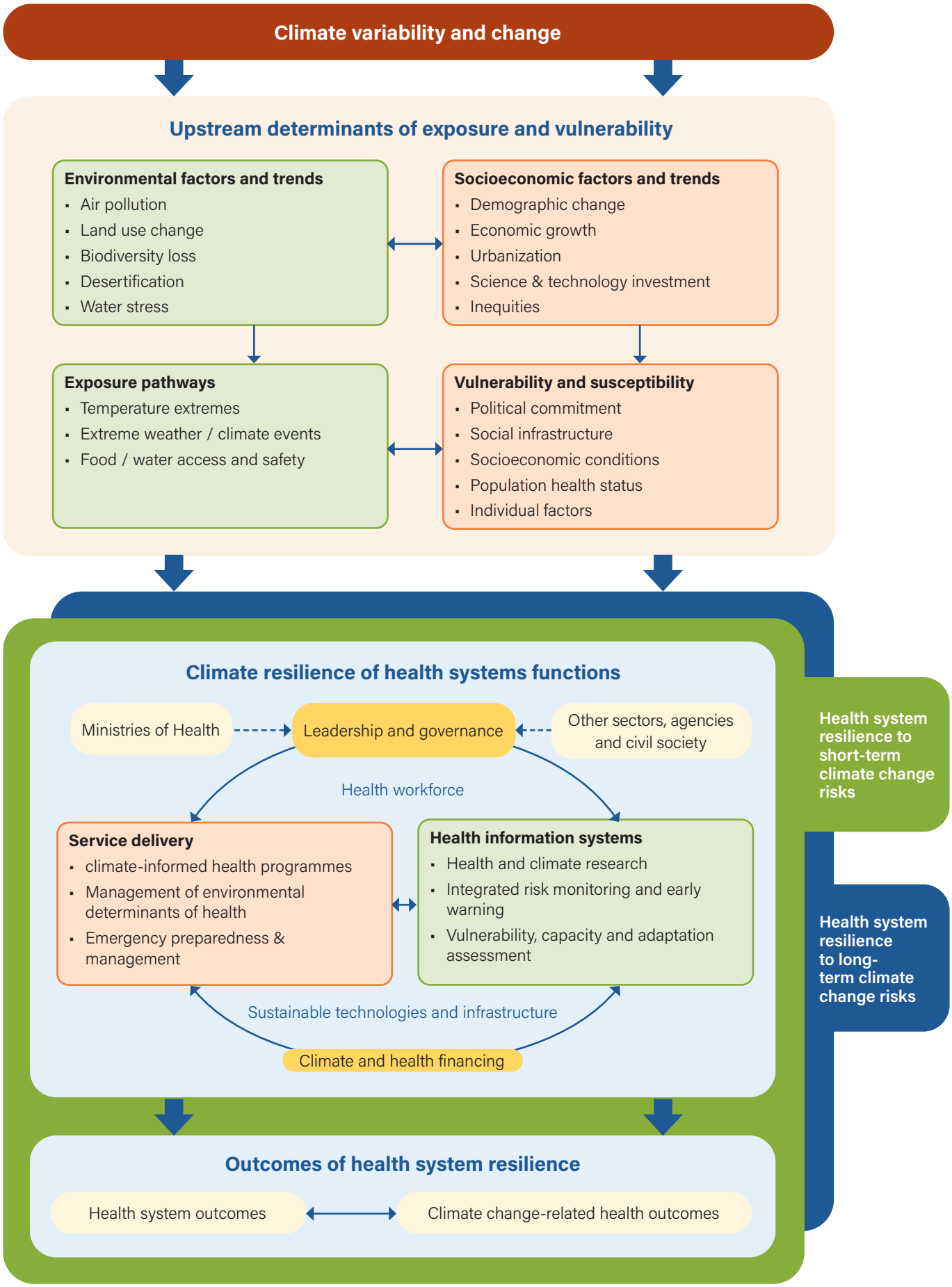
The framework can be used to measure progress towards climate resilience in health systems through indicators that track changes in: the upstream determinants of exposures and vulnerabilities; the robustness of each function of health systems; the overall capacity of a health system to manage climate-related shocks and stresses; and the extent to which resilience outcomes change following adaptation interventions. Short- and longer-term climate-related risks need to be monitored to ensure that near-term interventions build flexibility and capacity to prepare for and manage additional climate change impacts over the coming decades.

The centre of Figure 4, 'Climate resilience of health system functions' shows the interlinkages within the ten components of climate resilient health systems. Indicators developed for the different components would focus on the extent to which each component is prepared for climate change. For example, are the policies and programmes regularly evaluated and modified to ensure continued effectiveness as the climate continues to change? Does the health system have the capacity, training and tools to make quick pivots in operations and service delivery with emerging information on risks? Adaptability is one key for fostering resilience; another is focusing explicitly on increasing flexibility for the development and implementation of future adaptation options.

However, climate resilience will depend on more than the sufficient functioning of each building block of health systems – it will also depend on the effective interactions of the building blocks when faced with a shock or stress. As these increase in frequency and intensity over time, the demands on the individual components of health systems are likely to be more difficult to manage. No one single component will define resilience – the coordinated functioning of all components is required. It is proposed that indicators for each of the sub-categories included in the Framework are integrated into the monitoring system for climate resilient health systems. This will ensure a systems-based approach to measuring climate resilience.

The health sector is responsible for monitoring those indicators related to 'Climate resilience of health system functions' and 'Outcomes of health system resilience'. Progress across the different components of the Operational Framework will contribute to increasing overall climate resilience. Data are available for most, if not all, upstream determinants of exposure and vulnerability from sources external to the health system, often in country statistics from different government agencies (e.g., environment, meteorological services, finance, population census and others). The health sector will have to ensure coordination and facilitate the sharing of data collected elsewhere.

Figure 4: Framework for measuring the climate resilience of health systems



2.2 Monitoring upstream determinants of exposure and vulnerability

Climate change operates over decades or longer, altering daily, weekly and seasonal weather patterns, sea-level rise and ocean acidification. The extent to which these changes could affect population health and health systems depends on a range of interacting environmental and socioeconomic factors and trends. Climate change is a risk multiplier, interacting with environmental factors such as air pollution, land use change, biodiversity loss and desertification; these then affect exposure pathways, including water and food access and safety. Socioeconomic factors such as demographic change, economic growth, urbanization, investments in science and technology development, and the extent of gender equality and population inequities affect vulnerability and susceptibility. Each of these factors has multiple components that may affect the burden of climate-sensitive health outcomes and the effectiveness of health systems, such as the extent to which urbanization plans address the quality of housing stock. Together, these factors affect the climate resilience of health system functions.

For example, heatwaves can affect health systems by increasing demands for health care, putting pressure on health systems and service delivery. The magnitude and pattern of risks of heatwave-related mortality in a region depends on urbanization, land use (extent of green and blue spaces), infrastructure, air pollution, age structure of the population, proportion of people with chronic diseases that increase susceptibility, access to cooling and other factors. Therefore, efforts to understand how heat-related mortality could change with climate change are more robust when these factors are considered along with climate change, instead of just using projections of rising temperatures over coming decades. Many upstream determinants will change over time with the effect of exacerbating or ameliorating the health risks of heatwaves. Incorporating into projections assumptions about population growth and ageing, urbanization rates, land use change, economic growth and investments can provide insights into approaches for closing inequity gaps associated with, for example, heat-related mortality.

Social indicators monitor variables interacting with climate-related hazards that determine vulnerability and sensitivity. Examples include demographic data (e.g., number of young people), the availability of safe water, literacy/education rates (e.g., proportion of illiterate persons aged over 18), urbanization rates, access to health services, and poverty rates (e.g., proportion of persons living in poverty).

Indicators of these upstream determinants of exposure and vulnerability are generally already being collected by the Ministry of Health (e.g., number of adults over the age of 65 years and therefore more vulnerable to heatwaves) or are being collected by other sectors, agencies and civil society. For example, other government bodies often collect data on demographics, urbanization and weather and climate. Efforts to acquire data for indicators selected to measure climate resilient health systems will, therefore, require collaboration with officials in other ministries, agencies and organizations that collect this information.

Indicators of upstream environmental and socioeconomic drivers can assist health officials and others to identify populations at higher risk of climate-sensitive health outcomes. Depending on the jurisdiction, examples could include the proportion of households affected by floods, drought and storms per month; the proportion of households without regular access to safe water; the proportion

of the population with chronic diseases and/or over 65 years of age; or the number of deaths due to floods, droughts and storms. These and similar indicators can monitor how the composition and distribution of exposed and vulnerable groups change over time as the climate continues to warm.

2.3 Monitoring the climate resilience of health systems

The Framework for Measuring the Climate Resilience of Health Systems (Figure 4) highlights a number of key components of health systems that are integral for improving the capacity to address growing risks to health from climate change. It recognizes the central importance of health information systems as well as service delivery in keeping people and health systems safe from climate change, but also identifies leadership, the health workforce, governance and financing as well as resilient and environmentally sustainable technologies and infrastructure as being equally important.

As Figure 4 illustrates, health information systems that guide adaptation efforts are supported through health and climate change research; climate change and health V&A assessments; and risk monitoring and warning systems that integrate climate and weather information. Climate resilient service delivery depends upon the development of climate-informed health programmes; sustained efforts to manage key determinants of health; and robust emergency preparedness and management systems that can address threats from acute shocks and stresses from extreme weather events and disasters and related public health emergencies. In addition, efforts to develop a knowledgeable and trained health workforce and to develop new climate resilient technologies and infrastructures (for example, in the building of new health facilities) are strategic activities by health authorities to prepare for climate change.

The Framework recognizes the interplay of local to national vulnerabilities, capacities and actors and institutions as well as the requirement for strong leadership, governance and financing mechanisms. Leadership and governance, for example, can have an important influence on empowering the health workforce, and in supporting climate-informed service delivery. Furthermore, a range of actors from local to national organizations and institutions are responsible for preparing for, responding to, coping with and recovering from the health impacts associated with climate variability and change. Therefore, collaboration with decision-makers outside of the health sector is critical to maximize climate resilience.

Programming that systematically considers climate change in health system activities will make new demands on technical knowledge, infrastructure and capacities, require enhanced and novel surveillance, and necessitate engagement across all sectors where climate change-related impacts may affect human health (e.g., power generation and transmission). Adequate and sustained climate and health financing is required to support all these functions.

Sample indicators for each of the categories included under 'Climate resilience of health systems functions' in the Framework can be found in the WHO Operational Framework *(3)* (Figure 2). These may support efforts by health authorities to develop their own approach for assessing progress towards climate resilience, including the creation of jurisdiction-specific indicators that can be monitored over time.

2.4 Monitoring outcomes of health system resilience

Most health systems are already reporting numbers of climate-sensitive injuries, illnesses and deaths for a range of health outcomes. In addition, years of life lost from climate change can be used as an aggregate measure of the overall burden of disease that could be attributed to a changing climate. These data are essential for understanding trends in health outcomes themselves and/or trends in vulnerability, such as numbers of deaths in a heatwave or the proportion of the population that is vulnerable to extreme heat. Increasing investment in adaptation should lead to reductions in the numbers of adverse health outcomes and/or on changes in the strength of the association between hazard and health outcome over time. For example, the number of people exposed to heatwaves may remain the same or increase over time, but if resilience is increasing, then the rate of adverse health outcomes would decrease with greater awareness and effective adaptation interventions. Through a V&A assessment, baselines can be established and key indicators of the population health risks of climate change identified against which progress towards improving health can be measured.

Climate change affects not only population health but also the overall functioning of health systems and health care facilities. For example, severe storms, floods and wildfires can have devastating impacts on hospitals, clinics, community health centres and care homes (Box 2, below). Depending on the national context, countries will face different climate-sensitive health risks.

Box 2: Climate resilient health care facilities

Climate resilience is needed in the four fundamental requirements for providing safe and quality health care in the context of climate change: (i) health workforce – adequate numbers of skilled human resources, with decent working conditions, empowered and informed to respond to environmental challenges; (ii) water, sanitation, hygiene and health care waste management – the sustainable and safe management of water, sanitation and health care waste services; (iii) energy – sustainable and resilient energy services; and (iv) infrastructure, technologies and products – appropriate infrastructure, technologies, products and processes, including all the operations that allow for the efficient functioning of a health care facility. An assessment tool for resilience is provided in the WHO Guidance for Climate-Resilient and Environmentally Sustainable Health Care Facilities *(4)*. A companion report, Checklists to Assess Vulnerability in Health Care Facilities in the Context of Climate Change *(7)*, contains checklists to assess vulnerabilities in health care facilities and are intended for health care facility managers and other health workers aiming to understand the climate risks (large or small) that health care facilities may face, in terms of existing vulnerabilities, possible impacts and what actions are required. The checklists can be used to establish a baseline with regards to resilience in health care facilities. This will be used to inform the design of interventions to strengthen overall resilience to climate change. The checklists can also be used for iterative vulnerability assessments in health care facilities, to help health care facility managers: (i) identify climate hazards of concern; (ii) assess current vulnerability for each of the hazards, in each of the key components of health care facilities; and (iii) understand potential impacts posed by climate variability and change in each of the key components of health care facilities. Checklists for key climate hazards (floods, storms, sea-level rise, droughts, heatwaves, wildfires and cold waves) consist of separate sets for assessing vulnerabilities and impacts.

3 SELECTING INDICATORS FOR MEASURING THE CLIMATE RESILIENCE OF HEALTH SYSTEMS

A minimum set of indicators should be identified to monitor the resilience of health systems, based on priorities identified in the national V&A assessment, HNAP, or programmes being implemented for climate-related risks, and building on selected indicators already being tracked by the Ministry of Health and other partners. The process of identifying a minimum set of indicators may reveal gaps – such as data on climate-sensitive exotic diseases – indicating where new indicators and data sources may be needed. Indicators can be developed and tailored to a specific country or health authority to monitor the pace, timeliness, effectiveness and sufficiency of adaptation efforts.

There is no 'one size fits all' set of indicators for climate change and health adaptation and resilience building efforts. The objectives affect the types of indicators chosen. For example, the suitability of specific indicators would likely vary for different objectives such as measuring: health system resilience at global, national and local scales; progress on preparing for and managing the population health risks of climate change; progress on reducing greenhouse gas emissions from health system operations (e.g., health care, medical transport, medical products, infrastructure management etc.); and measuring the effectiveness of adaptation in a changing climate. This document focuses on indicators for measuring the climate resilience of health systems at national or local levels.

The levels established and information provided by an indicator should offer sufficient information to inform operational decisions. For example, a 'yes/no' response to a question on whether a health authority has conducted a V&A assessment does not provide information on when it was conducted, which health outcomes were included, or which (if any) recommendations have been implemented by the Ministry of Health at the national or subnational scale.

3.1 Criteria for indicator selection

Several criteria for indicator selection follow models developed for environmental health indicators, but few are specific for climate change. Robust indicators for the climate resilience of health systems include outcome and process indicators for all categories included in the 'Climate resilience of health system functions' category of the Framework. This will allow health authorities to assess the overall functioning of the health system when faced with a climate-related shock or stress. Process indicators are suitable to monitor the overall effectiveness of the health system itself in preparing for and responding to climate change. Useful criteria for selecting indicators relevant to a specific jurisdiction include that they are:

- specific, based on an association between climate and health
- actionable, related to climate and health conditions that are amenable to adaptive actions

- measurable, based on timely and unbiased data of acceptable quality
- understandable, applicable and acceptable to stakeholders and potential users
- representative of the issues and areas of concern
- consistent and comparable over time and space
- robust and unaffected by minor changes in method, scale or data
- scalable, capable of being used at different scales
- cost-effective, capable of being constructed and used at an acceptable cost–benefit ratio
- sustainable, able to provide data for the next 20–30 years

The availability, accessibility, quality and resource requirements of data for monitoring indicators often varies, suggesting that different approaches may be required to using indicators based on available human and natural resources at local to national scales.

Every context is different; therefore, indicators should be developed based on the national and subnational needs, level of capacity and the available human and financial resources. It is important to link to and integrate with indicators used by partners, such as weather and climate data as well as disaster preparedness. Indicators should be tracked, and analyses conducted of changes over time, relative to a baseline through subsequent V&A assessments and other studies and monitoring processes.

3.2 Selecting a first set of indicators

The first set of indicators can be selected through several processes. A team led by the Ministry of Health should be designated to evaluate the current understanding of the health risks of climate change. At the same time, relevant data should be collected within the Ministry and across health-relevant ministries to identify a set of indicators for monitoring that will assess the resilience of health systems across all categories of the Framework depicted in Figure 4. Many of these indicators will already be routinely collected, so mechanisms will need to be determined for sharing the data at the temporal and spatial scales needed. Data may need to be collected on new indicators – for example, indicators that require modeling or analysis. The team will need to specify the data to be collected, including the temporal and spatial scale, the process for collecting and reporting the data, and which group(s) will be responsible for analyzing the data. A team responsible for monitoring the indicators will need to be designated within the Ministry of Health.

For countries that have, or are conducting, V&A assessments, the indicators can be selected during that process. Generally, the goal of the V&A assessment is to identify priority health risks and adaptation options to manage those risks in a changing climate. These priorities, and the data and information collected to inform the V&A assessment, can be used to select a first set of indicators, which should include health system resilience.

The country could also consider data currently collected and reported in global monitoring mechanisms, such as the WHO Health and Climate Change Global Survey, to help identify suitable indicators. The responses to the survey signal areas of concern for population health and for the

effective functioning of health systems. In all cases, it would be beneficial, whenever possible, to align the selected priority indicators with key indicators reported in global monitoring mechanisms or processes such as the WHO Health and Climate Change Global Survey. Organizing a meeting of stakeholders responsible for the survey responses, including within the Ministry of Health and across health relevant ministries, can facilitate discussion and agreement on which indicators are priorities for monitoring health system resilience.

If no V&A assessment has been conducted, or if the country does not respond to the WHO Health and Climate Change Global Survey, then a first set of indicators can be selected by the designated team using the criteria discussed in section 3.1 for climate resilience of health system functions and climate-sensitive health outcomes that are a priority for the Ministry of Health. The identified indicators may come from research, a literature review, and/or expert or public consultation. The results can be validated and expanded upon when the country conducts a V&A assessment.

Whatever the process for identifying the first set of indicators, the designated team in the Ministry should explicitly outline a plan for continued improvement of the indicator set. As time goes on, new data sets will become available that may be more relevant or at a finer scale – these data sets could then replace those being used. As the climate continues to change, new indicators may be needed for climate-sensitive health outcomes new to the country or that are increasing in incidence. Changes in the geographic range of vector-borne diseases may mean that surveillance sites need to shift with the new reality. And some health outcomes could decline with additional climate change, such as where regions become too hot and dry for critical mosquito species. The designated teams can adjust the indicator list based on new insights from updated V&A assessments and HNAPs. How often the indicators should be evaluated ought to be specified in the plan for improving the indicators.

3.3 Indicators of upstream determinants of exposure and vulnerability

The primary responsibilities for collecting data on the upstream determinants of exposure and vulnerability lie outside the health sector. Therefore, it is important to link to existing efforts by those partners to inform the monitoring of climate resilience in health systems. Selection of the indicators to be monitored can be based on the results of the V&A assessment, HNAP, or knowledge gained through adaptation projects. Discussions with the experts who collect and analyze the exposure and vulnerability data would lead to a greater understanding of the strengths and challenges associated with the data and could lead to the selection of different datasets. It may be possible that the data owners could derive new metrics that better match the temporal and spatial scale of the health data.

Hydrometeorological services within ministries of the environment monitor weather, climate variability, and climate change. Selected indicators should monitor current weather patterns relevant for exposure pathways for climate-sensitive health outcomes – such as temperature, precipitation and extreme weather and climate events – and should provide projected changes of these variables under different pathways of greenhouse gas emissions. To ensure preparedness for a changing climate, projections should extend at least to mid-century so that proposed adaptations can be assessed against future climates, while still relevant to shorter health planning horizons. For health

care facilities, projections should be through to the end of the century because of the lifetime of infrastructure, although for some infrastructure the period may be shorter.

Ministries of the environment or other ministries and organizations also monitor environmental factors and trends (e.g., air pollution) as well as socioeconomic factors and trends, such as demographic change and economic growth.

Suggested indicators include:

- Temperature trends and projections until at least mid-century
- Precipitation trends and projections until at least mid-century
- Sea-level rise and projections until at least mid-century
- Trends in extreme weather and climate events and projections until at least mid-century
  - Heatwaves
  - Floods
  - Drought
  - Storm surge
  - Storms
  - Wildfires
- Trends in availability and quality of water and food

For vulnerability, selected indicators should monitor trends in factors that will affect exposure and vulnerability to climate variability and change, such as demographic change (e.g., older adults are more susceptible to heatwaves; children are more susceptible to food insecurity); economic growth (e.g., to provide information on resources and allocations for adaptation); urbanization (e.g., could lead to improved housing conditions or to unplanned settlements); and political commitment to climate change.

As indicators for upstream determinants of health are collected in other ministries or departments, developing memoranda of understanding or other agreements with relevant departments may be needed to facilitate data-sharing and access.

3.4 Indicators of climate resilience of health systems functions

Based on the Framework, Table 1 lists sample indicators to measure health system resilience to short-term risks (up to ten years) and long-term climate change impacts (ten years and over) for each component of the Operational Framework. For some health system functions (e.g., leadership and governance), the proposed indicators can be expected to be relevant for short- and long-term risks (e.g., national strategies for health and climate change and/or HNAP, iteratively developed and updated). For other functions (e.g., integrated risk monitoring and early warning systems), short- and long-term indicators will be needed to facilitate effective preparation. For example, early warning systems are often based on weather to sub-seasonal temporal scales, which means that indicators of their effectiveness can monitor short-term resilience. For vector-borne diseases, longer-term

indicators may be needed to track the rate at which vectors are changing their geographic range and/or length of seasonal activities.

The assessment of health system resilience is qualitative and there are different levels of difficulty in achieving the proposed goals (e.g., designating a climate change focal point in the Ministry of Health could be easier than having a national health and climate change plan in place). For each indicator, evidence-based quality standards (scaled by intensity/completeness of the response) and the dates of report and periodic review should be established. Integrated monitoring facilitates the collection and analysis of data on environmental hazards, socioeconomic factors, and health outcomes.

The proposed list of indicators in Table 1, below, is not prescriptive; but it is a comprehensive set that can guide countries to assess their health system resilience. Countries are encouraged to build on this list, identify their needs, finalize their own indicators and develop their own targets that are context specific (e.g., What fraction of the health workforce should be trained on climate change and health? By when should all health care facilities be retrofitted to be climate-proof?). New indicators can be fitted in one of the ten component areas. At times, it may be difficult to decide where any one indicator fits best; this should not detract from the exercise of identifying additional relevant indicators.

Building resilience in the short-term is equally important as building it over the long-term. Many countries have already initiated short-term actions to prepare for the health impacts of climate change; some of these may have important synergies with efforts to manage the COVID-19 pandemic. While some may find it easier to identify additional short-term indicators, attention should also be given to the long-term climate change risks that will require higher levels of resilience.

Table 1: Sample indicators of health system resilience to short-term and long-term climate change risks

Level of resilience:

Low (unavailable, unable, unprepared) **Medium** (in progress, incomplete, basic) **High** (completed, achieved, prepared)

Resilience to short-term risks (<= 10 years)				**Additional resilience to long-term climate change risks (>10 years)**			
Leadership and governance							
The Ministry of Health has a designated focal point responsible for health and climate change				Adequate and sustained human and financial resources in place to implement, review and update the HNAP			
Climate change and health integrated into health sector strategies and UHC, while an HNAP developed with an appropriate review and update cycle				Long-term risks inform the implementation and adaptation measures of key priorities integrated in the HNAP			
Institutional mechanisms between the Ministry of Health and key health-determining sectors support implementation of the HNAP				HNAP includes actions that strengthen the resilience of health systems to long-term risks			

Resilience to short-term risks (<= 10 years)				Additional resilience to long-term climate change risks (>10 years)			
HNAP includes actions to protect the health of populations and health systems operations from extreme weather events and current climate change				HNAP iteratively updated based on emerging evidence on climate change and health			
Main adaptation and mitigation strategies and policies in health-determining sectors that maximize health co-benefits identified and implemented				Routine assessment and implementation of adaptation and mitigation strategies and policies in health-determining sectors based on climate change projections that maximize health co-benefits			
Health workforce							
Health care workers have information and training to protect their health and their patients from climate hazards				Curricula on climate change and health developed and executed at relevant tertiary levels			
Ministry of Health staff in all health programmes have received recent training on topics related to health and climate variability and change				Health care workers have core competencies appropriate to their role and function to address climate change and health			
Ministry of Health staff in all health programmes have received recent training on climate resilient and environmentally sustainable health care facilities				Health workers understand potential future climate-related changes in e.g., food yields and infectious disease transmission and distribution			
Vulnerability and adaptation assessments							
Climate change and health V&A assessments conducted and the results integrated into health system planning				Climate change and health vulnerability assessments conducted iteratively			
Baseline rates of climate-sensitive health outcomes established in climate change and health vulnerability assessments				Future impacts of climate change established (quantitatively or qualitatively) in climate change and health vulnerability assessments			
Vulnerable populations and areas of high climate-related health risks identified and mapped				Global to local trends (e.g., population dynamics and migration) inform the estimation of future health risks and vulnerable populations and regions			
Identification of a robust process and indicators for measuring the climate resilience of health systems				Routine measurement of climate resilience of health systems and needed adaptations implemented			
Weaknesses in current technical and health service capacities and necessary adaptations identified				Health impact assessments conducted and implemented for key adaptation and mitigation policies and programmes of health-determining sectors			
Integrated risk surveillance & health early warning							
Climate-sensitive disease surveillance systems informed by weather information				Projections of changing distribution of diseases due to climate and other determinants informs surveillance and early warning systems			
Seasonality of disease transmission defined for priority climate-sensitive diseases				Development of more robust, longer-term seasonal forecasts for important climate-sensitive diseases			
Climate/weather information used to assess risk of outbreaks of climate-sensitive diseases				National guidance implemented on climate-informed health early warning systems			

Resilience to short-term risks (<= 10 years)				Additional resilience to long-term climate change risks (>10 years)			
Rapid diagnostics, syndromic surveillance and other detection tools developed, implemented and updated to track changing incidence rates				New technologies developed and deployed to track changing vulnerability and incidence rates			
Operational climate-informed health early warning systems for extreme weather and climate events developed, implemented and updated				Operational climate-informed health early warning systems expanded to include other key climate-sensitive health risks			
Health and climate research							
Collaborative mechanisms between the Ministry of Health and key national stakeholders developed to strengthen evidence and to conduct research on climate change and health				National health research funding mechanisms include climate change and health as a fundable stream			
National research agenda or science plan on climate change and health developed and informed by results of a V&A assessment and consultations with stakeholders				Tertiary educational institutions offer research programmes on climate change and health			
Ministry of Health has an environmental health programme budget dedicated to climate change and health research				Ministries of Health take action based on the findings of health and climate research			
Climate resilient and sustainable technologies and infrastructure							
Health care facilities are built or retrofitted to be climate-proof				New technologies developed and deployed to reduce impacts on health systems and infrastructures from climate change			
Health care facilities upgraded or retrofitted to address current impacts of climate variability including decisions regarding construction, technologies and procedures to ensure the provision of basic services (including energy, water and sanitation)				Health care facilities incorporate climate variability and change in decisions related to siting, construction, technologies and procedures to ensure the provision of basic services (including energy, water and sanitation)			
Health care facilities include sustainability in the selection of products and the procurement of services, including energy, water, transport and waste management, and review possible impacts of climate change on supply chains				Assessments conducted of health sector impacts on the environment, including greenhouse gas emissions and environmental sustainability, and necessary measures implemented			
Health care facilities develop plans to protect the health workforce and communities from climate hazards				Health care facilities capable of protecting the health, safety and security of their health workforce and communities faced with climate change			
Management of environmental determinants of health							
Clean energy promoted as a means to address the health impacts of climate change				Air quality and health improved from the wide implementation of renewable energy systems			
Climate resilient water safety plans integrate risks to health posed by extreme weather events				Climate resilient water safety plans propose improvements to water services to address the health risks posed by climate change			

Resilience to short-term risks (<= 10 years)				Additional resilience to long-term climate change risks (>10 years)			
Sanitation safety plans assess health risks posed by extreme weather events via impacts in sanitation systems				Climate resilient sanitation safety plans include improvements to sanitation systems to address the health risks posed by climate change via impacts in sanitation			
Climate resilient food systems promoted as a means to address the health impacts of climate change				Climate resilient food systems and sustainable diets promoted as a means to address climate change			
Climate-informed health programmes							
Climate change and health public awareness campaigns implemented				Public health programmes address key climate risks using most recent climate projection information			
Operational health sector response plan implemented for key climate-sensitive health risks				Public health programmes address the needs of at-risk groups (e.g., children, older people, immigrants) using the most recent climate projection information			
Health information systems ensure the production and application of reliable and timely information on health determinants, health systems performance and health status for managing climate-related health risks				Stakeholder mechanisms developed and updated to support participation, dialogue and information exchange, for civil society and community groups to adapt to climate change health risks in a manner that addresses eco-anxiety and empowers action			
A climate change and health communication strategy developed, implemented and updated, in collaboration with at-risk groups, with information for diverse audiences and events				Climate change and health training and capacity building sessions for health professionals, the media and community stakeholders in risk communication, including communicating uncertainty			
Emergency preparedness and management							
National guidance established for disaster risk management, in collaboration with other responsible ministries and departments				Health systems are able to respond to the targets in the Sendai Framework for Disaster Risk Reduction			
Availability of a local and national disaster risk reduction strategy, addressing extreme weather events and other climate-related health emergencies				Availability of a local and national disaster risk reduction strategy, addressing the increased number and severity of extreme weather events and climate change			
Weather monitoring, nowcasting products and weather forecasts trigger preparedness plans and Standard Operating Procedures for extreme weather events				Contingency plans for health care provision developed, implemented and updated to address changed patterns in extreme weather events and cascading risks			
Climate and health financing							
International climate finance made available to the Ministry of Health with a focus on building climate resilience				Funding made available from key health determining sectors to reduce climate change and health risks			
Climate change mitigation actions included in Ministry of Health budget				Adequate funds for core health and public health services are available to maintain functions			
Climate change adaptation actions included in Ministry of Health budget				Decadal and longer-term forecasts used to inform health investments			

3.5 Indicators for population health and health system outcomes

Climate change and the upstream drivers of exposure and vulnerability are not static, requiring adjustments as the drivers of risk change, with new risks arising and others being ameliorated in response to the magnitude and pattern of climate change. For example, the geographic range of malaria may expand in some regions with additional warming and may decrease in other regions that become too hot and dry for Anopheles mosquitoes; it may also change due to the introduction of public health measures to protect people. Additionally, although some health care facilities may not initially experience the devastating effects of climate change directly, they can still be susceptible to smaller incremental impacts that could accelerate and accumulate over time. Examples include receiving patient transfers from facilities experiencing interruptions to the delivery of food and medical devices from suppliers affected by extreme weather events, and cumulative economic impacts and longer-term stress and strain on health care staff. This means indicators will need to be deployed in new regions and potentially scaled back in others. Because the need to measure selected indicators will change over time, there should be a process for regularly evaluating, modifying and sunsetting indicators as needs change.

A starting point would be to monitor at least one indicator for each health outcome of concern and key indicators of health system/facility impacts from climate change. The results of previous V&A assessments may help in identifying the indicators; otherwise, existing research results and/or consultation with experts and the public may be used. Table 2 gives examples of indicators to measure population and health system outcomes.

Table 2: Sample indicators to measure population and health system outcomes

Population health outcomes	
Health outcome	**Example indicators**
Injury and mortality from extreme weather events	Number of deaths, missing persons and persons affected by climate-related disaster per 100,000 people
Heat-related outcomes	Excess mortality associated with exposure to periods of high ambient temperature
Respiratory illness from air pollution or aeroallergens	Number of emergency department visits for exacerbations of asthma and chronic obstructive pulmonary disease during and after wildfires
Waterborne diseases and other water-related health impacts	Incidence of acute gastrointestinal illness cases/outbreaks following heavy precipitation events
Vector-borne and zoonotic diseases	Changes in the incidence and geographic range of climate-sensitive infectious diseases, such as the incidence of dengue fever per 100,000 population per week or month

Malnutrition and foodborne diseases	Prevalence of stunting in children under five years old; Incidence of climate-related food-borne diseases (e.g., *Campylobacter, E. coli, Giardia, Salmonella*) in the spring and/or summer months
Mental and psychosocial health outcomes	Number of cases presenting at primary care for mood or behavioral disorders after extreme weather events
Equity impacts	Mortality impacts of extreme heat based upon income/ neighbourhood
Health system outcomes	
Impacts on health facilities and systems	**Example indicators**
Infrastructure	Frequency with which infrastructure damage is experienced from extreme weather events and disasters
	Disruption to power sources (by cause)
	Disruption to food and water supplies
Supply chains	Supply chains resilient to climate impacts (local, regional and international)
	Health procurement considers environmental sustainability and carbon intensity
Health workforce	Impacts on health care staff (physical and mental)
	Staff shortages
Patient care	Shortages of medical supplies (e.g., blood supplies, medical devices)
	Damage to medical equipment (e.g., electronic records)
	Disruption to operations (e.g., cancellation of surgeries, transfer of patients)
	Impacts on quality of patient care
	Number of times facility accepts patients from other health care facilities impacted by climate-related events
Financing	Economic losses to the health sector and health systems from extreme events and disasters

The growing risks from climate variability and change, and increasing interest from development partners, mean that many local actors are implementing adaption options designed by and for local human and natural systems, such as mangrove restoration to reduce the vulnerability of coastal communities to storm surges. Whilst most climate change impacts are experienced locally – such as floods, reductions in crop yields or the spread of diseases – these localized impacts can have national and international ramifications that require action beyond the local level. Local or regional adaptation activities should be embedded within national adaptation and development plans, to ensure that the adaptation options implemented directly or indirectly promote the achievement of national development objectives. If adaptation actions to protect health are captured or documented in another strategy – for example, in a National Adaptation Plan – the best way to measure health system resilience may be by reporting through that Plan in coordination with partners outside of the health sector. Actions in other sectors that adversely affect health may also require monitoring.

4 DATA SOURCES FOR INDICATORS TO MEASURE THE CLIMATE RESILIENCE OF HEALTH SYSTEM FUNCTIONS AND OUTCOMES OF HEALTH SYSTEM RESILIENCE

This section provides information on key activities and processes producing data and indicators on climate change and health at the regional, national, and global levels that can support efforts to measure the climate resilience of health systems using this Framework. Specific objectives identified by a health authority will affect the types of indicators chosen. Measuring health system resilience includes:

- Climate variability and change
- Upstream determinants of exposure and vulnerability
- Climate resilience of health system functions
- Climate change-related health outcomes (health system and individual health outcomes)

Health and other ministries and organizations regularly monitor data and trends that relate to indicators in these categories.

The data sources for the selected indicators will depend on the country or specific health authority and must be specified. The indicator system should consider the priority issues raised in any climate change and health V&A assessment and health components of National Adaptation Plans.

4.1 WHO Health and Climate Change Global Survey

The WHO Health and Climate Change Global Survey is a voluntary triennial survey sent to all 194 WHO Member States and a small number of Non-Member Territories *(14)*. It is completed by ministries of health in consultation with other health stakeholders, ministries and institutions. The survey forms the foundation of WHO's global monitoring of national progress on key health and climate change indicators. The WHO Health and Climate Change Global Survey report and dynamic data dashboard *(14)* summarize the survey findings. They provide a snapshot of progress on the implementation of health and climate change policies and plans; identify evidence gaps; indicate barriers to achieving adaptation and resilience priorities; and efforts to promote the health benefits of sector-wide climate mitigation action. In addition to tracking global progress, national level data is presented in the WHO/United Nations Framework Convention on Climate Change (UNFCCC) Health and Climate Change Country Profiles *(15)*. Ninety-five countries participated in the 2021 global survey.

4.2 Vulnerability and adaptation assessments at the population and health system levels

Conducting a national or subnational V&A assessment at the population and/or health system levels will provide information about current and future vulnerability to the health risks of climate variability and change, and the policies, programmes and capacities of health systems that could increase resilience (Box 3). The assessment outcome will provide information to identify, validate and adjust indicators. In addition, assessment findings will provide information and data to help populate many of the selected indicators when monitoring health system resilience, for example, changes in vulnerability over time as the climate warms, the effectiveness of adaptation options, and the functioning of the health system.

Box 3. Vulnerability and adaptation assessment

As part of its guidance on building climate resilience, WHO has developed guidance on conducting V&A assessments *(6)*. Its aim is to provide a basic and flexible tool for conducting a national or subnational assessment of current and future vulnerability to the health risks of climate variability and change. The tool allows countries to evaluate which populations and specific groups are most vulnerable to different kinds of health effects from climate change; to identify weaknesses in the systems that should protect them; and to specify interventions to respond. A V&A assessment is a participatory process and builds on the core principles of risk assessments, taking into consideration the unique challenges presented by climate variability and change, to provide policy-relevant information for maintaining and improving health systems in a changing climate.

V&A assessments aim to provide an improved understanding of climate-related risks to health and health systems, and relevant and actionable recommendations for policymakers on how they can strengthen health systems and increase the resilience of populations vulnerable to the impacts of climate change. V&A assessments are not only about understanding the potential implications of future climate change. They are about assessing vulnerability factors that interact with climate that can be modified through public health and related interventions to decrease existing risks to health.

4.3 Stress testing health systems to determine their resilience to climate-related shocks and stresses

Desk-based stress tests can be used to assess the resilience of health systems to climate-related shocks and stresses under projected climate conditions. A stress test posits, for example, an extreme heatwave, flood or storm with characteristics outside the range of recent experiences. The exercise moves beyond identifying likely challenges from exposure to the hazard to specifying policies and measures that would result in successfully managing a more severe hazard in a future climate. Stress

testing considers socioeconomic and political factors that can influence the extent of health system vulnerability and factors that can affect demands on the system by impacting population health.

Stress testing exercises are designed to identify conditions under which it would be difficult for the health system to maintain its essential function of providing services to protect population health and manage climate-sensitive health outcomes, and to identify interventions that could maintain essential system functions despite these shocks and stresses. These exercises focus on acute and chronic climate-related events and conditions, including those far outside the range of historic experience, that could directly impact health systems and/or climate-related events and conditions in non-health sectors that can indirectly impact health or health system function. The exercise can focus on one or more of the building blocks of health systems, with the aim of improving system resilience, robustness, redundancy and coordination.

The results of a stress test can be used to identify critical indicators for monitoring to ensure that capacity is being built in areas that need to be strengthened to handle weather and other climate-related hazards in a future that will be very different from today.

4.4 National and subnational surveillance systems

Surveillance systems are key elements of health information systems. Monitoring and surveillance systems / syndromic surveillance systems track illnesses, injuries and deaths and inform early warning systems that protect health (e.g., linked to meteorological information). They help prevent morbidity and mortality when the information collected is analyzed, disseminated and acted upon by health authorities, stakeholders and the public in a timely and effective manner, taking into account the multiple drivers of the health outcome of interest.

Departments within the Ministry of Health may already be tracking climate change-related health outcomes, such as the numbers of cases of dengue fever or the numbers of diarrhoeal disease deaths. Data can be collected on the impacts of some climate-related events on health care facilities, public health laboratories and other infrastructure.

Multiple processes collect national and subnational surveillance data that can be drawn upon in efforts to measure the climate resilience of health systems. Common surveillance programmes are described briefly below:

The International Health Regulations (IHR) are a binding international legal instrument on WHO Member States that aim to help the international community prevent and respond to acute public health risks with the potential to cross borders and threaten people worldwide. Countries are required to report to the World Health Organization regarding certain disease outbreaks and public health events. Building on the unique experience of WHO in global disease surveillance, alerts and responses, the IHR defines the rights and obligations of countries to report public health events and establish a number of procedures that WHO must follow in its work to uphold global public health security.

In 2015, WHO developed a monitoring and evaluation framework tool, the Joint External Evaluation (JEE). In addition to evaluating the capacities required under the IHR, the JEE and the National Action Plan for Health Security contribute to the implementation of the Sendai Framework for Disaster Risk Reduction. The indicators, with the highest levels for each, are:

- Planning an emergency preparedness and response mechanism
  - Based on updated all-hazard health emergency risk profile resource mapping, multisectoral and all-hazard public health emergency preparedness and response plans are tested and updated regularly.
- Management of health emergency response operations
  - A health sector emergency response coordination mechanism and incident management system, linked to a national emergency operation centre, have been tested and updated regularly.
- Emergency response mobilization
  - Resource mapping and mobilization mechanisms are tested and updated regularly.

WHO's Early Warning and Reporting System (EWARS) is designed to improve disease outbreak detection in emergency settings, such as in countries in conflict or following a natural disaster. 'EWARS in a box' contains all the equipment needed to establish surveillance and response activities, particularly in difficult and remote field settings without reliable internet or electricity supplies; it can serve roughly 500,000 people. EWARS is deployed during an emergency as an adjunct to the national disease surveillance system. After the emergency, EWARS should reintegrate back into the national system.

4.5 Global, regional and national monitoring processes

Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction 2015–2030, published by the United Nations Office for Disaster Risk Reduction *(16)* was the first major agreement of the post-2015 development agenda. The Sendai Framework works with the other 2030 Agenda agreements, including the Paris Agreement on Climate Change, the Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda and, ultimately, the Sustainable Development Goals. The Sendai Framework provides Member States with concrete actions to protect development gains from the risk of disasters. The Sendai Framework has four global priorities: i. understanding disaster risk; ii. strengthening disaster risk governance to manage disaster risk; iii. investing in disaster risk reduction for resilience; and iv. enhancing disaster preparedness for effective response and to 'build back better' in recovery, rehabilitation and reconstruction. There are 38 indicators within the seven targets.

Sustainable Development Goals

The United Nations (UN) Sustainable Development Goals (SDGs) include 17 goals and 169 targets. SDG3 on good health and well-being includes goals with targets (each with indicators) relevant to managing the risk of climate-sensitive health outcomes by increasing the resilience of health systems or by reducing the population health burden when climate change is explicitly taken into account. National governments are tracking indicators for all SDGs, many of which relate to the upstream drivers of health and well-being, including SDG1 (no poverty), SDG2 (zero hunger), SDG5 (gender equality), SDG6 (clean water and sanitation), SDG7 (affordable and clean energy), SDG10 (reduced inequalities), SDG11 (sustainable cities and communities), SDG12 (responsible consumption and production), SDG13 (climate action), SDG14 (life below water), and SDG15 (life on land) *(17)*.

The United Nations Statistics Division (UNSD), in collaboration with the UNFCCC, is conducting a global review of a core set of climate change statistics and indicators across drivers, impact, vulnerability, adaptation and mitigation to promote linkage to both science and policy *(18)*.

5 INTERPRETING RESULTS TO INFORM POLICY

5.1 How to interpret the results of monitoring climate resilience in health systems

Regularly monitoring the climate resilience of health systems will provide a wealth of information that can be used in many policy and planning processes to prepare for climate change, both within and outside of the health sector (see Section 6). However, given the complexity of interactions among many upstream determinants of exposure and vulnerability, the breadth of health system components that need to be monitored for resilience, and the large number of climate-sensitive health outcomes, a single quantitative resilience index or score will not likely be feasible to develop, nor would it be a valid measure for decision-making.

Documenting and interpreting the results of monitoring efforts may instead be accomplished through the application of complementary approaches:

- Broad consultation and dissemination of results with decision-makers, stakeholders and researchers to obtain feedback and their interpretation of them
- Routine engagement with these partners to validate the findings, or specific components, through heath system planning meetings, community workshops, V&A assessments or HNAP workshops, health system performance studies, etc.
- Regular efforts to refine and adjust the indicators used and the data acquisition methods. Aligning these efforts with the completion of V&A assessments and/or updates and evaluations of HNAPs can be beneficial
- Recording the baseline measures of resilience to identify specific trends that indicate increases or decreases over time and identifying an appropriate and accessible repository for this information

A useful way to record and communicate this information is through the use of a colour-coded table (as proposed in Table 1) that shows whether specific aspects of health systems are in place to support climate resilience (see example in Table 3). It would also show whether effective adaptation measures that could increase resilience have or have not been implemented and/or trends hindering resilience.

Table 3: Example of colour-coded responses regarding level of resilience

Level of resilience:

Low (unavailable, unable, unprepared)

Medium (in progress, incomplete, basic)

High (completed, achieved, prepared)

Resilience to short-term risks (<= 10 years)				Additional resilience to long-term climate change risks (>10 years)			
Leadership and governance							
The Ministry of Health has a designated focal point responsible for health and climate change			■	Adequate and sustained human and financial resources in place to implement the HNAP	■		
A national health and climate change plan (Health component of the National Adaptation Plan or HNAP) developed		■		Long-term risks inform the implementation and adaptation measures of key priorities integrated in the HNAP		■	
Institutional mechanisms between the Ministry of Health and key health-determining sectors support the implementation of the HNAP			■	HNAP includes actions to strengthen the resilience of health systems to long-term risks	■		
HNAP includes actions to protect the health of populations and health systems operations from extreme weather events and current climate change			■	HNAP iteratively updated based on emerging evidence on climate change and health	■		
Main adaptation and mitigation strategies and policies in health-determining sectors that maximize health co-benefits identified and implemented		■		Routine assessment and implementation of adaptation and mitigation strategies and policies in health-determining sectors based upon climate change projections that maximize health co-benefits		■	

Regular discourse and participatory engagement with many partners – health planners, health care professionals, affiliated health workers, community leaders, Indigenous communities, researchers, decision-makers in health relevant sectors and others – will support more accurate and appropriate interpretation of the indicators; for example, when data about health system capacity and adaptation points to an increase in resilience, but the burdens of specific climate-related health outcomes are increasing. Knowledge translation activities involving many opportunities to explore, analyze and discuss the results in multiple fora can help to elucidate critical drivers of risk, vulnerability and resilience that underly the results. Engagement with partners will also provide valuable input about how best to communicate the findings in a meaningful way to decision-makers and the public.

5.2 Informing policy processes and programme development with indicators of climate resilient health systems

At the national level, the policies and programmes may require adjustment as the risks from climate change increase, such as monitoring and surveillance of an emerging infectious disease that may expand into a particular jurisdiction. Information gained through the regular collection of data on the indicators presented in this working paper can be used to develop or adjust policies and programmes to increase health system resilience.

Information about the status of efforts towards building climate resilience only helps to protect human health if it is communicated in a timely manner to decision-makers, stakeholders and the public. A variety of mechanisms may be used to share and use the results such as:

- health system strategic planning activities (e.g., planning tables and events);
- development of dedicated reports, briefings or scorecards on health system resilience;
- development of cross-functional teams and cross-training of staff (e.g., public health, health care delivery, social services, climate services);
- annual subnational and national state of health reports;
- community health profiles;
- input to regular V&A assessments, HNAPs, Nationally Determined Contributions (NDCs), and National Communications;
- community/region hazard risk assessments; and
- international and regional climate change and health monitoring and reporting initiatives.

The monitoring and evaluation activities developed as part of a V&A assessment will provide helpful information for monitoring the climate resilience of health systems and should be used as a key information source that is regularly updated with iterative V&As.

UNFCCC National Climate Change Adaptation Plan processes

National Adaptation Plans (NAPs) are a state-led adaptation planning process sensitive to gender and equity considerations as well as broader national-level priorities *(19)*. NAPs are an iterative process inclusive to vulnerable groups that seeks to leverage the best available information (e.g., participatory processes, Indigenous knowledge, climate risk assessments, etc.).

NAPs aim to *(19)*:

- take stock of available information and needs;
- address capacity and knowledge gaps;
- identify national priorities and climate vulnerabilities;
- identify and review adaptation options;
- develop implementation strategies; and
- monitor and review adaptation progress.

The processes used to develop NAPs, as well as their structure, vary from country to country. However, all involve the identification and assessment of adaptation needs, which may be used to rank adaptation priorities. As adaptation is iterative – requiring ongoing assessment of risks, needs and opportunities – monitoring progress, setbacks and emerging trends is critical. The NAP development process often includes the establishment of a monitoring and evaluation framework to complement the actions identified in the NAP. Many health authorities develop HNAPs for their sector *(8)* that are integrated into broader NAPs. These frameworks can serve as a tool to monitor progress towards building climate resilience within health systems, and to determine when NAPs may require updating based on changing conditions or progress made. As NAPs are often multisectoral, health authorities can use them to gain insights on climate risks and adaptation progress in sectors that

influence the upstream determinants of health (e.g., agriculture) and help identify opportunities to achieve health co-benefits through intersectoral cooperation. Table 4 provides examples of health-relevant indicators for specific components of the Operational Framework that were included in NAPs submitted to the UNFCCC NAP Central Database.

Table 4: Sample indicators from the NAPs submitted to the UNFCCC NAP Central Database

Country	Example Health Performance Indicators for NAP
Suriname	· Expansion of preventative care programmes · Health care professionals trained in climate- and health-related areas · Increase in public awareness · Health and climate risk maps developed
Sri Lanka	· Assessment on the critical factors for controlling climate-induced disease incidents finalized · Number of plausible strategies identified for the management of climate-induced disease incidents · Amount of money allocated/spent for strengthening the alertness of the health system against climate-induced disease incidents
Kiribati	· Number of functioning early warning systems for water- and vector-borne diseases in priority locations · Staff in targeted health institutions with capacity to respond to – and mitigate the impacts of – climate-related health impacts is increased · 25% increase in outer islands that are engaged in regular environmental health surveillance activities (target and baseline to be established by the end 2015) · % decrease in the incidence of climate-related diseases · Number of family health clinics trained in women's mental health issues, climate change impacts and gender-based violence · Number of projects to improve health systems to respond to identified climate risks (to health or infrastructure) implemented according to asset management plan
Kenya	· Number of households with timely access to climate information · Percentage of population requiring humanitarian assistance
Grenada	· Climate information has been included in national disease surveillance system to strengthen the analysis and use of climate-sensitive data
Ethiopia	· % of target population covered by environment and health surveillance systems integrating climate change · % of health workers aware of climate change impacts
Brazil	· Protocol for monitoring public-health emergencies integrated with analysis of climatic, environmental and socioeconomic risk drafted

6 CONCLUSIONS

In understanding risk as the interaction of climate change-related hazards, populations exposed to such hazards and their underlying vulnerabilities, it becomes clear that there is a need to reduce hazards, exposures and vulnerabilities. Reducing hazards is the goal of mitigation by reducing greenhouse gas emissions. But current levels of action are insufficient and risks to health are increasing; the inertia of health systems also means that climate-related hazards will continue for at least several decades. Moreover, climate change increases the probability that health systems may suffer catastrophic impacts that overwhelm responses. Adaptation focuses on reducing exposures and vulnerabilities, but these may not be sufficient to counteract the impact of future climate hazards. This is equally valid for people as for health systems.

In this context, as risks continue to increase, bringing more severe impacts for health systems and health care facilities, countries need to understand when their health system can be considered resilient, and, if not, then to understand what areas need improvement. Taking WHO's Operational Framework for climate resilient health systems as its base, this guidance proposes both a framework and methods for measuring resilience.

The proposed framework for measuring the climate resilience of health systems – requiring the measurement of upstream determinants of exposure and vulnerability; the climate resilience of health system functions; and the outcomes of health system resilience – aims to respond to country needs to prepare health systems for climate change. This is best achieved by identifying information and indicators tailored to the specific needs of different health systems, as proposed in this guidance.

REFERENCES

1. Everybody's business: strengthening health systems to improve health outcomes: WHO's framework for action. Geneva: World Health Organization; 2007 (https://apps.who.int/iris/handle/10665/43918, accessed 21 April 2022).

2. Kutzin J. & Parkes S.P. Health systems strengthening, universal health coverage, health security and resilience. Bull. World Health Organ.; 2016(2) (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4709803/, accessed 21 April 2022).

3. Operational framework for building climate resilient health systems. Geneva: World Health Organization; 2015 (https://apps.who.int/iris/handle/10665/189951, accessed 21 April 2022).

4. WHO guidance for developing climate resilient and environmentally sustainable health facilities. Geneva: World Health Organization; 2020 (https://apps.who.int/iris/handle/10665/335909, accessed 21 April 2022).

5. Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies. Geneva: World Health Organization; 2010 (https://apps.who.int/iris/handle/10665/258734, accessed 21 April 2022).

6. Climate change and health: vulnerability and adaptation assessment. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/345968, accessed 21 April 2022).

7. Checklists to assess vulnerabilities in health care facilities in the context of climate change. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/340656, accessed 21 April 2022).

8. WHO guidance to protect health from climate change through health adaptation planning. Geneva: World Health Organization; 2014 (https://apps.who.int/iris/handle/10665/137383, accessed 21 April 2022).

9. Quality criteria for Health National Adaptation Plans. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/339454, accessed 21 April 2022).

10. Global warming of 1.5°C. Glossary. Geneva: Intergovernmenal Panel on Climate Change; 2018 (https://www.ipcc.ch/sr15/chapter/glossary/, accessed 21 April 2022).

11. Kruk M.E., Myers M., Varpilah S.T., Dahn B.T. What is a resilient health system? Lessons from Ebola. Lancet. 2015;385(9980):1910–2 (https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60755-3/fulltext, accessed 21 April 2022).

12. Thomas S., Sagan A., Larkin, J., Cylus J, Figueras J., Karanikolos, M. Strengthening health system resilience: key concepts and strategies. Brussels: European Observatory on Health Systems and Policies; 2020 (https://apps.who.int/iris/bitstream/handle/10665/332441/Policy-brief%2036-1997-8073-eng.pdf?sequence=1&isAllowed=y, accessed 21 April 2022).

13. Tol, R. and Yohe, G. The weakest link hypothesis for adaptive capacity: an empirical test. Glob. Environ. Change. 2007;17: 218–227 (https://doi.org/10.1016/j.gloenvcha.2006.08.001, accessed 21 April 2022).

14. WHO health and climate change global survey report: Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/348068, accessed 21 April 2022).

15. Health and climate change country profiles: Geneva: World Health Organization, 2021 (https://www.who.int/activities/monitoring-health-impacts-of-climate-change-and-national-progress, accessed 21 April 2022).

16. Sendai framework for disaster risk reduction 2015–2030. Geneva: United Nations Office for Disaster Risk Reduction; 2015 (https://www.undrr.org, accessed 21 April 2022).

17. Sustainable development goals – the 17 goals. Rome: United Nations Department of Economic and Social Affairs; 2021 (https://sdgs.un.org/goals, accessed 21 April 2022).

18. Global set of climate change statistics and indictors. New York: United Nations Statistical Division; 2020 (https://unstats.un.org/unsd/envstats/fdes/EGES7/Sess2_UNSD_Climate_global_set.pdf, accessed 21 April 2022).

19. Technical guidelines for National Adaptation Plans (NAPs). Bonn: United Nations Framework Convention on Climate Change; 2012 (https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans-naps/guidelines-for-national-adaptation-plans-naps, accessed 21 April 2022).

World Health Organization

Department of Environment, Climate Change and Health
World Health Organization (WHO)
Avenue Appia 20 – CH-1211 Geneva 27 – Switzerland
www.who.int/teams/environment-climate-change-and-health

9789240048102