

Rapid Synthesis

Identifying Approaches to Adapting Health Systems to Climate Change

13 January 2022



HEALTH FORUM

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**Rapid Synthesis:
Identifying Approaches to Adapting Health Systems to Climate Change
60-day response**

13 January 2022

McMaster Health Forum

The McMaster Health Forum's goal is to generate action on the pressing health-system issues of our time, based on the best available research evidence and systematically elicited citizen values and stakeholder insights. We aim to strengthen health systems – locally, nationally, and internationally – and get the right programs, services and drugs to the people who need them.

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Timeline

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. This synthesis was prepared over a 60-business-day timeframe. An overview of what can be provided and what cannot be provided in each of the different timelines is provided on McMaster Health Forum's Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response).

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Conflict of interest

The authors declare that they have no professional or commercial interests relevant to the rapid synthesis. The funder played no role in the identification, selection, assessment, synthesis or presentation of the research evidence profiled in the rapid synthesis.

Merit review

The rapid synthesis was reviewed by a small number of policymakers, stakeholders and researchers in order to ensure its scientific rigour and system relevance.

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KEY MESSAGES

Question

- What are the features of approaches that have been taken to adapt health systems to climate change?

Why the issue is important

- Climate change is leading to observable changes in environmental and social conditions around the world that pose a risk to human health.
- The World Health Organization (WHO) has emphasized that mounting an effective response to the risks to human health posed by climate change is now urgent for all countries.
- Health systems are vulnerable to the impacts of climate-related weather events and diseases, which can lead to increased need for emergency and routine health services, adverse occupational hazards for health workers, and damage to essential health-system infrastructure and operations.
- Adaptation of health systems is needed to mitigate the impacts of climate change so that adequate coverage of basic healthcare can be provided in an equitable and cost-effective way.
- This rapid synthesis explores approaches that have been taken to adapt health systems to the impacts of the changing climate.

What we found

- We identified three low-quality systematic reviews, 13 other types of reviews (e.g., scoping, narrative, or integrated reviews), and 21 primary studies.
- The WHO operational framework for building climate resilient health systems and its related health-systems building blocks (i.e., leadership and governance, health information systems, service delivery, health workforce, essential medical products and technologies, and financing) were considered while reviewing documents for inclusion and organizing the evidence.
- The literature generally provided descriptions or recommendations of potential approaches to adapting health systems for climate change resilience.
- The identified literature recommended the involvement of community partnerships, systems leaders, and decision-makers to ensure collaboration in adaptation planning and the uptake of relevant research evidence across the different sectors.
- Some of the identified literature concluded that there is a need to build capacity in different health services (e.g., mental health), health professionals (e.g., nurses and physicians), and the use of eHealth technologies to address climate-related stress and shock.
- A recent scoping review identified tools and methods that support the integration of health into climate change mitigation and adaptation policies, including descriptions of nested models, impact assessment tools (e.g., health impact assessments, comparative risk assessments, integrated environmental health impact assessments, environmental assessments), and adaptation tools (e.g., vulnerability and adaptation assessment, the WHO Health National Adaptation Plan process, and economic assessment tool).
- We also conducted a jurisdictional scan of select countries (Australia, New Zealand, Northern Ireland, Scotland, Sweden, United States – Oregon, Washington, California) and all Canadian provinces and territories to identify real-world approaches to adapting health systems to climate change.
- We found that in most of the jurisdictions reviewed, climate change adaptation strategies or programs have been developed at the national, state, and local levels, but with limited focus on health-system adaptation approaches specifically.
- Investments are being made by the countries reviewed and Canadian provinces and territories in monitoring and preparedness efforts for climate change adaptation through the development of adaptation strategies, screening and analysis tools, and climate change and health profile reports.
- Notably, efforts to improve climate resilience by enhancing health-system infrastructure on a large scale was identified in Northern Ireland, Scotland, Sweden and New Zealand, and financial investments are being made by the Government of Canada to support provinces in their initiatives to improve on the climate resilience of their health systems.

QUESTION

What are the features of approaches that have been taken to adapt health systems to climate change?

WHY THE ISSUE IS IMPORTANT

There is clear evidence that climate change is leading to observable changes in environmental and social conditions around the world that pose a risk to human health. These changes include increased frequency of severe weather events and changing patterns in vector-, food- and water-borne diseases. These can lead to disruption of livelihood and mass displacement, slowing down of economic growth, and exacerbation of poverty.(1) A recent report by the Intergovernmental Panel on Climate Change (IPCC) has highlighted that human-caused CO₂ emissions is the main driver of global climate warming,(2) and the World Health Organization (WHO) has emphasized that mounting an effective response to the risks to human health posed by climate change is now urgent for all countries.(3)

According to a Health Care Without Harm climate footprint report, the healthcare sector has been identified as a major contributor to climate change as a carbon emitter of 4.4% net global emissions in 2019.(4) At the same time, health systems are particularly vulnerable to the impacts of climate change. Climate events can lead to increased need for emergency and routine health services, adverse occupational hazards for health workers, and damage to essential health-system infrastructure and operations.(5) Given this, there is a need for health systems to be adapted to respond to the impacts of climate change so that healthcare can be provided in an equitable and cost-effective way. While there is a need to fully acknowledge and examine how health systems are contributing to the impacts of climate change, this rapid synthesis specifically focuses on approaches that have been taken to adapt health systems to the impacts of the changing climate.

WHAT WE FOUND

We conducted a synthesis of evidence identified from the searches described in Box 2. When reviewing the evidence, we focused on the types of documents that specifically described climate resilience approaches that can be mobilized by health systems. Given the narrow scope of the rapid synthesis, we did not include any documents that described climate mitigation measures (e.g., reducing carbon emissions, developing climate resilient infrastructure in healthcare) or broader disaster risk-reduction approaches. The six main building blocks of the WHO operational framework for building climate resilient health systems (i.e., leadership and governance, health information systems, service delivery, health workforce, essential medical products and technologies, and financing) was used as a guiding reference while reviewing documents for inclusion.(6)

Box 1: Background to the rapid synthesis

This rapid synthesis mobilizes both global and local research evidence about a question submitted to the McMaster Health Forum's Rapid Response program. Whenever possible, the rapid synthesis summarizes research evidence drawn from systematic reviews of the research literature and occasionally from single research studies. A systematic review is a summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and appraise research studies, and to synthesize data from the included studies. The rapid synthesis does not contain recommendations, which would have required the authors to make judgments based on their personal values and preferences.

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. An overview of what can be provided and what cannot be provided in each of these timelines is provided on the McMaster Health Forum's Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response)

This rapid synthesis was prepared over a 60-business-day timeframe and involved four steps:

- 1) submission of a question from a policymaker or stakeholder (in this case, the British Columbia Ministry of Health);
- 2) identifying, selecting, appraising and synthesizing relevant research evidence about the question;
- 3) drafting the rapid synthesis in such a way as to present concisely and in accessible language the research evidence; and
- 4) finalizing the rapid synthesis based on the input of a merit reviewer.

We identified three low-quality systematic reviews, 13 other types of reviews (e.g., scoping, narrative, or integrated reviews), and 21 primary studies. Table 1 provides detailed insights from the most relevant research evidence from the identified documents, which are categorized by the six main building blocks to strengthening health systems as defined by the WHO's operational framework for building climate resilient health systems. The building blocks contain examples of sub-components specific to climate change.(6) Other details from the identified documents such as case examples, and enablers and barriers to implementation, are provided in Appendices 1 and 2.

We also conducted a jurisdictional scan of select countries (Australia, New Zealand, Northern Ireland, Scotland, Sweden, United States – Oregon, Washington, California) and all Canadian provinces and territories to identify real-world approaches to adapting health systems to climate change within each of these jurisdictions. Within each country, we reviewed national and sub-national documents that were publicly available. Additional details are provided in Tables 2 and 3.

Key findings from the research evidence

The included systematic reviews, other types of documents, and primary studies generally provided descriptions or recommendations of potential approaches to adapting health systems for climate change resilience. Most of the included documents in Table 1 contained information relevant to the WHO building blocks leadership and governance,(7-13) and health information systems.(8; 14-19) We identified limited available evidence related to service delivery,(20; 21) health workforce,(22-24) and essential medical products and technologies.(25) We did not identify any relevant research evidence for the financing building block. However, some of the literature indicated that building and investing financial capacity would be an important enabling factor.(9; 11; 12)

The WHO operational framework for building climate resilient health systems defined the building block leadership and governance as strategies, health policies, and management of climate-related stress and shocks to health systems.(6) Most of the included documents relevant to this building block described or recommended the involvement of community partnerships, systems leaders, and decision-makers to ensure collaboration in adaptation planning and the uptake of relevant research evidence.(7-13) A recent low-quality systematic review on climate and other disaster resilience measurement methods and indicators reported that the most frequently recommended adaptation strategies included: 1) empowering local governments and leaders to carry out adaptation planning; 2) raising community awareness through education about disaster preparedness; and 3) enhancing community infrastructure and communication (e.g., recruiting community champions to explain strategies in the local context, increasing effective communication between governments and communities).(7)

Box 2: Identification, selection and synthesis of research evidence

We identified research evidence (systematic reviews, other types of reviews, and primary studies) by searching (in November 2021) Health Systems Evidence (www.healthsystemsevidence.org), Social Systems Evidence, PubMed, EBSCOhost, ProQuest, and Web of Science. In Health Systems Evidence, we searched for “climate”. In Social Systems Evidence we searched for adapt* AND health combined with all the topics included under the program and services filter for climate action, and those related to recycling, waste, environmental resilience and environmental-threats management under the program and services filter for environmental conservation. In PubMed, we searched for meta-analyses, reviews and systematic reviews published within the last 10 years using the following combination of terms: climate change AND (resilien* OR adapt*) AND (health system OR healthcare system). In the other databases (EBSCOhost, ProQuest, Web of Science), terms from the PubMed search were adapted according to each database.

We supplemented these searches with hand searches of government resources from select jurisdictions and the provinces and territories in Canada.

The results from the searches were assessed by one reviewer for inclusion. A document was included if it fit within the scope of the questions posed for the rapid synthesis.

For each systematic review we included in the synthesis, we documented the focus of the review, key findings, last year the literature was searched (as an indicator of how recently it was conducted), methodological quality using the AMSTAR quality appraisal tool (see the Appendix for more detail), and the proportion of the included studies that were conducted in Canada. For primary research (if included), we documented the focus of the study, methods used, a description of the sample, the jurisdiction(s) studied, key features of the intervention, and key findings. We then used this extracted information to develop a synthesis of the key findings from the included reviews and primary studies.

The Monash Sustainable Development Institute conducted a recent literature review, a policy analysis, and case studies on Australia's healthcare systems adaptations in response to climate change, and concluded with key recommendations for Australian decision-makers and systems leaders, such as the need for:

- funding and implementation of a coordinated national strategy on climate change and health (e.g., fostering collaboration across different sectors, community engagement, and use of systems-thinking approaches);
- committing to delivering net zero healthcare (e.g., developing plans by using [NHS 'Net Zero' model](#));
- investing in climate-health vulnerability and capacity assessments with a focus on locally led planning (e.g., conducting vulnerability and capacity assessments, and embedding these into healthcare system management, accreditation standards and performance measures);
- establishing research funding for climate-health resilience (e.g., implementing and evaluating climate-health interventions, knowledge translation);
- developing climate health capacity in the healthcare workforce and the wider health system (e.g., training professionals, integrating education into existing training degrees and continuing education);
- embedding Aboriginal and Torres Strait Islander knowledge and leadership (e.g., supporting culturally safe and holistic community-led approaches); and
- investing in prevention and early intervention (e.g., developing population-level measures to support health-system resilience such as [England's heat wave plan](#), reducing financial and environmental costs and wastes).(9)

A primary study broadly described Australia's national plans and emergency teams (i.e., Australian Government Disaster Response Plan, National Response Plan for Mass Burn Casualty Incidents, Australian Medical Assistance Teams, and Domestic Response Plan for Mass Casualty Incidents of National Consequence), and the establishment of committees (i.e., Australian Health Protection Committee and the Health All-Hazards Working Group (which involves the Disaster Preparedness and Management Unit)).(10) Further details about Australia's approaches to adapting health systems to climate change are provided in the jurisdiction scan.

Among a set of recommendations to address vulnerabilities of Indigenous health systems in Canada due to climate change, one review emphasized that partnerships with Indigenous peoples and organizations are important to identify health needs, generate knowledge, prioritize adaptations, and improve health systems.(26)

Health workforce refers to building and strengthening the technical capacity of health professionals and organizations within health systems to respond to climate change.(6) A recent low-quality systematic review, another type of review, and a primary study respectively concluded that there is a need to build capacity in mental health (e.g., by training mental health providers and social workers to support their clients, and developing a mental health support line related to climate-related stress and shocks),(22) in nurses (e.g., by supporting community members and involving nurse input during hospital disaster plans),(23) and physicians (e.g., by integrating climate change as a topic in existing medical education programs).(24) [A recent scoping review identified tools and methods for integrating health into climate change mitigation and adaptation policies](#), including:

- nested models (includes multiple models that account for mitigation scenarios, modifications in greenhouse gas (GHG) emissions, atmospheric pollutant concentrations, and health-effects assessments);
- impact assessment tools (e.g., health-impact assessments, comparative risk assessments, integrated environmental health-impact assessments, climate-change assessments); and
- adaptation tools (e.g., Vulnerability and Adaptation assessment, Health National Adaptation Process, economic assessment tool) (Published 4 March 2021).(14)

The [authors of a primary study developed a set of indicators to guide and monitor climate change adaptation in U.S. state and local health departments](#) in the Pacific Northwest, which included: 1) monitor climate-related health threats; 2) diagnose and investigate climate-related health threats; 3) inform, educate, and

empower regarding climate-related health outcomes; 4) mobilize community partnerships regarding the response to extreme weather and climate events; 5) develop policies on weather and climate preparedness and climate-change response; 6) enforce laws relevant to climate-change response efforts; 7) link to/provide healthcare for climate-related health outcomes; 8) ensure competent workforce; 9) evaluate climate-change preparedness and response efforts; and 10) research (Published February 2020).(19)

Health-information systems include the breadth of research programs and evaluations such as vulnerability, capacity and adaptation assessments, integrated risk monitoring and early warning systems, and health and climate research.(6) A recent scoping review identified tools and methods that support the integration of health into climate change mitigation and adaptation policies, which included descriptions of nested models, impact-assessment tools (e.g., health-impact assessments, comparative risk assessments, integrated environmental health-impact assessments, environmental assessments), and adaptation tools (e.g., vulnerability and adaptation assessment, WHO's Health National Adaptation Plan process, and economic assessment tool).(14) Additionally, two primary studies and one literature review described enablers and barriers to heatwave early-warning systems in European countries,(18) the use of vulnerability and adaptation assessments,(15) and guidance for conducting climate and health stress tests.(17) The authors of a literature review on integration of climate-change adaptation into public-health practice recommended the development of a centralized tool repository in addition to building capacity among public-health practitioners and systems leaders.(16) The authors of a primary study developed 10 indicators to guide and monitor climate change adaptation in U.S. state and local health departments in the Pacific Northwest, which include:

- monitoring climate-related health threats;
- diagnosing and investigating climate-related health threats;
- informing, educating, and empowering the public health workforce regarding climate-related health outcomes;
- mobilizing community partnerships regarding the response to extreme weather and climate events;
- developing policies on weather and climate preparedness and climate change response;
- enforcing laws relevant to climate change response efforts;
- linking to or providing healthcare for climate-related health outcomes;
- ensuring the development of a competent workforce;
- evaluating climate change preparedness and response efforts; and
- conducting research.(19)

Essential medical products and technologies may include the utilization of climate resilient and sustainable technologies and infrastructure.(6) One primary study found limited examples on the use of eHealth as adaptation strategies, but suggested that telemedicine, point-of-care diagnostics, and mobile devices could be beneficial during climate-related stress and shock events.(25)

Service delivery refers to adapting current healthcare delivery systems to ensure climate resilience.(6) This may include the management of environmental determinants of health (e.g., water and sanitation, nutrition, air quality, control of climate-sensitive diseases), climate-informed health programs, and emergency preparedness and management. A recent narrative review examined the mental health impacts of global climate change and recommended stepped-care approaches and task-shifting as strategies for delivering mental health services in response to climate change.(20) A primary study that focused on the perceptions of Ontario's public officials on climate change reported that top-down support by provincial and federal governments would be required to prioritize developments on health-systems adaptations for climate-change resilience.

Key findings from the jurisdictional scan

Similar to our findings from the research evidence, most of the information that we found from the jurisdictional scan was relevant to the WHO building blocks leadership and governance and health

information systems.(8; 14-19) We identified limited information related to service delivery, health workforce, essential medical products and technologies, and financing.

In terms of leadership and governance, we found that in most of the jurisdictions reviewed, climate change adaptation strategies or programs have been developed at the national, state, and local level. However, there was limited focus on health-system adaptation approaches specifically. The adaptation programs of [Northern Ireland](#), [Scotland](#), and [Sweden](#) have been designed to respond to identified climate change risks and focus on enhancing the resilience of societal supporting systems, including health and emergency services. For example, all [U.K. health services](#) (including NHS Northern Ireland and Scotland) have committed to net zero carbon emissions. NHS Scotland released a draft [Climate Emergency and Sustainability 2022-2026 plan](#). The plan focuses on specific areas such as sustainable buildings and land, travel, goods and services, care, and communities. The plan involves all 22 Health Boards to establish a sustainable care clinical-planning team with a larger Climate Emergency Response Team that includes individuals from service management and planning, clinical, public health, resilience and business continuity, transport, and procurement. Each Health Board is responsible for appointing a Climate Emergency and Sustainability Champion from the board members, appoint an executive lead, establish a strong governance structure, foster a culture of stewardship, and ensure health professionals complete online training modules about climate emergency. Additionally, Scotland aims to develop an NHS Scotland Sustainability Network to provide opportunities for peer mentoring and support.

The Australian states of [Queensland](#) and [Victoria](#) each have climate adaptation plans that include strengthening health systems. In Queensland's plan, the need to address the specific adaptation needs of critical essential-services systems like health has been identified as one of the four pathways to adaptation. In Victoria's plan, short-, medium-, and long-term goals for health and human-services systems adaptation have been proposed. In [Sweden](#), [Scotland](#), and [California](#), climate policy development and implementation action is required within a specified timeframe by climate change legislation, and intergovernmental and intersectoral networks are being created to enhance climate change action in [Scotland](#), [North Ireland](#), and [Sweden](#). Additionally, in the Swedish region of Stockholm, the Stockholm Regional Council defined environment sustainability goals for health and medical care in their [Environment Programme 2017-2021](#) that specifies actions to reduce environmental impacts from pharmaceuticals, food, textiles, and other goods.

We also found that the governments of [New Zealand](#), [Oregon](#) state, and [California](#) have adopted climate change risk and adaptation frameworks or strategies with a health-equity focus to help prioritize decision-making and actions to address climate change risks. Specifically:

- New Zealand's [Framework for Adapting to Climate Change](#) identifies investments, actions and responsibilities being undertaken by the government to make New Zealand more climate resilient, and a [climate change risk-assessment guide](#) is also used to support decision-making on adaptation with flexibility to adjust for local values;
- Oregon's [2021 State Agency Climate Change Adaptation Framework](#) is divided into three parts – guiding principles, administrative framework, and climate change adaptation strategies – and includes six themes for adaptation approaches, one of which is public health; and
- California's [Climate Adaptation Strategy](#) details over 1,000 ongoing actions and 76 policy recommendations being undertaken by state government agencies to improve public-health preparedness and emergency response.

Within Canada, we found that the federal government has a [Climate Action Plan](#) that describes some efforts to support First Nations and Inuit communities in managing health impacts of climate change, and a [national adaptation policy is being developed](#) that aims to generate and share knowledge, build adaptive capacity, and integrate climate change adaptation into federal policy and planning. Regional and provincial climate change action plans that address public health have also been or are in the process of being developed in [Quebec](#), [New Brunswick](#), [Newfoundland and Labrador](#), and the [northern provinces and territories](#).

We found that in relation to the health workforce building block, training and support for health professionals involved in the work of climate-change adaptation is a key focus of [California](#) and Oregon state entities, as well as the [Government of Canada](#) which has funded the [Climate Change Toolkit for Health Professionals](#) produced by the Canadian Association of Physicians for the Environment (CAPE) to support health professionals and students in advocating for climate-change mitigation policies and programs in their workplaces and communities. Oregon's [Climate Change Adaptation Framework](#) also calls for increased diversity in the state's workforce that are engaged in climate change work.

In reference to health information systems, our jurisdictional scan found several of the assessment tools and methods mentioned in the evidence documents described above. Resources and tools for adaptability assessment are distributed to local health departments and partners by both public and private entities in California, and climate change and health profile [reports](#) and [screening tools](#) are also used in the state to predict and prepare for the impacts of extreme climate weather events. We also found that [Oregon](#) and [Washington's](#) adaptation health-research programs and evaluations focused on responding to wildfire and excessive heat climate events to better protect workers from exposure, and make climate change data more easily accessible to the public.

Within Canada, we found that, according to a [Pan-Canadian Framework on Clean Growth and Climate Change](#), the federal government intends to invest in surveillance and monitoring, risk assessments, modelling, and laboratory diagnostics related to diseases and illnesses driven by climate change. We also identified an assessment approach from a Government of Canada [report](#) to determine vulnerabilities and adaptive capacity that incorporates climate models and scenarios, expert judgment, epidemiological and ecological studies, a literature review, and stakeholder consultation. Provincially, we found that climate-change impact assessments are being conducted in [Ontario](#) and [New Brunswick](#), and frameworks and guidelines are used in British Columbia to direct monitoring and preparedness efforts for climate change adaptation. Additionally, vulnerability and adaptation reports published by provincial governments in [New Brunswick](#), [P.E.I.](#), [Yukon](#), and [Northwest Territories](#) describe the actions that have been taken by these provinces to respond to climate change. Assessment tools have been developed and used in several provinces to measure the health vulnerability of communities and plan responses to extreme climate events, including:

- the [climate vulnerability index](#) used in B.C. to measure how susceptible communities in the Vancouver Coastal Health and Fraser Health regions are to the health effects of extreme heat, wildfire smoke, flooding and air pollution;
- Saskatchewan's [Hazard, Risk and Vulnerability Analysis \(HRVA\) tool](#) that aims to help a community make risk-based choices to mitigate hazards and prepare for response to and recovery from hazard-related events, and a [spring run-off potential map](#) that shows areas that have received below normal precipitation and helps municipalities understand drought susceptibility, and plan for droughts and water shortages;
- reporting by Alberta Health Services (AHS) of [Active Health Advisories](#) on their website, which sometimes addresses climate change-induced events;
- Manitoba's [Hazard Risk Vulnerability Analysis Tool \(HRVA\)](#) that permits users to search for natural hazard information by specific geographic location and links to disaster information related to flooding, wildfires, drought, and disease outbreaks;
- Ontario's [Climate Change and Health Toolkit](#) that includes guidelines to assess climate change and health vulnerability and adaptation, a workbook, and a modelling study of climate change and health;
- the [Health Care Facility Climate Change Resiliency Toolkit](#) developed by the Nova Scotia Department of Environment, in collaboration with the Canadian Coalition for Green Health Care, that health facilities can use to assess their resiliency to climate change;
- [climate-change indicators](#) used by the New Brunswick Government to better understand how the climate is changing; and
- a [Climate Change Risk Assessment tool](#) used in P.E.I. to identify and better understand climate change risks, set priorities for adaptation planning, and inform decision-making.

Findings related to essential medical products and technologies were identified in New Zealand where the Government is recommending that all new large-scale health infrastructure projects have the New Zealand [Green Building Council Green Start Accreditation](#) which proves that they meet best practice sustainable design and build benchmarks. New hospitals in New Zealand will also be guided by the requirements of the [Carbon Neutral Government Programme](#) for a green construction standard that considers low-carbon construction design and environmentally sustainable infrastructure. In Sweden, Stockholm Regional's [Environment Programme](#) contains indicators to reduce emissions of environmentally harmful substances and to manage the disposal of pharmaceuticals in a safer and more efficient way. It also describes indicators for reducing the emissions of anesthetic gases and reducing the proportion of disposable and reusable textiles in circulation in organizations. The program's goals have been actioned through the [New Karolinska Solna](#) hospital project in Stockholm, opened in November 2016, which has been designed to halve its environmental impact by having 99.7% of its energy come from renewable energy with low CO2 emissions, using a combination of recycled energy from ventilation air, district heating, remote cooling, and a separate geothermal plant.

In terms of service delivery adaptation to climate change, we found that in preparation for heat-related and other emergencies, the state Departments of Health in both California and Washington provide resources to better inform health and emergency professionals and the public of how to handle health issues that could arise for patients and residents. In Canada, the Governments of [Ontario](#), [New Brunswick](#) and [Nova Scotia](#) have developed heat-warning systems to improve communication between regional authorities and residents during extreme events. New Brunswick has also invested in [updating hospitals](#) to minimize the risk of flooding, and Quebec has taken measures to raise awareness of climate change impacts through the “[Mon climat, mon santé](#)” (My Climate, My Health) program. Lastly, the northern regions of Canada receive service delivery supports for climate change adaptation through several federal programs, including Transport Canada's [Northern Transportation Adaptation Initiative Program](#), which works to maximize limited northern resources and support activities that seek to improve resilience, Health Canada's [Climate Change and Health Adaptation Program](#) (CCHAP), and Natural Resources Canada's [Climate Change Geoscience Program](#), which supports vulnerability assessment of land-based and coastline infrastructure in northern regions.

Financing, the final building block of the WHO operational framework for building climate resilient health systems, refers to the climate and health financing required to effectively protect health systems from climate change.(6) Our jurisdictional scan identified several climate funding initiatives in the countries reviewed:

- the New Zealand Government's [Budget 2021](#) will provide \$67.4 million to support the country's transition to a carbon neutral public sector by the year 2025, and the Ministry of Health is developing a [prioritization framework](#) for investment proposals to support environmentally sustainable construction of new infrastructure, and to ensure that the process for investments is transparent and fair;
- the Scottish Government has provided funding for [Adaptation Scotland](#) to provide practical advice and support for organizations, businesses, and communities on adapting to climate change;
- [municipalities in Sweden can apply for funding](#) for implementing preventive measures against landslides and other climate-related disasters;
- Governor Gavin Newsom of California signed a [\\$3.7 Billion Climate Resilience Package](#) to build resilience in vulnerable front-line communities over three years against the state's multi-faceted climate risks;
- Oregon's 2020 [Natural Hazard Mitigation Plan](#) included, for the first time, a chapter on extreme heat which made the state [eligible for Federal Emergency Management Agency funding](#) for mitigation actions that reduce identified risks; and
- Both California and Oregon are state recipients of the [Climate-Ready States and Cities Initiative grants](#) issued by the U.S. Centers for Disease Control and Prevention that financially support states that are most vulnerable to the health effects of climate change in developing and implementing adaptation plans, and addressing gaps in public-health functions and services.

Canada's [Climate Change and Health Adaptation Capacity Building Contribution Program](#) has funded 10 projects at \$300,000 each to support the increase of climate resilience of the health system, and the Ontario

government launched a \$1 million “Build Back Better” pilot project in 2018 that provided municipalities with Disaster Recovery Assistance funding up to 15% above the estimated re-building cost to make it more resilient to extreme weather. Lastly, we found that the Government of Canada announced in 2021 that \$1.65 million in federal funding will be allocated to the launch and operation of a new regional hub for climate services (CLIMATlantic) in New Brunswick, that will provide regional and authoritative climate information, data, tools, and training to the four Atlantic provinces.

Table 1: Overview of approaches to adapt health systems to climate change from relevant research evidence (categorized by the building blocks of WHO's operational framework for building climate resilient health systems)

WHO operational framework for building climate resilient health systems	Key findings on approaches to adapt health systems to climate change
Leadership and governance	• A recent low-quality systematic review evaluated disaster-resilience measurement methods and indicators and found that the most frequently recommended adaptation strategies include: 1) empowering local governments and leaders to carry out adaptation planning; 2) raising community awareness through education about disaster preparedness; and 3) enhancing community infrastructure and communication (e.g., recruiting community champions to explain strategies in the local context, increasing effective communication between governments and communities) (AMSTAR rating 3/9; Published October 2018)(7) • A recent low-quality systematic review analyzed community resilience and disaster recovery where the authors reported that attention should be given to developing community partnerships, systems leaders, and decision-makers to ensure that multiple levels of community resilience processes and outcomes are taken into account (AMSTAR rating 1/9; Published 6 September 2019)(8) • A recent literature review, policy and institutional analyses, and a series of cases by the Monash Sustainable Development Institute identified limited information available on policy and regulatory support for adapting Australia's healthcare systems to respond to climate change, resulting in the authors concluding with seven recommendations: ○ The implementation and funding of a coordinated national strategy on climate change and health (e.g., fostering collaboration across different sectors, community engagement, and use of systems thinking approaches) ○ The commitment to delivering net zero healthcare (e.g., developing plans based on existing frameworks from NHS and WHO) ○ Investment in climate health vulnerability and capacity assessments with a focus on locally led planning (e.g., conducting vulnerability and capacity assessments, and embedding these into healthcare system management, accreditation standards and performance measures) ○ The establishment of research funding for climate health resilience (e.g., implementing and evaluating climate health interventions, knowledge translation) ○ The development of climate health capacity in the healthcare workforce and the wider health system (e.g., training professionals, integrating education into existing training degrees and continuing education) ○ The embedment of Aboriginal and Torres Strait Islander knowledge and leadership (e.g., supporting culturally safe and holistic community-led approaches) ○ The investment in prevention and early intervention (e.g., developing population-level measures to support health-systems resilience, reducing financial and environmental costs and wastes) (Published 2021)(9) • A primary study focusing on Australia's preparation for climate change described the range of its national plans for disaster preparedness such as the Australian Government Disaster Response Plan, National Response Plan for Mass Burn Casualty Incidents, Australian Medical Assistance Teams, and Domestic Response Plan for Mass Casualty Incidents of

	National Consequence, and established committees such as the Australian Health Protection Committee and the Health All-Hazards Working Group (which involves the Disaster Preparedness and Management Unit) (Published 29 March 2011)(10) • A primary study interviewed systems leaders from the federal and regional governments within Canada and Germany to understand the process to adapt public-health systems to respond to climate change and the authors concluded that institutional learning at multiple levels is key to increasing adaptive capacity ○ The authors indicated that the adaptive management framework may be potentially useful as it highlights key areas of focus such as developing and disseminating usable knowledge, collaborating and coordinating for shared knowledge, claim leadership, and build financial capacity (Published January 2019)(11) • A study by the Lancet Commission on health and climate change policies concluded with key recommendations for governments such as investing in climate change and public-health research, monitoring and surveillance, scaling up financing for climate-resilient health systems, and adopting mechanisms to facilitate collaboration between ministries of health and other government departments, organizations (Published 15 June 2015)(12) • A primary study that examined the perceptions of systems leaders in Canada on climate change described that while climate change was not seen as a current priority by health leaders, governments should be actively involved in engaging with health-system leaders and cities to foster inter-sectoral and multi-level efforts (Published 23 April 2018)(13) • A primary study that reviewed vulnerabilities of the Indigenous health systems in Canada concluded that existing determinants are at risk for increased sensitivity and constrained adaptive capacity with climate change (e.g., increased poverty, limited surveillance and early warning capacity, lack of comprehensive and culturally relevant health measures, inefficient access to healthcare, inequalities, jurisdictional challenges). ○ Among the set of recommendations, the authors emphasized that partnerships with Indigenous peoples and organizations are important to identify health needs, generate knowledge, prioritize adaptations, and improve health systems. (Published October 2010)(26)
Health workforce	• A recent low-quality systematic review about Australia's adaptations to climate change described the need for capacity building of mental health in rural areas (e.g., training for mental health and social workers, the development of a mental health support telephone line) (AMSTAR rating 3/11; Published 14 September 2018)(22) • An older literature review focused on the potential role of nurses during wildfire disasters and found that they could play a role in the mitigation phase of disasters (e.g., analyzing hospital disaster plans, supporting community members, providing education) (Published December 2016)(23) • A primary study examined climate change and the physician specialty workforce, with the authors recommending that climate change should be included as a topic in existing medical education programs (Published 19 May 2021)(24)
Health information systems (e.g., vulnerability; capacity; adaptation assessment; integrated risk monitoring and early	• A recent low-quality systematic review analyzed community resilience and disaster recovery where the authors reported that the use of "big data" from social media datasets was an emerging measurement of community disaster resilience (AMSTAR rating 1/9; Published 6 September 2019)(8) • A recent scoping review identified tools and methods for integrating health into climate change mitigation and adaptation policies, including:

warning; health and climate research)	○ Nested models (includes multiple models that account for mitigation scenarios, modifications in GHG emissions, atmospheric pollutant concentrations, and health-effects assessments) ○ Impact-assessment tools (e.g., health-impact assessments, comparative-risk assessments, integrated environmental health-impact assessments, climate change assessments) ○ Adaptation tools (e.g., Vulnerability and Adaptation assessment, Health National Adaptation Process, economic assessment tool) (Published 4 March 2021)(14) • A literature review described the use of a five-step vulnerability and adaptation assessment, which promotes the development of partnerships and helps garner information to address climate change-related risks (e.g., frame and scope, conduct, understanding health impacts, adapt to climate change by prioritizing and implementing health protection measures, establish a process for managing and monitoring health risk) (Published 23 November 2018)(15) • The authors of a literature review on integrating climate change adaptation into public-health practice recommended the development of a centralized tool repository in addition to strengthening capacity building to understanding the impact of climate change on public-health systems (Published 12 February 2012)(16) • A primary study described the characteristics of heatwave early-warning systems (HEWS) in European countries and found that the main features include timely and accurate heat warnings, tailored communications about warnings and adaptation actions for the most vulnerable populations, and heat avoidance advice to the general population (Published 12 December 2011)(17) • A primary study described the detailed methods and guidance for conducting climate and health stress tests, with the authors explaining that these types of tests provide health authorities with the opportunity to examine the climate resilience of specific components of health systems (e.g., health facilities, specific organizations or departments), or interacting components (e.g., health facilities, integrated disease surveillance and warning, pharmacies, community care, health insurance services) (Published 2018)(18) • The authors of a primary study developed a set of indicators to guide and monitor climate change adaptation in U.S. state and local health departments in the Pacific Northwest, which included: 1) monitor climate-related health threats; 2) diagnose and investigate climate-related health threats; 3) inform, educate, and empower regarding climate-related health outcomes; 4) mobilize community partnerships regarding the response to extreme weather and climate events; 5) develop policies on weather and climate preparedness and climate change response; 6) enforce laws relevant to climate change response efforts; 7) link to/provide healthcare for climate-related health outcomes; 8) ensure competent workforce; 9) evaluate climate change preparedness and response efforts; and 10) research (Published February 2020)(19)
Essential medical products and technologies (e.g., climate resilient and sustainable technologies and infrastructure)	• A primary study described that there are limited examples on the use of eHealth as adaptation strategies, but highlighted that telemedicine, point-of-care diagnostics, and mobile devices could be beneficial when there is damaged infrastructure, in low-resource settings, and in remote settings (Published 5 June 2012)(25)
Service delivery (e.g., management of environmental determinants of health; climate-	• A recent narrative review examined the mental health impacts of global climate change and recommended stepped-care approaches (e.g., evidence-based treatments based on timing and distress level of the disaster, fostering community resilience) and task-shifting (e.g., delivery of mental health services to non-specialists such as community health workers

informed health programs; emergency preparedness and management)	and spiritual leaders) as strategies for delivering mental health services in response to climate change (Published 18 November 2020)(20) • A <u>primary study that focused on Ontario public officials' perceptions on climate change</u> found that climate change is not a stand-alone issue, but rather managed through provincial mandated programs such as those that address extreme temperatures and air quality, vector-borne diseases, water, public-health emergency management, and some that are explicit climate change adaptation initiatives or plans implemented in the health department ○ Respondents indicated that adaptation efforts rely on local political will and federal support, multi-disciplinary partnerships, and local leaders that can act as enablers to provide support and legitimacy for climate change adaptation. ○ To prioritize developments needed for adaptation, public-health respondents suggested top-down support by provincial and federal governments. In addition, they noted that adaptation constraints include limited resources (short-term funding, human resources, lack of data), perceived lack of urgency, and communication barriers) (Published 19 June 2012)(21) • A <u>recent scoping review identified tools and methods for integrating health into climate change mitigation and adaptation policies</u>, including: ○ Nested models (includes multiple models that account for mitigation scenarios, modifications in GHG emissions, atmospheric pollutant concentrations, and health-effects assessments) ○ Impact-assessment tools (e.g., health-impact assessments, comparative-risk assessments, integrated environmental health-impact assessments, climate change assessments) ○ Adaptation tools (e.g., Vulnerability and Adaptation assessment, Health National Adaptation Process, economic assessment tool) (Published 4 March 2021)(14) • The <u>authors of a primary study developed a set of indicators to guide and monitor climate change adaptation in U.S. state and local health departments</u> in the Pacific Northwest, which included: 1) monitor climate-related health threats; 2) diagnose and investigate climate-related health threats; 3) inform, educate, and empower regarding climate-related health outcomes; 4) mobilize community partnerships regarding the response to extreme weather and climate events; 5) develop policies on weather and climate preparedness and climate change response; 6) enforce laws relevant to climate change response efforts; 7) link to/provide healthcare for climate-related health outcomes; 8) ensure competent workforce; 9) evaluate climate change preparedness and response efforts; and 10) research (Published February 2020)(19)
Financing (e.g., climate and health financing)	<i>None identified</i>

Table 2: Approaches to adapt health systems to climate change from other countries

Country	Description of approaches to adapt health systems to climate change
Australia	Leadership and governance • The Australian government has not integrated health into any of its climate change policies

	○ Prior to COP26, the Global Climate and Health Alliance gave Australia a score of 0/15 when compared to other countries based on its lack of climate policies that address health impacts, health in adaptation measures, health co-benefits, economics and finance, and overall integration of health ● Australia's National Climate Resilience and Climate Adaptation Strategy recognizes that all levels of government have a role to play in climate change adaptation and puts the responsibility of health and well-being firmly in the hands of state, territory, and local governments: ○ One of the four pathways for adaptation of the Queensland government's Climate Adaptation Plan is Sectors and Systems, which emphasizes the need to address the specific adaptation needs of major economic sectors and critical systems that provide essential services, including health facilities ○ Victoria just completed consultation for its Health and Human Services Adaptation Action Plan 2022-2026, which outlines the health and human services system's scope, governance, risks and opportunities, and also proposes goals for the short-, medium-, and long-term to address the impacts of climate change ○ In Western Australia, implementation of 10 recommendations for responding to the health impacts of climate change from a Climate Health Inquiry Report in 2020 has yet to commence, but recommendations related to health-system adaptation include strengthening adaptation in specific extreme weather events, establishing early warning systems across environment and health, creating a new governance structure for mitigation and adaptation, and raising public awareness of climate-related health risks and co-benefits through consultation and partnerships ● The National Strategy, however, does not specifically address health-system adaptation Health workforce ● <i>None identified</i> Health information systems ● <i>None identified</i> Essential medical products and technologies ● <i>None identified</i> Service delivery ● <i>None identified</i> Financing ● <i>None identified</i>
New Zealand	Leadership and governance ● The New Zealand Government uses a Framework for Adapting to Climate Change that specifically focuses on climate change adaptation initiatives for the country, and the Ministry of Environment has developed a climate change risk assessment guide through consultation with a variety of local stakeholders that supports decision-making on adaptation with flexibility to adjust for local values ○ The framework identifies investments, actions and responsibilities being undertaken by the government to make New Zealand more climate resilient, but health systems were not a particular focus of the actions identified

	Health workforce • <i>None identified</i> Health information systems • <i>None identified</i> Essential medical products and technologies • New Zealand's Minister of Health explained at a press conference in June 2021 that the design of new hospitals in New Zealand will be guided by the requirements of the Carbon Neutral Government Programme for a green construction standard that considers low-carbon construction design and environmentally sustainable infrastructure ○ One such hospital is the New Dunedin Hospital that is being built in two phases to incorporate low-energy intelligent lighting systems, waste minimization practices, use of low-emissions transport by staff, and technologies that will make patient flow, diagnostics and treatment more efficient. ○ The New East wing of the Taranaki Base Hospital will also be built for climate change adaptation and resilience by using rooftop solar panels to generate energy, constructing an energy centre providing 72-hour backup power, and designing the wing's roof to withstand ashfall from any future volcanic event • Seven critical actions are being taken across healthcare infrastructure projects, one of which includes recommending that all new large-scale health infrastructure projects have the New Zealand Green Building Council Green Start Accreditation ○ Green Star is Australia's largest voluntary sustainability rating system that is available for every commercial building type, including schools, office buildings, and hospitals, and has been adapted for New Zealand ○ A Green Star accredited building has proven that it meets best practice sustainable design and build benchmarks Service delivery • <i>None identified</i> Financing • According to New Zealand's Minister of Health, the Ministry is developing a prioritization framework for investment proposals to support environmentally sustainable construction of new infrastructure and to ensure that the process for investments is transparent and fair • The New Zealand Government's Budget 2021 will provide \$67.4 million to support the country's transition to a carbon-neutral public sector by the year 2025 ○ This includes funding for the State Sector Decarbonisation Fund which will support the replacement of coal boilers with clean alternatives in hospitals
United Kingdom – Northern Ireland	Leadership and governance

	• The U.K. government recently stated that all U.K. health services, including NHS Ireland, have committed to become net zero and build climate resilience through the COP26 health program ◦ NHS Northern Ireland will be developing a sustainable and low-carbon health system, produce an assessment of GHG emissions and action plan for the health and social-care system, influence supply chains to reduce carbon emissions in supplying health and social care, and develop a continual program to assess the health system's vulnerability to climate change and identify adaptations for resilience • Under the United Kingdom's 2008 Climate Change Act, the U.K. is required to publish a country-wide climate change risk assessment every five years, and the act stipulates reports must be prepared and be submitted to the U.K. Parliament by the U.K. Government and the administration of Northern Ireland, Scotland, and Wales • The Northern Ireland government prepared an Adaptation Programme to respond to the climate change risks and opportunities for Northern Ireland as identified in the U.K. Climate Change Risk Assessment • Northern Ireland's second Climate Change Adaptation Programme was published in September 2019 and it covers the period 2019-2024, and sets the policies, strategies, and delivery-plan actions by which Northern Ireland Civil Service departments will deliver outcome objectives • The Adaptation Programme outlines a roadmap for a resilient Northern Ireland system and departments, with the following five objectives: 1) fulfil statutory duties; 2) work in partnership across government and with relevant stakeholders to strengthen and develop policy; 3) raise awareness of climate change risks and effects; 4) promote and support the advancement of scientific evidence; and 5) engage with other administrations • The Adaptation Programme has been taken forward by the Cross-Departmental Working Group on Climate Change, chaired by the Minister of the Environment, and requires annual reporting to the Northern Ireland Executive on the progress of implementing the action plans • Climate Northern Ireland, an intersectoral network funded by the Northern Ireland's Department of Agriculture, Environment and Rural Affairs, is comprised of organizations from across central and local government, the business community, academic community, and the voluntary sector, and acts as a primary point of contact • Climate Northern Ireland works to promote action to address climate change across all sectors of society through four areas of work: ◦ policy development, including supporting dissemination of the Climate Change Risk Assessment and identifying research in areas with evidence gaps ◦ secretariat for steering group, including creating sectoral steering-group forums ◦ increased adaptation and mitigation awareness, including bringing together organizations interested in delivering mitigation support ◦ increased adaptation and mitigation action, including developing tools, methods, advice and guidance to enable stakeholders to undertake adaptation and mitigation action Health workforce • <i>None identified</i>
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	Health information systems • <i>None identified</i> Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • <i>None identified</i>
United Kingdom – Scotland	Leadership and governance • NHS Scotland aims to be a net-zero greenhouse gas emissions health service by 2040 or earlier, and released a draft Climate Emergency and Sustainability 2022-2026 plan that is open for public consultation ○ The plan focuses on sustainable buildings and land, travel, goods and services, care, and communities ○ The plan involves 22 Health Boards to establish a sustainable clinical-care planning team with a larger Climate Emergency Response Team that includes individuals from service management and planning, clinical, public health, resilience and business continuity, transport and procurement ○ Each Health Board is responsible for appointing a Climate Emergency and Sustainability Champion from the board members, appoint an executive lead, establish strong governance structure, foster a culture of stewardship, ensure health professionals complete online training modules about climate emergency ○ NHS Scotland will establish an NHS Scotland Sustainability Network to provide opportunities for peer mentoring and support ○ The plan includes available data on energy consumption and where data or measures are missing • Under the United Kingdom's 2008 Climate Change Act, the U.K. is required to publish a U.K.-wide climate change risk assessment every five years, and the Act stipulates reports must be prepared and be submitted to the U.K. Parliament by the U.K. government and the administration of Northern Ireland, Scotland, and Wales • Scotland's Climate Change Act 2009 requires the preparation of strategic programs for climate change adaptation to be put in practice after each round of the Climate Change Committee (CCC)'s U.K. Climate Change Risk Assessment • In addition, the Act requires annual reporting to the Scottish Parliament on progress of delivering these strategic programs, and for the CCC's Adaptation Committee to prepare two reports within the lifetime of each program setting out its independent assessment of the progress made towards its objectives and goals ○ The most recent report published in May 2021 used an outcomes-based approach derived from the United Nation's Sustainable Development Goals to ensure that actions over the next five years increase the capacity of Scotland's people, communities, businesses, and public sector to adapt to climate change • The second edition of the Scottish Climate Change Adaptation Programme was launched in September 2019 by the Scottish Government and outlines how Scotland is preparing for the impacts of climate change over the period to 2024, and it responds to the climate change risks set out in the CCC's U.K. Climate Change Risk Assessment

	○ The program takes an outcomes-based approach to integrating adaptation into the Scottish Government’s policy-development process and service delivery, and describes seven outcomes, each with their own building blocks ○ One of the outcomes focuses on enhancing the resilience of society’s supporting systems, including health and emergency services, to climate change ● A network of regional community climate action hubs was created to provide a more strategic, regional-focused approach to climate change action and adaptation ○ The network of regional hubs is spread across Scotland to effectively support communities in making the transition to low-carbon and climate-resilient living Health workforce ● <i>None identified</i> Health information systems ● <i>None identified</i> Essential medical products and technologies ● <i>None identified</i> Service delivery ● <i>None identified</i> Financing ● The Scottish Government has provided funding for Adaptation Scotland, a program that provides practical advice and support for organizations, businesses, and communities on adapting to climate change
United States – California	Leadership and governance ● The California Department of Public Health’s Climate Change and Health Equity Section (CCHES) embeds health and equity in California climate change planning and works with local, state, and national partners to assure that climate change mitigation and adaptation activities have beneficial effects on health while not exacerbating already existing unfair and preventable differences in health status of some groups (health inequities) ○ CCHES implements California’s climate change laws and executive orders, contributing health-equity considerations ● California’s Climate Adaptation Strategy specifically recognizes the impacts of climate change on public health and details over 1,000 ongoing actions and 76 policy recommendations being undertaken by the California Department of Public Health (CDPH), the California Environmental Protection Agency (CalEPA), and other state agencies to improve public-health preparedness and emergency response ○ The CDPH, in collaboration with the Governor’s Office of Planning and Research and Strategic Growth Council, provide technical assistance and monitoring of progress by state agencies toward protecting climate-vulnerable communities while accounting for climate change in all infrastructure and investment plans as required by Executive Order B-30-15

	○ CDPH also engages with communities facing disproportionate impacts of climate change, and provides input to state grant and program guidelines on suggested best practices for robust engagement of communities in climate change policy decisions related to the Executive Order B-30-15 and the Adaptation Planning Grant created by Senate Bill 1 ○ Next steps outlined in the strategy include ensuring warning tools are multilingual and easily accessible to all communities, providing support for adaptation planning at the local level, ensuring agencies have resources available for mental health supports following emergencies, and ensuring that vulnerable populations can access cooling centres or similar resources when needed Health workforce ● California Department of Public Health's (CDPH) Emergency Preparedness Office coordinates Public Health Emergency Preparedness Training Workshops for counties, local healthcare facilities, and state entities Health information systems ● The CalBRACE project provides resources and technical assistance for the state and local public-health departments to build climate adaptation capacity and enhance resilience at the local and regional levels ○ The goals of the CalBRACE project are to enhance the California Department of Public Health's (CDPH) capability to plan for and reduce health risks associated with climate change ● The CalBRACE Project produced a climate change and health-vulnerability assessment framework that helped to identify where a person's or neighbourhood's susceptibilities to injury or disease exist due to their distance and sensitivity to climate-related environmental exposures or hazards ○ Adaptive capacity can offset the potential for injury and disease from exposure and sensitivity to hazards associated with climate change ● The CDPH Climate Change and Health Equity Section developed climate change and health indicators, narratives, and data to provide local health departments and partners with tools to better understand the people and places in their jurisdictions that are more susceptible to adverse health impacts associated with climate change, specifically extreme heat, wildfire, sea level rise, drought, and poor air quality ○ The assessment data can be used to screen and prioritize where to focus deeper analysis and plan for public-health actions to increase resilience ● CDPH will continue to conduct Community Assessments for Public Health Emergency Response (CASPER), a rapid community-needs assessment method developed by the Centers for Disease Control and Prevention (CDC) to assess local jurisdictions' preparedness for Zika, drought, wildfire, and earthquakes, as well as to assess health and mental health impacts after events ● CalEnviroScreen is a screening tool that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution ○ CalEnviroScreen maps indicators, including pesticide use, drinking water quality, and toxic exposures that will likely be exacerbated by higher temperatures associated with climate change
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	• CalEPA's Office of Environmental Health Hazard Assessment (OEHHA) conducts research on the health impacts of extreme heat, drought, air pollution, trace chemicals of landfill biogas, and wildfire • The Climate Change and Health Profile Reports are designed to help counties in California prepare for the health impacts related to climate change through adaptation planning Essential medical products and technologies • <i>None identified</i> Service delivery • The CDPH Licensing and Certification Program ensures the safety and continuity of care for patients/residents at the facilities it licenses during heat-related emergencies Financing • Governor Gavin Newsom signed a \$3.7 Billion Climate Resilience Package to build resilience in vulnerable front-line communities over three years against the state's multifaceted climate risks, including extreme heat and sea-level rise • The California Department of Public Health is the recipient of one of the 11 Climate-Ready States and Cities Initiative grants issued by the U.S. Centers for Disease Control and Prevention through their Climate and Health Program ○ The grant aims to support states that are most vulnerable to the health effects of climate change in developing and implementing adaptation plans and addressing gaps in public-health functions and services
United States – Oregon	Leadership and governance • The State of Oregon issued a 2021 State Agency Climate Change Adaptation Framework to plan for and respond to climate change impacts in a transformative, coordinated, and efficient manner that amplifies the impact and minimizes redundant effort ○ The Framework is divided into three parts – Guiding Principles, Administrative Framework, and Climate Change Adaptation Strategies – and includes six themes for adaptation approaches, one of which is Public Health • The Oregon Health Authority (OHA) has a five-year state health improvement plan (2020-2025), Healthier Together Oregon, that calls for addressing economic drivers of health, including elements related to housing and climate resilience • OHA is in the process of developing a new Environmental Public Health Modernization Plan and an updated State Health Improvement Plan, both of which prioritize integration of climate change, equity, and social justice into public-health programming and policy • OHA led an interagency Climate Equity Workgroup within the Climate Change Adaptation Framework (CCAF) planning project to develop a new Climate Equity Blueprint for guiding Oregon state agencies to use equity best practices in climate-adaptation planning and action, and contracted for climate equity consultants to provide training to participating CCAF agency staff Health workforce

	- The adaptation strategies under Theme 4 (Public Health) of the State Agency Climate Change Adaptation Framework calls for: - Increasing the diversity of the state’s workforce engaged in climate work to reflect the State of Oregon’s population, and to ensure effective climate adaptation - Supporting community-driven and place-based climate adaptations by providing technical assistance, resources, training, and tools for community partners Health information systems - The adaptation strategies under Theme 4 (Public Health) of the State Agency Climate Change Adaptation Framework states that the OHA will partner with the Oregon Occupational Safety and Health Administration to develop a proposal for standards to protect workers from exposure to wildfire smoke and excessive heat Essential medical products and technologies <i>None identified</i> Service delivery <i>None identified</i> Financing - Oregon’s 2020 Natural Hazard Mitigation Plan included, for the first time, a chapter on extreme heat which made the state eligible for Federal Emergency Management Agency funding for mitigation actions that reduce identified risks - OHA is the recipient of one of the 11 Climate-Ready States and Cities Initiative grants issued by the U.S. Centers for Disease Control and Prevention through their Climate and Health Program - The grant aims to support states that are most vulnerable to the health effects of climate change in developing and implementing adaptation plans and addressing gaps in public-health functions and services
United States – Washington	Leadership and governance <i>None identified</i> Health workforce <i>None identified</i> Health information systems - The Washington State Department of Health partnered with the University of Washington Climate Impacts Group to study what impact climate change will have on health, and climate change was recently added to the mandate of the state’s Office of Emergency Preparedness and Response - The Washington State Department of Health also developed a cumulative impact analysis (CIA) to designate communities highly affected by climate change and fossil-fuel pollution

	- The Washington Tracking Network focuses on making public-health data more accessible and tracks climate change projections and indicators related to wildfire occurrence and flooding risks Essential medical products and technologies <i>None identified</i> Service delivery - The Washington State Department of Health developed the Home Emergency Guide booklet in 2012 that described ways to prepare for and handle the health problems that arise during emergencies, especially those related to the loss of electricity, storing food safely, cooking and heating safely, getting safe drinking water, and avoiding disease Financing <i>None identified</i>
Sweden	Leadership and governance - The Swedish Climate Act requires the government to draw up a climate-policy action plan every four years that includes a description of policy development and implementation actions to ensure that it meets its emission reduction commitments and national targets - Sweden adopted a National Climate Change Adaptation Strategy in August 2018 that made changes to the Planning and Building Act to improve municipalities' preparedness for climate change - One of these changes was to require municipalities to provide an assessment of the risk of damage from climate-related flooding, landslides, and erosion to the built environment in their structure plans, and on how the risk can be reduced or eliminated - Several bodies have also been established by the Swedish government to support the national work on climate change, including the Swedish National Expert Council for Climate Adaptation that provides data to inform future strategies, and the Swedish National Knowledge Centre for Climate Change Adaptation that acts as a hub for knowledge about climate change - In 2015, a vulnerability assessment of climate change impacts in Sweden was conducted and several recommended actions from this assessment are being carried out - To improve adaptive capacity, plans are being made by national authorities and regional bodies to direct their work related to climate change - In the region of Stockholm, the Stockholm Regional Council defined environment sustainability goals for health and medical care in their Environment Programme 2017-2021, that specifies actions to reduce environmental impacts from pharmaceuticals, food, textiles and other goods Health workforce <i>None identified</i>

	Health information systems • <i>None identified</i> Essential medical products and technologies • In terms of pharmaceuticals, Stockholm Regional's Environment Programme contains indicators to reduce emissions of environmentally harmful substances and to manage the disposal of pharmaceuticals in a safer and more efficient way • The Environment Programme also describes indicators for reducing the emissions of anesthetic gases by 40% in 2021 compared to 2011, and reducing the proportion of disposable and reusable textiles in circulation in organizations for more than 30 days to less than 25% • The New Karolinska Solna project in Stockholm, first opened in November 2016, has been designed to halve its environmental impact by having 99.7% of its energy come from renewable energy with low CO2 emissions, using a combination of recycled energy from ventilation air, district heating, remote cooling, and a separate geothermal plant Service delivery • <i>None identified</i> Financing • Municipalities in Sweden can apply for funding for implementing preventive measures against landslides and other climate-related disasters
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Table 3: Approaches to adapt health systems to climate change from Canadian provinces and territories

Province/territory	Description of approaches to adapt health systems to climate change
Pan-Canadian	Leadership and governance • Health Canada is leading the development of the 2021 update to the Health of Canadians in a Changing Climate: Advancing our Knowledge for Action report, which will include health-sector adaptation, capacity and resilience approaches • The Government of Canada developed its 2020 climate action plan, <i>Canada's Climate Actions for a Healthy Environment and a Healthy Economy</i>, which describes some efforts to support First Nations and Inuit communities in managing health impacts of climate change, and establishing partnerships and stakeholders for the development of a national adaptation strategy

	- The Federal Adaptation Policy Framework for Climate Change indicates that the federal government aims to generate and share knowledge, build adaptive capacity, and integrate adaptation into federal policy and planning Health workforce - The Government of Canada established the Canadian Centre for Climate Services, which aims to build local capacity, offer training and support, and other services to provinces and territories - The Government of Canada has funded the development of the Climate Change Toolkit for Health Professionals that was produced and published by the Canadian Association of Physicians for the Environment (CAPE) in April 2019, to support health professionals and students in healthcare in advocating for climate change mitigation policies and programs in their workplaces and communities - The Toolkit provides education on the health impacts of climate globally and in Canada, as well as the actions that can be taken in healthcare facilities to mitigate and adapt to climate change Health information systems - The Government of Canada's 2008 report about Human Health in a Changing Climate describes an assessment approach to determine vulnerabilities and adaptive capacity - Assessment methods and tools include climate models and scenarios, expert judgment, epidemiological and ecological studies, literature review, and stakeholder consultation - Key assessment components include assessing health risks and vulnerabilities, assessing capacity of communities, identifying vulnerable populations and knowledge gaps, and conducting literature reviews - The Pan-Canadian Framework on Clean Growth and Climate Change indicates that the federal government will invest in surveillance and monitoring, risk assessments, modelling, and laboratory diagnostics related to diseases and illnesses driven by climate change Essential medical products and technologies <i>None identified</i> Service delivery <i>None identified</i> Financing - The Climate Change and Health Adaptation Capacity Building Contribution Program has funded 10 projects at \$300,000 each to support the increase of climate resilience of the health system (e.g., assess climate change vulnerability, establish adaptation plans and evaluation strategies)
British Columbia	Leadership and governance

	• We identified several documents addressing climate changes and Indigenous people and while none directly addressed health-system considerations, a report prepared for the Assembly of First Nations provides recommendations for action and another highlights First Nations leadership in addressing climate change • <i>None identified</i> Health workforce • <i>None identified</i> Health information systems • The climate vulnerability index measures how susceptible communities in the Vancouver Coastal Health and Fraser Health regions are to the health effects of extreme heat, wildfire smoke, flooding and air pollution • The B.C. Climate Action Secretariat (CAS) developed a framework for a strategic assessment of climate-related risks that can be used to prioritize adaptation responses ◦ This risk assessment enables the provincial government to compare climate risks with other risks, develop priority risks, and identify potential situations where response capacity may be exceeded • The B.C. Government has also developed a set of resources, tools and factors about climate change for provincial public-sector organizations • The Framework for Collaborative Action on Health & Climate Change supports users to better understand the connections between health and climate change and enable action to address these challenges ◦ It is a map of issues and resources to build climate change resilience and prevent the health impacts of climate change • The Health and Smoke Exposure (HASE) Coordination Committee was created to coordinate planning and response efforts related to public-health impacts of wildfire smoke events in B.C ◦ The BC Health and Smoke Exposure (HASE) Coordination Committee Guideline, prepared by the HASE Committee, assesses the risk of smoke conditions and will inform recommendations for health interventions during wildfire smoke events • The Lower Mainland Facilities Management (LMFM) and Vancouver Coastal Health (VCH) have set out guidelines to outline impacts of the climate on health facilities, as well as recommendations to build climate change resilience in new and existing health facilities Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • <i>None identified</i>
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Alberta	Leadership and governance • <i>None identified</i> Health workforce • <i>None identified</i> Health information systems • Alberta Health Services (AHS) has a webpage for Active Health Advisories, which may or may not include climate change-induced problems Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • <i>None identified</i>
Saskatchewan	Leadership and governance • <i>None identified</i> Health workforce • <i>None identified</i> Health information systems • The Hazard, Risk and Vulnerability Analysis (HRVA) tool aims to help a community make risk-based choices to address vulnerabilities, mitigate hazards, and prepare for response to and recovery from hazard-related events, and ensure the health and safety of the public • Saskatchewan's Climate Resilience 2021 Report outlined how the Water Security Agency (WSA) produces a spring runoff-potential map, showing areas that have received below normal precipitation, which are then evaluated for their capacity to meet projected water demand ○ This tool can help municipalities understand drought susceptibility and support planning for droughts and water shortages for communities Essential medical products and technologies • <i>None identified</i>

	Service delivery • <i>None identified</i> Financing • <i>None identified</i>
Manitoba	Leadership and governance • <i>None identified</i> Health workforce • <i>None identified</i> Health information systems • Manitoba's Hazard Risk Vulnerability Analysis Tool (HRVA) permits users to search for natural hazard information by specific geographic location, and contains links to disaster information related to flooding, wildfires, drought, and disease outbreaks to improve the health system's resiliency to climate change Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • <i>None identified</i>
Ontario	Leadership and governance • The Ontario Public Health Association, in collaboration with Ontario's public-health inspectors, released a report in 2017 titled "Climate Change and Public Health in Ontario" that described conclusions from a climate change public-health survey that revealed that some public-health units had collaborated with their municipalities to develop climate change mitigation plans, although the priorities of these plans were found to be inconsistent Health workforce • <i>None identified</i> Health information systems

	• In 2016, the previous Ontario government developed the Climate Change and Health Toolkit to meet the public-health challenges of climate change in the province ○ It has been designed to raise awareness about the health impacts of climate change, identify local vulnerabilities, and to support an adaptive, resilient public-health system that is responsive to the emerging risks and impacts of climate change ○ The toolkit includes guidelines to assess climate change and health vulnerability and adaptation, a workbook, and a modelling study of climate change and health. • The province launched its first multi-sector climate change impact assessment in 2020, including looking at health • Ontario Public Health Standards (OPHS) for Healthy Environments and Climate Change mandate the province's health units to assess vulnerability to climate change and health with stakeholders, with many requirements Essential medical products and technologies • <i>None identified</i> Service delivery • The previous Ontario government also developed the "Harmonized Heat Warning and Information System (HWIS) - Standard Operating Practice" aimed at reducing health vulnerability to heat and heat-related illnesses ○ The HWIS enables regional authorities (i.e., public-health units) to use consistent communication when notifying residents about heat events to better protect them and vulnerable populations Financing • The provincial government is working towards secured consultants for the Sarnia Area Environment Health Project to assess the risk of air pollution in this region • Since 2018, the province has launched a \$1 million "Build Back Better" pilot project that provided municipalities with Disaster Recovery Assistance funding up to 15% above the estimated rebuilding cost in order to make it more resilient to extreme weather
Quebec	Leadership and governance • In 2012, the Quebec government under Premier Jean Charest and Minister of Sustainable Development, Environment and Parks Pierre Arcand released "Québec in Action: Greener by 2020 – 2013-2020 Climate Change Action Plan (Phase 1)" with a subsection on maintaining individual and community health ○ This action plan aimed to implement adaptation measures to prevent and limit diseases, injuries, mortality, and psychosocial impacts (i.e., by implementing an air-quality policy) Health workforce • <i>None identified</i> Health information systems

	• The <i>Observatoire québécois de l'adaptation aux changements climatiques (OQACC)</i> (Quebec Observatory for Adaptations to Climate Change) is largely funded by the Quebec government and Université Laval, and it describes, explores, and disseminates knowledge regarding many themes in climate change adaptation in Quebec, including those related to major health issues (i.e., pollen allergies, Lyme disease) • The Quebec government offers advice to prevent environmental/climate change-induced illness Essential medical products and technologies • <i>None identified</i> Service delivery • The <i>Institut national de santé publique du Québec</i> (National Institute of Public Health of Quebec) a program named "Mon climat, mon santé" (My Climate, My Health) to help individuals better adapt to climate change by providing education, tips, and a regular bulletin related to climate change and health, and lets Quebec residents know how to get involved in other ways Financing • <i>None identified</i>
New Brunswick	Leadership and governance • The New Brunswick Government published a Climate Change Action Plan that highlights strategies the province is taking to reduce the impacts of climate change on public health, which includes: ○ developing a public-health communication strategy ○ supporting ongoing research on climate change risks ○ developing public-health surveillance tools following extreme weather events ○ continuing to implement an extreme Heat Alert and Response System (HARS) throughout the province • According to New Brunswick's Climate Change Action Plan progress report 2020, the government has made concerted efforts towards health systems adaptations ○ The government has established a committee of Cabinet dedicated solely to the issue of climate change (chaired by the Premier to oversee the implementation) ○ A <i>Climate Change Act</i> was passed in March 2020 as a commitment to address climate change mitigation and adaptations ○ The government has established partnerships with other departments and continues to build partnerships with municipalities to develop health surveillance tools for morbidity, mortality and mental health stress following extreme weather ○ The HealthADAPT project aims to build capacity at all levels (local, regional, provincial) to identify, adapt, and respond to the impacts of climate change on human health Health workforce • <i>None identified</i>

	Health information systems • The government of New Brunswick developed climate change indicators that includes information on climate, water and people to help New Brunswickers better understand how the climate is changing • A 2021 report by the Government of New Brunswick, Understanding Climate Change and Health Implications explores health vulnerability and adaptation assessment for the province, which provides key recommendations to continue this progress ○ Utilize the Health Canada Guide and the Ontario Climate Change Health Tool Kit to develop the New Brunswick model ○ Establish health indicators, vulnerability, and climate change indicators ○ Utilize bottom-up and top-down methods that reflects local realities ○ Develop public-engagement and communication strategies with key stakeholders ○ Establish pilot communities Essential medical products and technologies • <i>None identified</i> Service delivery • The New Brunswick government implemented a Heat Alert and Response System (HARS) throughout New Brunswick • Due to prior flooding, the Government of New Brunswick has invested in updating hospitals to minimize the risk of flooding Financing • A large amount of research work in New Brunswick is funded through the Environmental Trust Fund • The government of Canada announced in 2021 that \$1.65 million in federal funding will be dedicated to the launch and operation of a new regional hub for climate services (CLIMATlantic) in New Brunswick to serve the four Atlantic provinces ○ CLIMATlantic will provide regional and authoritative climate information, data, tools, and training
Nova Scotia	Leadership and governance • The government established the Climate Adaptation Leadership program, which supports government departments such as the Health and Wellness and industry partners to prepare for climate-related public-health and health-infrastructure risks Health workforce • <i>None identified</i> Health information systems • In 2018, the Department of Health and Wellness developed a Heat Alert and Response system to inform the public about extreme heat • The Nova Scotia Department of Environment, in collaboration with the Canadian Coalition for Green Health Care, has developed the Health Care Facility Climate Change Resiliency Toolkit that health facilities can use to assess their resiliency to climate change

	Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • The government of Canada announced in 2021 that \$1.65 million in federal funding will be dedicated to the launch and operation of a new regional hub for climate services (CLIMATlantic) in New Brunswick to serve the four Atlantic provinces ◦ CLIMATlantic will provide regional and authoritative climate information, data, tools and training
Prince Edward Island	Leadership and governance • <i>None identified</i> Health workforce • <i>None identified</i> Health information systems • The PEI Climate Change Risk Assessment is a tool to identify and better understand climate change risks, set priorities for adaptation planning, and inform decision-making • The PEI Climate Change Adaptation Recommendations Report outlines 97 climate change adaptation actions for 10 sectors, including public health and safety Essential medical products and technologies • <i>None identified</i> Service delivery • <i>None identified</i> Financing • <i>None identified</i>
Newfoundland and Labrador	Leadership and governance • The Government of Newfoundland and Labrador released The Way Forward on Climate Change in Newfoundland and Labrador, a collaborative, five-year action plan that includes 45 actions that the provincial government has committed to implementing to reduce greenhouse gas emissions, build resilience to the impacts of climate change, and support clean economic growth

	○ The action plan sets out to engage Indigenous communities for climate change adaptation through participation in initiatives such as the development of the federally led Arctic Policy Framework, Northern Adaptation Strategy, and the Northern Transportation Adaptation Initiative Program Health workforce • <i>None identified</i> Health information systems • <i>None identified</i> Essential medical products and technologies • <i>None identified</i> Service delivery • The Government of Newfoundland and Labrador developed the Turn Back the Tide Campaign which provides a range of documents intended for households, businesses or communities, that may serve as guidelines for addressing climate change-related concerns, such as building energy-efficient homes; greenhouse-gas management for small businesses; climate change projections for the province; understanding the risk and developing best practices for sustainable communities; assessing climate change vulnerability in your community; or managing municipal infrastructure in a changing climate. Financing • <i>None identified</i>
Yukon	Leadership and governance • Indigenous and Northern Affairs Canada (INAC) received funding through the 2016 federal budget to work collaboratively with northern partners to develop a Northern Adaptation Strategy and support climate change adaptation in northern Canada, including the Territorial Governments of Yukon, Northwest Territories and Nunavut ○ The Northern Adaptation Strategy is a formal, high-level plan that identifies priorities for action on adaptation and is endorsed by federal, territorial, and Indigenous partners Health workforce • <i>None identified</i> Health information systems • Environment Yukon's Climate Change Secretariat commissioned a report to provide the public and other stakeholders with an understanding of how climate change is affecting Yukon, what actions have been taken to date for adaptation, and the key challenges needed to be addressed for the future

	○ The report highlighted two critical adaptation programs that have served as drivers of territorial efforts to address climate change impacts: 1) Indigenous and Northern Affairs Canada's Climate Change Preparedness in the North Program supports identification and assessment of climate-related risks, adaptation research and planning, and efforts to address climate change issues, such as infrastructure, extreme weather events, and permafrost degradation; and 2) Health Canada's Climate Change Health Adaptation Program emphasizes a community-focused approach, projects that address climate change-related needs identified by the community, strengthening a community's adaptive capacity, and involving community members in the project's findings ○ The report identified 35 current projects financed through the Climate Change Preparedness in the North Program and 23 projects in the Yukon funded through Health Canada's Adaptation Program Essential medical products and technologies ● <i>None identified</i> Service delivery ● Transport Canada's Northern Transportation Adaptation Initiative Program incorporates development activities to maximize limited northern resources that seek to: ○ design, develop, and adopt innovative technologies, tools, and best practices ○ understand more about the impacts of climate change on the northern transportation system ○ make existing and future northern transportation infrastructure and operations more resilient and adaptable to climate change ○ encourage the development of northern expertise Financing ● Transport Canada's Northern Transportation Adaptation Initiative Program provides funding to help meet some of the challenges of climate change in Yukon, Northwest Territories, Nunavut, and communities in Nunavik and Nunatsiavut
Northwest Territories	Leadership and governance ● Indigenous and Northern Affairs Canada (INAC) received funding through the 2016 federal budget to work collaboratively with northern partners to develop a Northern Adaptation Strategy and support climate change adaptation in northern Canada, including the Territorial Governments of Yukon, Northwest Territories and Nunavut ○ The Northern Adaptation Strategy is a formal, high-level plan that identifies priorities for action on adaptation and is endorsed by federal, territorial, and Indigenous partners ● A 2017 report from the Auditor General of Canada to the Northwest Territories Legislative Assembly focused on whether the Northwest Territories Department of Environment and Natural Resources and the Department of Infrastructure took adequate steps to meet their commitments to reduce territorial greenhouse-gas emissions, and to adapt to climate change impacts in the Northwest Territories ○ The findings of the audit showed that the Department of Environment and Natural Resources did not fulfil its leadership role and meet its commitments on climate change

	○ The department did not identify the risks to the Northwest Territories posed by climate change, establish a climate change adaptation strategy, or provide departments and communities with easy access to the necessary information to address climate change impacts ○ The audit provided recommendations that the Department of Environment and Natural Resources agreed to take on to develop a strategic framework that will address both climate change mitigation and adaptation ● The Government of Northwest Territories published the 2030 NWT Climate Change Strategic Framework and 2030 NWT Climate Change Strategic Framework 2019-2023 Action Plan outlining the Government's comprehensive and coordinated response to climate change, with long-term approaches to developing a stronger economy, better understanding of climate change impacts, and improving the Territories' resilience and adaptation to climate change ○ The Action Plan has been developed by the Government of Northwest Territories in collaboration with various partners, including territorial and federal governments, Indigenous governments and/or organizations, and community organizations, and is the first of two five-year plans to address the goals laid out in the Framework ○ Among the goals in the Action Plan, the third goal of building resilience and adapting to climate change focuses on four overarching action areas: 1) supporting ecosystem viability and sustainability; 2) managing the natural environment and demands on it; 3) protecting and supporting people and communities; and 4) designing, building, and maintaining resilient infrastructure Health workforce ● <i>None identified</i> Health information systems ● <i>None identified</i> Essential medical products and technologies ● <i>None identified</i> Service delivery ● Transport Canada's Northern Transportation Adaptation Initiative Program incorporates development activities to maximize limited northern resources that seek to: ○ design, develop, and adopt innovative technologies, tools and best practices ○ understand more about the impacts of climate change on the northern transportation system ○ make existing and future northern transportation infrastructure and operations more resilient and adaptable to climate change ○ encourage the development of northern expertise Financing ● Transport Canada's Northern Transportation Adaptation Initiative Program provides funding to help meet some of the challenges of climate change in Yukon, Northwest Territories, Nunavut, and communities in Nunavik and Nunatsiavut
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Nunavut	Leadership and governance - Indigenous and Northern Affairs Canada (INAC) received funding through the 2016 federal budget to work collaboratively with northern partners to develop a Northern Adaptation Strategy and support climate change adaptation in northern Canada, including the Territorial Governments of Yukon, Northwest Territories and Nunavut - The Northern Adaptation Strategy is a formal, high-level plan that identifies priorities for action on adaptation and is endorsed by federal, territorial, and Indigenous partners. Health workforce <i>None identified</i> Health information systems <i>None identified</i> Essential medical products and technologies <i>None identified</i> Service delivery - Health Canada's renewed Climate Change and Health Adaptation Program (CCHAP) for the period of 2017-2022 took a new approach to program delivery in the North that builds on past results and consolidated knowledge gained from the previous CCHAP by established regionally based projects that reflect on key priorities identified by northern communities - Natural Resources Canada's Climate Change Geoscience Program covers three projects that support northern regions - Land-based infrastructure that focuses on regions with existing road and airport infrastructure, and is undertaking terrestrial terrain characterization, mapping and assessment of climate change susceptibility - Coastal infrastructure that conducts northern coastline characterization, mapping and assessment with focus on regions with existing and potential coastal infrastructure - Essential climate variables that monitors and assess key components of the climate system - Transport Canada's Northern Transportation Adaptation Initiative Program incorporates development activities to maximize limited northern resources that seek to: - design, develop, and adopt innovative technologies, tools, and best practices - understand more about the impacts of climate change on the northern transportation system - make existing and future northern transportation infrastructure and operations more resilient and adaptable to climate change - encourage the development of northern expertise Financing - Transport Canada's Northern Transportation Adaptation Initiative Program provides funding to help meet some of the challenges of climate change in Yukon, Northwest Territories, Nunavut, and communities in Nunavik and Nunatsiavut
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APPENDICES

The following tables provide detailed information about the systematic reviews and primary studies identified in the rapid synthesis. The ensuing information was extracted from the following sources:

- systematic reviews - the focus of the review, key findings, last year the literature was searched, and the proportion of studies conducted in Canada; and
- primary studies - the focus of the study, methods used, study sample, jurisdiction studied, key features of the intervention and the study findings (based on the outcomes reported in the study).

For the appendix table providing details about the systematic reviews, the fourth column presents a rating of the overall quality of each review. The quality of each review has been assessed using AMSTAR (A MeaSurement Tool to Assess Reviews), which rates overall quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. It is important to note that the AMSTAR tool was developed to assess reviews focused on clinical interventions, so not all criteria apply to systematic reviews pertaining to delivery, financial or governance arrangements within health systems. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, a review that scores 8/8 is generally of comparable quality to a review scoring 11/11; both ratings are considered “high scores.” A high score signals that readers of the review can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the review should be discarded, merely that less confidence can be placed in its findings and that the review needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7 (Suppl1):S8).

All of the information provided in the appendix tables was taken into account by the authors in describing the findings in the rapid synthesis.

Appendix 1: Summary of findings from systematic reviews and other types of reviews about approaches to adapt health systems to climate change

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
Systematic reviews	How is Australia adapting to climate change based on a systematic review? (22)	This systematic review focused on how climate change adaptation occurred in Australia. In terms of the health adaptations identified that responded to climate change, the review found that reported concrete actions to address the impacts of climate change on mental health included capacity building in rural areas in the form of training for mental health and social workers, and the development of a mental health support telephone line.	Published 14 September 2018	3/11 (AMSTAR rating from McMaster Health Forum)	0/390
	A synthesis of disaster-resilience measurement methods and indices (7)	This study evaluated past measures of disaster resilience by conducting a synthesis analysis based on a review of literature on disaster-resilience measurement published between 2005 and 2017. Indicators for evaluating disaster resilience were classified into seven categories (economic, social, institutional, community, infrastructure, environmental/ecological, and others) based on several existing resilience-measurement frameworks and indices. Education, income, employment, and previous disaster experience were identified as important indicators in resilience measurements. The most frequently recommended adaptation strategies identified from the analysis were empowering local governments and leaders to carry out adaptation planning, raising community awareness through education about disaster preparedness, and enhancing community infrastructure and communication. Encouraging community members to reserve personal savings for emergencies, recruiting community spokespersons to explain disaster risk-mitigation strategies in the local context, and increasing effective communication between governments and communities were also identified as additional adaptation strategies. The study concludes that in order to obtain a fulsome understanding of the resilience process, resilience measurement needs to be moved from static measurement to dynamic system modelling so that the underlying interactions between different components of the system can be captured.	Published October 2018	3/9 (AMSTAR rating from McMaster Health Forum)	8/174
	A review of the literature on community resilience and disaster recovery (8)	This literature review analysed how disaster professionals have been conceptualizing and applying community disaster-resilience mechanisms based on literature published in 2018. In terms of measurements for community resilience, the review found that assessing community recovery from disasters over time has been very challenging for academics and practitioners given the need to objectively measure resilience, how it has changed over time, and how investments in resilience creates value for the costs incurred.	Published 6 September 2019	1/9 (AMSTAR rating from McMaster Health Forum)	Not reported

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		One study evaluated for this review found that even when a disaster-recovery tracking tool with clearly defined resilience metrics was used to compare disaster case studies across Texas, U.S., the challenges and impediments faced in collecting the data needed to use the tool made the assessment difficult. It was suggested that a more flexible set of basic metrics combined with enhanced training for disaster-assessment practitioners would be more effective at enhancing community capacity for measuring recovery and resilience. The review also highlighted the use of “big data” from social media datasets as an emerging measurement of community disaster resilience. During the aftermath of Hurricane Sandy in 2012, researchers used data from Twitter to examine how individuals sought out help using the social media platform and to better understand geographic patterns of impact, resilience, and vulnerability. The review concluded that the practice of resilience requires authentic community partnerships between all stakeholders involved so that effective resilience and recovery programs can be developed. Given the complex relational feedback loops between individual decision-making, state actors, and system-level infrastructure and resources, attention should be given to multiple levels, scales, and temporalities of community-resilience effects and outcomes.			
Other types of reviews (e.g., scoping, integrative, narrative)	<u>Tools and methods to include health in climate change adaptation and mitigation strategies and policies: A scoping review</u> (14)	This scoping review aimed to identify and assess tools and methods for integrating health into climate change mitigation and adaptation policies. The tools and methods identified were classified into four categories – nested models, impact assessment tools, adaptation tools and conceptual frameworks. Nested models have been used to assess the effect of greenhouse gas (GHG) reduction policies and urban planning on health, and were found to be adaptable to varying scales of study. Nested models generally consist of different mitigation scenarios, a model that converts these scenarios into modifications in GHG emissions, a model that estimates the atmospheric pollutant concentrations from the emissions, and a health-effects assessment model. Impact-assessment tools described in the review included health impact assessments (HIA), comparative risk assessments (CRA), integrated environmental health impact assessments (IEHIA), and environmental assessments. HIAs can be used to evaluate the potential health impacts of climate change policies, CRAs can be used to inform decision-making about	Published 4 March 2021	Not applicable	2/35

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		climate change mitigation, and IEHIAs can help to assess the real-world health-related issues associated with changes in the environment. The two types of environmental assessments identified from the review, environmental impact assessments (EIA) and strategic environmental assessments (SEA), are used to assess the environmental impact of projects, and of policies, plans or programs, respectively. The review also described adaptation tools, including the Vulnerability and Adaptation (V&A) assessment, the Health National Adaptation Process (HNAP), and an economic assessment tool. The V&A assessment was developed as a tool to help decision-makers prioritize the health sector in their climate change adaptation efforts, while the HNAP is used to ensure that climate change health-risk management is integrated into the overall national adaptation plan of a country. The economic assessment tool was developed specifically for Member States of the European Region of the WHO to estimate health and adaptation costs of climate change. Lastly, three examples of conceptual frameworks were provided, all of which were used to link climate change and adaptation actions to health risks and impact. Other methodological approaches identified included the participatory approach and mixed methods, which combined several different analytical approaches. Nested models were identified most frequently in this review, followed by HIAs. Several of the identified tools have similar structures, such as the HIA, SEA, and EIA, which all aid in decision-making processes and attempt to integrate the perspectives of different stakeholders into the assessment process. Some tools could be used differently depending on the strategy for adaptation or mitigation to climate change. V&A assessments and HNAP, for example, are dedicated to adaptation contexts while nested models are almost exclusively used to assess mitigation strategies in prospective studies. Most of the studies included were mainly conducted in wealthier developed nations and regions, and no studies were conducted in Africa, the Middle East or South America where mortality risks due to climate change could be significant. The authors concluded that more research is needed to evaluate the effectiveness of the tools and methods identified, and to quantify the uncertainties associated with climate change projections and health-impact estimates.			

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
	Wildfire disasters and nursing (23)	The review focused on the variety of health effects from wildfires in California and the potential role that nurses may have in mitigating the harms of such disasters. The authors described how nurses should understand the disaster's implications to healthcare, including the disaster cycle (mitigation, preparedness, response, and recovery), and nursing's role in the cycle. Nurses can be involved in the mitigation phase of disasters by analyzing the practicality and effectiveness of hospital disaster plans such as developing healthcare sites to divert sub-acute patients from overwhelmed acute-care facilities. Nurses can also be better prepared for disasters by volunteering in organizations such as the Medical Reserve Corps or the American Red Cross. They can also help to educate clients about the health effects of wildfires as well as developing accommodations for people affected by poor air quality. Nurses must also understand the context of wildfires to appropriately care for civilians and responders, specifically in response measures such as evacuations. In the recovery phase of a disaster, nurses can support caregivers and community members, especially when disasters have taken a toll on a community emotionally and physically.	Published December 2016	Not applicable	Not reported
	Assessing health vulnerabilities and adaptation to climate change: A review of international progress (15)	The review described how vulnerability and adaptation (V&A) assessments are an important tool to establish partnerships and garner information to address climate change-related risks. The goal of V&A assessments is to support the implementation of adaptation and risk-management measures to increase resilience to climate change and reduce risks for the most vulnerable populations. The five steps for undertaking a V&A assessment are: 1) frame and scope the assessment; 2) conduct the vulnerability and adaptation assessment; 3) understand future impacts on health; 4) adapt to climate change by prioritizing and implementing health protection measures; and 5) establish a process for managing and monitoring the health risks of climate change. A key barrier to conducting V&A assessments includes providing information in a timeframe that is relevant for decision-making, that is, ensuring they identify both short-term and long-term adaptation options.	Published 23 November 2018	Not applicable	Not reported

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Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		Greater capacity building which facilitates assessments from local to national scales could support collaborative efforts to increase resilience to climate change.			
	<u>Towards improved linkage of disaster risk reduction and climate change adaptation in health: A review</u> (27)	The review described how building links between Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) is important to ensure a robust approach when dealing with climate disasters and their risks, and maximizing efficiency to reach common goals. Increasing the linkage between DRR and CCA necessitates collaboration on science and technology in risk assessment and acknowledges different agendas to negotiate collaborative ways forward. The focus of reducing risks should be on breaking cycles of vulnerability and adapting to changes in hazards and the populations. This linkage calls for greater collaboration between climate scientists, health researchers and policymakers on post-disaster surveillance and data collection. Practitioners and administrators, with their existing knowledge on approaches for DRR and CCA, play an important role in bridging the gap between them.	Published 18 April 2018	Not applicable	Not reported
	<u>Integrating climate change adaptation into public health practice: Using adaptive management to increase adaptive capacity and build resilience</u> (16)	The aim of this review was to explore possible explanations for the lack of work on adaptive capacity, outline climate–health challenges that may lie outside public health’s coping range, and consider changes in practice that could increase public health’s adaptive capacity. Authors conducted a substantive, interdisciplinary literature review focused on climate change adaptation in public health, social learning, and management of socio-economic systems exhibiting dynamic complexity. The review highlighted two competing views of how public health should engage climate change adaptation. Perspectives differ on whether climate change will primarily amplify existing hazards, requiring enhancement of existing public-health functions, or present categorically distinct threats requiring innovative management strategies. In some contexts, distinctly climate-sensitive health threats may overwhelm public health’s adaptive capacity. Addressing these threats will require increased emphasis on institutional learning, innovative management strategies, and new and	Published 12 February 2012	Not applicable	Not reported

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		improved tools. Adaptive management, an iterative framework that embraces uncertainty, uses modelling and integrates learning, may be a useful approach. The authors illustrate its application to extreme heat in an urban setting. The study concluded that increasing public-health capacity is crucial for certain climate–health threats. Focusing efforts to increase adaptive capacity in specific areas, promoting institutional learning, embracing adaptive management, and developing tools to facilitate these processes are important priorities and can improve the resilience of local public-health systems to climate change. The authors called for the development of a centralized tool repository along with an increased focus on learning, modelling, and adaptive management will help increase the resilience of local public-health systems.			
	Strategies for delivering mental health services in response to global climate change: A narrative review (20)	The review examined the mental health impacts from global climate change. The authors described how there are numerous studies that have linked acute and extreme weather events to an increase in mental health effects. A recommended strategy to deliver mental health services is a stepped-care approach to support different levels of interventions depending on the timing and distress level of the disaster. Selective strategies, which target disaster survivors who are at increased risk of developing a mental, emotional or behavioural disorder, focus on resilience building and psychosocial recovery. These approaches can be enhanced using evidence-based treatments administered by mental health professionals. Task-shifting delivery of mental health services to non-specialists such as community health workers, teachers, or spiritual leaders, has been effective in increasing access to and acceptability of services treating mental health disorders. It can also increase the autonomy and capacity of communities to deliver sustainable interventions. Service providers can also foster community resilience through implementing interventions in at-risk populations, such as a family skills-training program designed to reduce risk factors for behavioural, emotional and academic concerns in youth.	Published 18 November 2020	Not applicable	Not reported

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Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		This study outlines multiple interventions to mitigate distress after a natural disaster and increase resilience to the adverse effects of climate change.			
	Heat-health vulnerability in temperate climates: Lessons and response options from Ireland (28)	The review describes how heat poses both a public and occupational health challenge, with little coordinated effort placing vulnerable populations at risk. Heat-vulnerable populations include older people, the chronically ill, infants, pregnant women, children, outdoor workers, the socio-economically disadvantaged, and urban dwellers. Food systems and the health sector are also heat-vulnerable. There has been an increase in heat-related health searches over time in Ireland, demonstrating growing societal concern to temperature increases, reinforcing a gap in societal concern and national policy regarding heat-health challenges. Specific, actionable adaptation and mitigation strategies are recommended through a “health and climate change in all policies” approach and by developing a public health-focused heat-health action plan.	Published 30 March 2020	Not applicable	Not reported
	Preventing and mitigating health risks of climate change (29)	The review described how health systems urgently need to be improved alongside the implementation of mitigation and adaptation policies. Proposed adaptation policies include developing health/heat early-warning systems (HHEWS), explicitly considering the ‘heat island’ and ‘greenness’ effects in urban planning, accounting for increasing average and extreme temperatures in housing standards, community education programs regarding the health risks of heatwaves and protective measures, and the creation and enhancement of climate-resilient healthcare facilities.	Published 19 July 2019	Not applicable	Not reported
	Population health adaptation approaches to the increasing severity and frequency of weather-related disasters resulting from our changing climate: A literature review and application to Charleston, South Carolina (30)	Few studies have proposed quantitative disaster-epidemiology tools to aid public-health officials in the preparation and response against weather-related disaster events. The public-health community generally does not understand the available epidemiological tools to assist local communities in preparing for, responding to, and recovering from weather-related disasters. Cities across the U.S. are already working to assess their vulnerability and resilience to weather-related disasters through the inclusion of climate change in emergency preparedness plans, developing adaptation strategies, and	Published 5 December 2018	Not applicable	Not reported

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		equipping local hospitals and other public-health systems with climate information. More work and public-health funding is needed to support local and state-level efforts in weather-related disaster management in the context of climate change. American population-health disaster preparedness programs must be adapted to address the increasing risks resulting from climate change to local public health.			
	Heatwave early-warning systems and adaptation advice to reduce human health consequences of heatwaves (17)	The aim of this study was to identify the characteristics of heatwave early-warning systems (HEWS) in European countries in order to inform response plans and policies for reducing the human health consequences of heatwaves. HEWS policies and documents were searched for from 33 European countries, and 12 of these countries were found to have HEWS. The main features of a typical HEWS are timely and accurate heat warnings, tailored communications about warnings and adaptation actions for the most vulnerable populations, and heat avoidance advice to the general population. Indicators for triggering a heat warning that were identified in the study include maximum temperature, heat index, synoptic and other combinations of temperature, and persistence. Variability was found among HEWS in how thresholds were determined and what threshold would trigger action. There was little to no information identified by the study on when heatwave alerts should be downgraded, and one included article suggested that HEWS that trigger high alert levels only in the initial days of a heatwave do not sufficiently capture the greatest increases in mortality that occurs later on in the heatwave and results from the prolonged exposure to high temperatures. In terms of communication with populations about heat warnings and adaptation strategies, the study highlights that advice that is tailored to specific audiences tends to be received better than general advice. Information has been shared in different HEWS through multiple tailored-information brochures, plain-language advice, visual symbols and pictures, websites, media releases, Braille, and audio tape. HEWS documents also suggest a number of social-adaptation strategies, such as reaching out to at-risk individuals and having caregivers create contingency plans when they are unavailable, to counter the social risks during a heatwave. Providing public spaces that are air-conditioned	Literature last searched May 2011	Not applicable	Not reported

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Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		was found to be a preferred, more equitable adaptation strategy included in HEWS documents as opposed to recommending that individuals install air conditioners in their households. Actions related to healthcare provision that were found to be incorporated into HEWS were increasing or recalling staff to respond to heat-related emergencies, postponing non-emergency services, and increasing hospital beds and ambulances. Preventive strategies that were highlighted included construction of buildings to aid in passive cooling and protecting buildings from heating up, using renewable energy and energy-efficient equipment, and creating and preserving natural parks and green spaces. More research is needed to evaluate the actions that were actually taken during HEWS compared to those recommended and the impact of those actions.			
	<u>Climate change and adaptation of the health sector: The case of infectious diseases</u> (31)	The review examined health sector strategies and the involvement of other sectors such as meteorology, civil defense, and environmental sanitation. The review suggested a few approaches to adapting the health sector such as increasing social capital of communities, advancing epidemiological surveillance, and developing early warning systems.	Published 15 July 2015	Not applicable	Not reported
	<u>Constraints and barriers to public-health adaptation to climate change</u> (32)	This study outlined a variety of constraints and barriers to public-health adaptations to climate change. Uncertainties in climate projects and uncertainties of future demographic, socio-economic, and technologic conditions that will change the exposure, sensitivity and adaptive capacity of populations are challenges for public-health adaptation. Managing the health effects of climate change are costly, and often the countries that are most affected by climate change have the least amount of financial resources. This barrier will exacerbate existing health inequalities and social determinants of illness and premature death. Conditions for creating new technology to increase adaptivity to climate change requires access to expertise, knowledge and funding. Due to cost and skill limitations, it is also difficult to bring the internet to remote areas in developing countries.	Published February 2011	Not applicable	Not reported

Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		Current institutional and governmental arrangements are unlikely to ensure an effective adaptation strategy as fragmentation and policy contradictions are often a serious problem in all levels of government. There is no lead agency responsible for public-health adaptation. Strong social networks can also be a barrier as misconceptions by the elderly and their contacts about the health risks of climate disasters can prevent proactive adaptation. The authors concluded that an individual's own knowledge about climate change is insufficient for adaptation as many individuals are not aware of the impacts of climate change. Higher-income earners also perceive a lower risk from climate change as they have the means to deal with the threats.			
	Climate change and Australia's Healthcare systems: A review of literature, policy, and practice (9)	The authors conducted a systematic literature review, policy and institutional analyses, and a series of cases studies to understand and provide evidence-based recommendations for Australia policymakers, health systems, health professionals and for communities. The systematic literature review identified 17 reviews of health-system response to climate change, but there is limited information available on policy and regulatory support and implementation in policy and practice. The policy and institutional analysis identified that there is a lack of policy drivers and that there is a need for capacity building for health professionals related to climate change and health. The case study identified the severe impact of drought, bushfires, extreme heat, and other climate-related events on the health systems. The authors concluded with seven recommendations: 1) the implementation and funding of a coordinated national strategy on climate change and health (e.g., fostering collaboration across different sectors, community engagement, and use of systems-thinking approaches); 2) the commitment to delivering net zero healthcare (e.g., developing plans based on existing frameworks from NHS and WHO); 3) investment in climate health vulnerability and capacity assessments with a focus on locally led planning (e.g., conducting vulnerability and capacity assessments, and embedding these into healthcare system	Published 2021	Not applicable	Not applicable

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Type of review	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
		management, accreditation standards and performance measures); 4) the establishment of research funding for climate health resilience (e.g., implementing and evaluating climate health interventions, knowledge translation); 5) the development of climate-health capacity in the healthcare workforce and the wider health system (e.g., training professionals, integrating education into existing training degrees and continuing education); 6) the embedment of Aboriginal and Torres Strait Islander knowledge and leadership (e.g., supporting culturally safe and holistic community-led approaches); and 7) the investment in prevention and early intervention (e.g., developing population-level measures to support health-systems resilience, reducing financial and environmental costs and wastes).			

Appendix 2: Summary of findings from primary studies about approaches to adapt health systems to climate change

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
<u>Climate change adaptation in South Africa: A case study on the role of the health sector</u> (33)	<i>Publication date:</i> 19 March 2019 <i>Jurisdiction studied:</i> South Africa <i>Methods used:</i> Case study	Effective climate change adaptation will require certain features of the health system: 1) national and local-level policy frameworks and plans, supported by adequate resources; 2) long-term communication strategies, such as heat education campaigns; and 3) strength of data systems and surveillance, as heightened surveillance is required for climate change-related infectious diseases, together with efforts to systematically document the effectiveness of adaptation responses and to identify opportunities for improving services.	The included studies' data and characteristics were extracted and grouped on similar topics during analysis to highlight commonalities or differences.	The review identified few studies presenting findings of an intervention or used high-quality methodology. It appears that several policy frameworks for climate change have been developed at national and local government levels, however, there is little attention to health concerns and the specific needs of vulnerable groups, as only a few of the included studies (n=8) covered disaster preparedness and responses, including of the health systems and population groups, occupations, and housing types most vulnerable to heat exposure and disasters. The studies show that there are established systems for forecasting extreme weather and tracking infectious diseases such as malaria in South Africa, however, there is little evidence suggesting that the country is well prepared for extreme weather events or the already strained health system's preparedness for such events. In addition, the evidence suggests that health workers' training comprises minimal attention to climate change and its related health risks.
<u>An examination of the intersection of climate change, the physician specialty workforce, and graduate medical education in the U.S.</u> (24)	<i>Publication date:</i> 19 May 2021 <i>Jurisdiction studied:</i> United States <i>Methods used:</i> Descriptive	There is a current maldistribution of providers in the United States, in which rural and inner-city communities have insufficient numbers of providers when compared with urban or affluent areas, and there is a lack of a cohesive, comprehensive national plan to meet current and future physician workforce needs. The need for an increase in health workforce, particularly physicians, is influenced by numerous factors, including the size and distribution of patient and physician populations, physician retirement, burnout,	A descriptive study was conducted to explore the available literature on the intersection of future physician workforce needs, priorities of graduate medical education programs, and resident education within the larger context of climate change and its impacts.	Drawing from the findings of the descriptive study, the authors provided key steps for moving forward on an agenda that intersects climate change, health, impacts on physician-workforce needs, and graduate medical education program training and system. There is a need to align healthcare workforce and graduate medical education priorities to determine the appropriate number of training slots in key specialties that are affected by climate change. Climate change should be identified as a national priority for graduate medical education programs to ensure that a climate lens is incorporated into the existing curricula. Collaborations between community advocacy organizations, educational institutions, and healthcare

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
		relocation, and the regional maldistribution of providers. National policies promoting models of team-based delivery of healthcare have helped transform many healthcare organizations, however there should still be an alignment of graduate medical education and programs' priorities with the current workforce needs. Currently, the United States' medical education system for both undergraduate and graduate lacks a uniform governance model, making it difficult to set overall priorities for training. There should be a change in graduate medical education's governance and coordination between federal and state institutions, accreditation agencies, physician licensing boards, residency programs, and medical schools to examine the number of training slots needed within regions and states based on reflection of the regional context of climate-health impacts.		organizations should be supported and promoted, especially given the widespread impact of climate change on many facets of health, systems, and communities. The current Health Resources and Services Administration's National Health Service Corps Loan Repayment Program should be expanded with climate and health readiness to include regions of the U.S. expected to face shortages of key specialists and primary-care providers due to climate change. There should be increased opportunities for medical studies to be mentored by residents and faculty in climate-sensitive specialties experiencing physician shortages, such as infectious-diseases specialties. Climate and public health experts and leaders should be given the opportunity to provide feedback in physician-workforce modelling studies, in addition to soliciting feedback from clinicians and patients.
Preparing health services for climate change in Australia (10)	<i>Publication date:</i> 29 March 2011 <i>Jurisdiction studied:</i> Australia <i>Methods used:</i> Policy analysis	Australia has a range of national plans for disaster preparedness, such as the Australian Health Protection Committee which acts as the national health emergency management committee and carries authority to plan, prepare, and coordinate the national health response to emergencies and incidents. The Health All-	Not reported	This policy analysis aims to focus on the health-system responses to catastrophic and passive health risks resulting from climate change, and provides a discussion on how best to prepare Australian health services for climate change-related health risks, such as heat waves, fire risks, poor air quality, and infectious diseases. The authors outline three key principles to guide policy makers and planners in preparing the Australian health system for climate change: 1) flexibility; 2) strategic

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
		Hazards Working Group involves the Disaster Preparedness and Management Unit, and facilitates development of a series of responses. Australia's national response has plans for multiple significant events, including the Australian Government Disaster Response Plan, National Response Plan for Mass Burn Casualty Incidents, Australian Medical Assistance Teams, and Domestic Response Plan for Mass Casualty Incidents of National Consequence. These plans interact with each other and form the basis for many of the emergency health-service responses for climate-related events.		allocation of resources; and 3) robustness of health services. Health service responsiveness to climate changes requires flexibility to meet varying demands in type and scale of service. In addition, mobility of health services is critical in responding to disasters, such as rapid deployment of health-service response teams to affected regions of extreme weather events to provide emergency management and triage. Strategic allocation of resources should begin by building on existing services and resources, then identifying likely regional impacts and needs, followed by prioritization of vulnerable regions and populations. Health systems should be robust enough to cope with increased capacity for climate change-related emergencies and incidents. Thus, the robustness of health systems and services heavily depends on resilient infrastructure, consistent services, and a sustainable workforce.
Climate change adaptation in the reorganized U.K. public-health system: A view from local government (34)	<i>Publication date:</i> May 2016 <i>Jurisdiction studied:</i> United Kingdom <i>Methods used:</i> In-depth interviews	The 2013 reform of England's public-health system established Public Health England (PHE), which has nine local centres, responsible at the local level for health improvement, health care, public health, and health protection. The centres provide specialized guidance and support to local government, such as the Directors of Public Health (DPHs) at local authorities, and other local partners. In addition, PHE centres lead public-health emergency responses provide local health-protection services, develop and support local public works, and provide education	In-depth interviews were conducted with four directors of Public Health England centres and four with Directors of Public Health at Local Authorities. Four senior professionals in the public-health system whose role is directly related to climate change and adaptation were consulted.	The interview responses from public-health officers indicated that climate change is a risk to public health in England, there is a gap between national research and policy and local needs, and reframing adaptation is likely to advance the issue. Short-term climate change risks identified were predominantly extreme events, such as heatwaves and floods, with appropriate public-health measures. However, there was less clarity regarding long-term risks, and respondents found it difficult to define them. Public-health officers expressed that they are unaware of relevant national documents, such as the UK National Adaptation Plan (NAP), and that many national documents are too extensive and long to be used during busy times. Officers did not indicate that there was a need to prioritize further research regarding health impacts of

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Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
		and training. The DPHs are the statutory chief officers responsible for local authorities' duties to improve public health, alongside providing expert guidance to elected members and senior public-health officers, and any public-health functions delegated by the Secretary of State.		climate change. All respondents expressed that they did not see it as their role to lead adaptation policy, although are willing to implement national policy that is relevant to their local levels. Public-health officials identified several barriers to advancing public-health adaptation to climate change, including low-risk perceptions, lack of long-term clarity, lack of public and political will, short-term 4-5 years political cycle, and other public-health priorities.
Opportunities for action toward a sustainable health system (13)	<i>Publication date:</i> 1 October 2020 <i>Jurisdiction studied:</i> Canada and global <i>Methods used:</i> Commentary analysis	Not reported	Not reported	This commentary highlights considerations and needs that can be applied to prepare the Canadian and global health systems for climate change, in addition to supporting efforts to mitigate the population-health implications of climate change: 1) comprehensive supplies and equipment, such as adapting local and global medical supply chains to become more resilient; 2) appropriately trained staff and workforce, including training on emerging patterns of health and disease, advancing equity, and emergency preparedness and response; 3) resilient and appropriate physical infrastructure and robust digital infrastructure to enable virtual care; and 4) integrated policies and procedures that are responsive to evolving needs and challenges.
Stress testing the capacity of health systems to manage climate change-related shocks and stresses (18)	<i>Publication date:</i> 2018 <i>Jurisdiction studied:</i> Not reported <i>Methods used:</i> Not reported	Not reported	The three basic stages of a stress test are: 1) prepare the climate change and health stress test; 2) conduct the stress test; and 3) communicate the results to key stakeholders.	This study provides detailed methods and guidance for conducting climate and health stress tests, centering on three primary activities: 1) preparing and scoping the stress test; 2) successfully conducting the stress test; and 3) communicating the results to key stakeholders to facilitate policy and programmatic reforms. The study highlights that climate change and health stress tests build upon efforts already being taken to help adapt health systems to climate change, through exploring the extent to which each component of health systems is prepared to manage increases in climate-related shocks and stresses in the context of other challenges, which is a key

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				indicator of resilience. Like many of the projected risks of climate change, impacts to health systems will not be felt equally between or within countries. The importance of a stress test is that it requires minimal time and resources, making it a highly accessible technique to low-capacity health authorities in diverse regional contexts. Information and data provided by an increasing number of climate change and health-vulnerability assessments at national and sub-national levels will support robust stress-test studies. Since health systems differ drastically within and between countries, the scope and methods employed in stress-test studies will need to be tailored to suit the needs of decision-makers. Stress tests provide health authorities with the opportunity to examine the climate resilience of specific components of health systems (e.g., health facilities, specific organizations or departments) or interacting components (e.g., health facilities, integrated disease surveillance and warning, pharmacies, community care, health insurance services). For this reason, the tool can be used by decision-makers responsible for broad health-system functions (e.g., a national ministry of health) or specific components (e.g., a health facility). Health authorities conducting stress tests will benefit through sharing of information about experiences in conducting workshops of different scope, in different jurisdictions, and with different partners. Stress testing utilizes tools familiar to key stakeholders that facilitate vulnerability assessments and, similar to methods employed by public-health officials, risk-assessors, emergency managers, and decision-makers. In many regions, scenario-based emergency-management exercises are mandatory components of all-hazard risk planning. Introducing or augmenting existing activities with climate stress testing would add value to these efforts, and would enhance preparedness planning for a climactically different and potentially more dangerous future. Stress testing should be part of efforts to identify evolving hazards to

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Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				health systems, and to identify and address weak components, feeding into ongoing all-hazards planning.
Enabling local public-health adaptation to climate change (11)	<i>Publication date:</i> 2019 <i>Jurisdiction studied:</i> Canada, Germany <i>Methods used</i> Qualitative	Thirty interviewees were selected through a combination of purposeful sampling (i.e., individuals working on adaptation and/or health in the given jurisdiction) and snowball sampling.	Thirty semi-structured interviews were conducted with federal, regional and municipal governments, and local public-health authorities, from the health and environment sectors in each of the sampled jurisdictions. Interviews with non-governmental key informants were also conducted.	This study aims to examine how federal and regional governments can contribute to enabling and supporting public-health adaptation to climate change at the local level in federal systems. Based on interviewees' recommendations and complemented by scientific literature, authors develop a set of practical measures that could enable or support local-level public-health adaptation. The study finds that adaptive capacity varies widely between local public-health authorities, but most report having insufficient funding and staff for adaptation activities. Findings of the study suggest that management of these threats is likely to require innovative strategies acknowledging that the systems protecting public health have limited resources and are dynamic, incompletely understood, and subject to multiple stakeholders. Institutional learning at multiple levels is key to increasing adaptive capacity, and adaptive management is a potentially useful framework. Authors propose 10 specific measures that upper-level governments can take to build local public-health authorities' capacity for adaptation, under the interrelated target areas of: building financial capital; developing and disseminating usable knowledge; collaborating and coordinating for shared knowledge; and claiming leadership. Federal and regional governments have an important role to play in enabling local-level public-health adaptation, and have many instruments available to them to fulfil that role. Selecting and implementing measures to enable local public-health authorities' adaptive capacity will require tailoring to, and consideration of the local context, and needs.
Climate change and human health--what influences the adoption of	<i>Publication date:</i> 2011 <i>Jurisdiction studied:</i>	225 Environmental Health Directors who are responsible for planning climate-related health impacts through	The study describes key factors that may affect the uptake of climate change-related health initiatives and	The study surveyed 225 environmental health directors in the United States and found that individual-level attitudes and beliefs and organizational-level barriers influence the adoption of climate change adaptation programs in public-

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Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
<u>adaptation programming in the United States public-health system?</u> (35)	United States <i>Methods used:</i> Survey	programmatic activities within their department	behaviour, primarily focusing on individual and organizational factors such as environmental attitude, political views, gender, risk perception	health agencies. The environmental health directors suggested that local public-health agencies should highlight the potential impacts of climate change on the health system in order to increase adoption.
<u>Indicators to guide and monitor climate change adaptation in the US Pacific Northwest</u> (19)	<i>Publication date:</i> 2020 <i>Jurisdiction studied:</i> Pacific Northwest, United States <i>Methods used:</i> Descriptive	17 health department officials in the Pacific Northwest	The study's goal was to develop a set of indicators to guide and monitor climate change adaptation in U.S. state and local health departments The 10 indicators and relevant activities are: 1) monitor climate-related health threats; 2) diagnose and investigate climate-related health threats; 3) inform, educate, and empower regarding climate-related health outcomes; 4) mobilize community partnerships regarding the response to extreme weather and climate events; 5) develop policies on weather and climate preparedness and climate change response; 6) enforce laws relevant to climate change response efforts; 7) link to/provide healthcare for climate-related health outcomes; 8) ensure competent workforce; 9) evaluate climate change preparedness and response efforts; and 10) research	The authors utilized the Ten Essential Services (TES) of Public Health as the framework to build and organize indicators of climate change adaptation activity given that it is a simple and familiar tool to many state and local health agencies. A narrative literature review was conducted to determine existing indicators used by state and local health departments. To understand the relevance and utility of the identified indicators, the authors conducted 11 key informant interviews based on a sample set of 17 state and local health departments. The key informants highlighted that specific indicators should be allocated to local health departments, while the full set of indicators should be the responsibility of larger organizations with full capacity. The key informants raised factors that need to be considered in addition to the indicators such as collaboration and partnerships, communications, equity, resources, capacity and authority, use of existing emergency preparedness and response capacity, and training. The lack of clarity regarding the role of public health was a challenge to receiving adequate resources and capacity allocation. Templates and guidance on conducting health-impact assessments may facilitate their ability to coordinate with other sectors.

Identifying Approaches to Adapting Health Systems to Climate Change

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
Health service planning and sustainable development: considering what, where and how care is delivered through a pro-environmental lens (36)	<i>Publication date:</i> 2018 <i>Jurisdiction studied:</i> Australia <i>Methods used:</i> Descriptive	Health service planning occurs at three levels: 1) state-based; 2) municipal-level; and 3) health service organizations	The study describes the role of health services planners in sustainable clinical service plans, what care is delivered, where care is delivered, how care is delivered, the contextual challenges and enablers, external policy context, and their leadership	The study describes the role of health-service planners and their role to champion and reorient healthcare towards sustainable approaches. The study concludes that there are key enablers to address contextual challenges such as policy factors (e.g., political will, policy vision, and transformative business models), health-service leadership (e.g., clear communication to senior leadership about the needs and evaluation requirements), and carbon literacy (e.g., pro-environmental education for health-service planners and other key leaders, development of measurement tools to calculate carbon emissions before and after development of models of care).
Health and climate change: Policy responses to protect public health (12)	<i>Publication date:</i> 2015 <i>Jurisdiction studied:</i> Multiple – international <i>Methods used:</i> Descriptive	Recommendations developed by the Lancet Commission, a multidisciplinary and international collaboration with academic centres in Europe and China	The study describes key recommendations for the next five years for the government	The Lancet Commission developed a set of recommendations for government. Health-related recommendations and approaches included the investment of climate change and public-health research, monitoring and surveillance, scaling up financing for climate resilient health systems, and adopting mechanisms to facilitate collaboration between ministries of health and other government departments and organizations.
Extreme weather and climate change: Population health and health system implications (5)	<i>Publication date:</i> 2021 <i>Jurisdiction studied:</i> United States <i>Methods used:</i> Descriptive	Not reported	The study describes building blocks of climate-resilient health systems which include a knowledgeable health workforce with related tools, health information systems to support effective management of health risks from extreme events, effective service delivery including preparation for emergencies, and adequate financing	The study describes key aspects to prepare health systems for extreme climate and disasters. The study highlights the need for a national health-adaptation plan that includes conducting vulnerability and adaptation assessments and stress tests. The authors recommend the involvement of other sectors such as disaster risk-management committees, meteorological services, agriculture, and water. The author notes that there are challenges to developing climate-resilient health systems such as the mismatch between research needs and funding priorities, and how climate change is often framed as an environmental problem instead of a whole-of-society challenge.
Climate change and eHealth: A promising strategy for health sector mitigation and adaptation	<i>Publication date:</i> 2012 <i>Jurisdiction studied:</i> Sweden	Not reported	The study provides examples of eHealth adaptation strategies such as telemedicine in disasters, point-of-care diagnostics for disease outbreaks, public-	The study describes some examples of eHealth adaptation strategies and their potential impacts and challenges. For telemedicine, on-site medical staff and citizens will benefit when there are damaged roads and hospital buildings. The authors identified that there is a need to improve disaster preparedness and infrastructure for robust mobile

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
(25)	<i>Methods used:</i> Descriptive		health surveillance of disease and mapping strategies using mobile devices, and remote education in preparedness and adaptation for health professionals and the public	communications. For point-of-care diagnostics, this strategy may provide early point-of-care in low-resource settings and minimize spread of disease. However, similarly to telemedicine, there will be a need to develop infrastructure for mobile communications, and need for clinical training in working in remote and low-resource settings. Mobile devices used during surveillance is cost-efficient, but requires policies, education, and adaptation to new technology. And finally. remote education in preparedness will provide beneficial opportunities for health workers to learn, but also requires support from policies. The authors recommend national policies and legislation that create incentives for mitigation and adaptation actions in the healthcare sector. However, they also note that there is limited knowledge on the environmental impact of eHealth and examples of eHealth as adaptation strategies.
A comparative analysis of climate-Risk and extreme event-related impacts on well-being and health: policy implications (37)	<i>Publication date:</i> 13 February 2018 <i>Jurisdiction studied:</i> Multiple <i>Methods used:</i> Cross-comparison survey	The eight example countries and cities included in this study were Austria, Ethiopia, Malaysia, Uruguay, the Southeast Queensland region in Australia, and three cities – La Paz, Bolivia, Douala, Cameroon, and Dar-es-Salaam, Tanzania. These examples were chosen mainly because they represented various geographical regions and contexts.	The methodology used in this study included identifying the sample countries and compiling a list of climate risks and extreme events, collecting evidence-based statistics, and conducting a comparative analysis of climate risks and extreme events. Only national-level indicators were used for the comparative study.	This study focused on evaluating the health impacts of climate risks and extreme events by evaluating eight examples from industrialized and developing countries. Some suggestions for how to avert these impacts are provided. The comparative analysis conducted of the climate risks and impacts of the sample of countries found that they all showed some degree of vulnerability to climate change and extreme events. While some countries were found to be highly sensitive and severely vulnerable to mainly one extreme event, such as Australia with extreme heat and Uruguay with flooding, others were found to suffer strong climate distress with moderate impacts. The study suggests that the adaptation deficit of poorer countries that will likely experience more severe weather events should be reduced by decoupling vulnerability to extreme events from economic growth, by, for example, reducing exposure and improving after-event actions. It also highlights the need to strengthen surveillance capacity through local early-warning systems and to increase consensual governance choices and sound policymaking.
Making administrative	<i>Publication date:</i> 9 June 2018	The Estonian health system services a population of 1.3	A “Climate Change Adaptation Development	This study assesses factors determining the effectiveness of Estonia’s health system in assessing and managing the

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
systems adaptive to emerging climate change-related health effects: Case of Estonia (38)	<i>Jurisdiction studied:</i> Estonia <i>Methods used:</i> Mixed methods – interviews, survey, document analysis	million with relatively large income disparities and health inequalities among different age, education, and ethnic groups. The projected risks of climate change to the country include an increase in heatwaves during the warmer months, forest fires, prolonged pollen seasons, more extreme storms, and the spread of some infectious diseases. These will pose a direct challenge to medical care and rescue capacity.	Plan until 2030” was ratified by the Estonian parliament in 2017, but the resources required for the action plan were significantly smaller than what was proposed. Planning of climate change responses is divided between several ministries, and emergency situations are regulated by the Emergency Act. The study found that there was no integrated approach to climate adaptation in the country.	health risks of climate change. Applying the WHO’s Framework for Building Climate Resistant Health Systems, the study incorporates a document analysis, 21 interviews with key informants connected to the health system, and an analysis of a 2015 population-based survey to assess the health-system climate adaptation policy development and implementation. Interviews indicated that respondents did not feel like there was a need to deal with climate adaptation separately and believed that it should have been sufficiently addressed by existing legislation. Respondents also indicated that the Health Board had insufficient capacity to manage emergency situations, and that since health services and providers operate under private law, their competencies and preparedness for climate-related emergencies have not been analyzed or regulated. The study highlights the need for improved information sharing with the public about climate change risks and responses that is practical, cost-effective, and reduces barriers to access. A lack of interest or worry about climate change by the public was identified due mostly to the preoccupation of socio-economic instability in the country. Identified factors influencing administrative capability to cope with climate change included the scarcity of necessary expertise and coordination between ministries when dealing with emergency situations. Lastly, a lack of financing has hindered the country’s ability to be prepared for emergencies with sufficient infrastructure and staff, assess health effects and rescue necessities, and to diversify information systems.
Health system plan for implementation of Paris agreement on climate change (COP 21): A qualitative study in Iran (39)	<i>Publication date:</i> 11 September 2020 <i>Jurisdiction studied:</i> Iran <i>Methods used</i> Qualitative methods	Not reported	Not reported	The study conducted a Delphi method with 23 experts in health and climate change to identify components of a health-system plan for climate change. Important examples of implementing the Paris Agreement on climate change in the Iran health system include: “participation in the formulation of strategies for mitigation and adaptation, identifying vulnerable groups,

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				assessing vulnerability, increasing the capacity of health services delivery during extreme events, using early warning systems, using new technologies to increase the adaptation, evaluation of interventions, financial support, increasing the number of researchers, increasing the knowledge and skills of staff, and finally public awareness.”
<u>Are we ready for it? Health systems preparedness and capacity towards climate change-induced health risks: perspectives of health professionals in Ghana</u> (40)	<i>Publication date:</i> 9 May 2019 <i>Jurisdiction studied:</i> Ghana <i>Methods used:</i> Mixed methods – interviews and surveys	Uneven development between the two districts of study has translated into a short-staffed, under-served health system in the northern district of Savelugu-Nanton when compared to that of Ada East in the south. Savelugu-Nanton has a bigger land area and population compared to Ada East’s, with a population-to-doctor ratio in the Northern region of 13,877:1, compared to a population-to-doctor ratio in the southern region of 3,751:1. Ghana has seen an increasing prevalence of parasitic diseases, specifically malaria and lymphatic filariasis, in recent decades, due in part to rising temperatures caused by climate change	Health professionals in two districts in Ghana – Savelugu-Nanton and Ada East – were asked about their perception of their and the country’s preparedness and capacity to respond to climate change health risks. Health centres and hospitals in the study districts were randomly selected, and the health professional in each selected site whose birthday was closest to the day of the survey was selected. A total of 99 surveys were completed and 20 in-depth interviews were conducted for the study.	This study explored the perceptions of health professionals in two districts in Ghana about preparedness and capacity for the potential impact of climate change. It draws on two components of the 2015 WHO framework for building climate-resilient health systems – health workforce and emergency preparedness and management. Of the 99 health professionals surveyed in the study, 52 were from Ada East and 47 were from Savelugu-Nanton, and of the 20 interviews conducted, eight were in Ada East and 12 were in Savelugu-Nanton. Most health professionals who completed the survey indicated that they had considered climate change health information in their work, but had not carried out any related research on the subject, such as what actions could be taken to accommodate changes related to the climate. Most respondents also reported not receiving training on climate change-related health risks, and 65% of the professionals in each district reported not having enough information to respond to public-health issues related to climate change. The interview responses were categorized into three areas: health training, perceived preparedness for managing climate change-related emergencies, and reforms and actions required. In the area of health training, interview responses reflected those of the surveys that training on the health implications of climate change was very minimal, if any. Training workshops are often focused mostly on a specific disease outbreak. In terms of perceived preparedness, some respondents working in District Hospitals perceived their institutions to

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				be fully prepared to handle any potential emergencies from climate-sensitive infectious diseases, even when they acknowledged that resources and personnel to respond were limited. Other respondents (mostly those working in lower-level health centres) felt completely unprepared for climate change health effects in their institutions, mainly because of insufficient staffing. Interestingly, the respondents indicated preparedness for known health risks and diseases in Ghana, but not for the emergence of new or emerging climate change-related diseases, which could imply that the two regional health systems included in this study may not be adequately prepared to respond to climate change-related risks. Lastly, the study found that all study participants agreed that health-sector reform was urgently needed to improve preparedness for climate change impacts. Climate change skill building and provision of logistics and infrastructure were the two areas that were highlighted by health practitioners as needing reform. Respondents said that more investments needed to be made in health research, staff training, recruitment, and a climate change policy to capture all of the intended reforms. The study concluded that there is an urgent need to strengthen technical and professional capacity, provide training on climate change for practitioners, and develop and implement a comprehensive climate change policy in Ghana.
Health-system adaptation to climate change: A Peruvian case study (41)	<i>Publication date:</i> 2 December 2020 <i>Jurisdiction studied:</i> Peru <i>Methods used:</i> Policy analysis	Healthcare in Peru is provided by Ministry of Health (MINSA), the private sector, EsSalud, the Armed Forces, and the National Police Health services. Services of the MINSA, which provides care to the majority of the population, are decentralized and operated by regional governments. Each of these subgroups operate, to some extent, as a separate health	Peru developed national and regional climate change adaptation plans between 2001 and 2017 in alignment with the United Nations Framework for Climate Change Convention (UNFCCC) agreements, and the delegation of policy development to regional departments in 2002. A legal decree was published in 2014	This article explored the role and priority of health within Peru's national and regional climate-adaptation planning process. It argued that health for the most marginalized populations in Peru is not sufficiently included in regional adaptation plans to ensure health equity in the country's climate change response. A policy analysis of 17 of the 25 regional adaptation plans was conducted using the Walt and Gibson policy approach of evaluating actors, content, and process. Despite having strategies, goals and plans related to health, many regional governments did not include the Ministry or

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
		system with little coordination between them, and a large proportion of the population incur out-of-pocket expenses for healthcare. There are 25 regional departments that are responsible for developing and implementing climate change adaptation plans.	to ensure that a Health National Adaptation Plan (HNAP) was developed, and vulnerability studies began to be conducted in 2015 as part of the Regionals and 2015 National Strategies to identify zones and sectors most vulnerable to climate change, with a specific focus on marginalized populations.	Regional Health Directorate, which is the regional health authority, in the execution of their climate change adaptation strategies. Most regional departments had majority government institutions engaged in planning and executing their adaptation plans, one of which even included oil and mining companies despite the potential dangers they pose to the environment. Health appeared to not have been a priority in regional climate change plans prior to 2011, and even then, health was often referred to in relation to infrastructure and health services and not ecosystem health. There was general national and regional epidemiological and surveillance data as well as a vulnerability assessment of the most vulnerable areas that would be affected by climate change. Food security/malnutrition and airborne respiratory diseases were identified as the two most pressing health hazards, and were linked to natural disasters like flooding and drought, but regional departments only focused on adapting by increasing investment in infrastructure and human resources, and there are no health-related adaptations at the national level. The analysis revealed that most regional departments recognized the diversity of health needs for their populations given how geographically diverse Peru is. Each regional department accounted for the unique background of their biodiverse areas, and recognized the need for more research on what impacts climate change will have on their regions, and the need to incorporate the use of traditional Indigenous knowledge into their planning processes. Gender equality was also addressed in a few regional plans as gender was identified as a crucial determinant of health in daily life in both urban and rural areas in Peru. Peru's national adaptation plans from 2002 to 2015 focused on the legal and conceptual processes that had an impact on adaptation planning, and these processes have been monitored over time via national communication

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				plans. Regional departments that have followed the MINAM guidelines to develop committees to design and implement strategies have gained in structure and organization. This analysis concluded that the Peruvian government needs to address the barriers of a complex healthcare system, lack of cohesion within and amongst regional departments, and lack of financial support in order to adapt the health sector to climate change. Marginalized populations also need to be engaged more in regional health research and the adaptation strategy-development process, and mental health needs to be included in adaptation discussions and strategies.
Monitoring and evaluation indicators for climate change-related health impacts, risks, adaptation, and resilience (32)	<i>Publication date:</i> 6 September 2018 <i>Jurisdiction studied:</i> Cambodia <i>Methods used:</i> Case study	This article incorporated a review of evidence on adaptation indicators for monitoring and evaluation (M&E) of climate change-related health risks, and evaluated the application of M&E adaptation indicators into the Royal Government of Cambodia's National Climate Change Action Plan. Major priorities for adaptation that were identified were vector- and water-borne diseases and the health impacts of extreme weather events.	A variety of indicators are proposed in this article that focus on vulnerability, climate change impact, health-system resilience, and adaptation processes. The article also describes how the M&E adaptation indicators were introduced into the Ministry of Health of Cambodia's climate change plan in order to help the ministry establish early-warning systems, guide policy development, increase public awareness, and develop assistance programs.	This article incorporated a review of approaches to using climate and health adaptation indicators for monitoring and evaluation (M&E) of climate change-related impacts and resilience. The article also explores an example of the application of principles of indicator development at the Ministry of Health in Cambodia. In its review of indicator development and monitoring, the article describes efforts made by researchers in the United States and Canada, and by the Lancet Commission on Health and Climate Change and the World Health Organization, all of which applied different indicators based on various measurements, such as exposure to temperature change and changes in labour productivity. The article highlights that improvements in M&E indicators are needed in three broad areas: vulnerability and exposure to climate hazards, current impacts and projected risks, and adaptation processes and health-system resilience. Vulnerability indicators are used to identify populations that are at risk of adverse outcomes because of climate change, and may include the number of people in poverty, data on children and pregnant women, and the number of people living with chronic diseases. Other relevant

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				information could include data on healthcare-delivery infrastructure, access to health services, insurance coverage, and access to education. Indicators of health climate change impact are usually based on data on mortality due to exposure to climate hazards, changes in the incidence and geographic range of infectious diseases that are climate-sensitive, and under-nutrition. Indicators of adaptation effectiveness may track seasonal changes, geographic range, and incidence of climate-sensitive outcomes, as well as adaptive capacity. However, there is limited consensus on how to determine if an adaptation program or project is successful. Other indicators for measuring health-system resilience may include monitoring the frequency of vulnerability assessments, tracking the progress of integrating health into National Adaptation Plans, and tracking the implementation of strategies from these plans. Indicators could also measure the awareness of the health impacts of climate change by health practitioners, and awareness of efforts to address climate change-related health risks. The article also mentions that local and national indicators are needed to measure the extent to which health policies assess and manage climate-related risks at a system level, the design, implementation and evaluation of interventions, and the incorporation of knowledge and learning into iterative management cycles. At the Ministry of Health in Cambodia, M&E indicators were needed to establish early-warning systems, guide policy development, increase public awareness, and develop assistance programs within the context of limited resources. Categories of M&E indicators were developed based on the literature and consultation, and a tool was developed in collaboration with the WHO and stakeholders to guide the Ministry of Health in selecting the most appropriate indicators to continuously track long-term trends in climate change-related health risks.

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
				There is no one-size-fits-all set of indicators or monitoring and evaluation program for climate change adaptation. Evidence suggests that indicators in health systems need to be linked to indicators in other sectors so that adequate information is collected and available to respond to and prevent future health risks caused by climate change. The article points out that indicators must be useful, valid and sensitive, and they must also be flexible to account for the uncertainties associated with climate change and the complexities of adaptation itself.
Opportunities for engaging Canadian health systems in addressing the challenge of climate change (42)	<i>Publication date:</i> 23 April 2018 <i>Jurisdiction studied:</i> Canada <i>Methods used:</i> Mixed methods - Qualitative key informant interviews and environmental scan	Canada operates with 13 parallel systems, rather than a singular health system, organized and largely funded by each province and territory alongside a distinct system of insured services provided to specific populations by the federal government. Provinces and territories differ in their governance arrangements and coordination of service delivery, in which some provinces have created health authorities with responsibility and oversight of several health services, including hospitals and other community-based services.	Qualitative key informant interviews were conducted with 17 health leaders and change advocates to understand the perception of the challenge of climate change, what are the health policy concerns, and what change efforts might enable the prioritization of the issue. Key informants were identified through public sources, were known to the study team, or were identified by other interview respondents. An environmental scan was conducted to identify organized initiatives within OECD countries seeking to mobilize change within healthcare systems, through a search strategy based on initiatives' network connections. The data extraction template for the scan was iteratively developed to generate categories and typologies to collect,	The qualitative interviews conducted with 17 health leaders and change advocates indicated the following key findings: 1) climate change is not currently a priority for health systems in Canada; 2) climate change has potential to drive change in health systems if it had a more direct impact on healthcare operations; and 3) governments, cities, local communities, and hospitals are seen as key actors for mobilizing health-system responses. There was a clear consensus that climate change is not a concern for the current state of interest among health-system leadership in Canada, and although many efforts had been made within health systems to address the challenges of climate change, with particular attention on energy efficiency, such issues were not on the forefront of leadership interest. Interview respondents emphasized that climate change was not viewed as a core mandate of healthcare organizations, and unless climate change was directly and significantly affecting the health of populations receiving care, then the focus on healthcare delivery was not seen as aligned with climate change. Climate change was ranked low in the priority setting of health systems, and the priorities that motivate health systems were seen to be primarily clinical and related to recent crises, such as the opioid epidemic, timeliness of

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
			aggregate and compare the data.	care provision, care for the elderly, and adequacy and accessibility of mental health services. Although not all interview respondents were convinced on the need for health-system reform to respond to the challenges of climate change, there was agreement on the necessary actors and mechanisms that are capable of mobilizing health-system responses. Actors would include active involvement of governments alongside active engagement of health-system leaders and cities to foster inter-sectoral (health, environment) and multi-level (federal, provincial, municipal) efforts. Among mechanisms, respondents brought attention to governmental mechanisms that might encourage efforts from different health sectors.
Adaptation to climate change in the Ontario public health sector (21)	<i>Publication date:</i> 19 June 2012 <i>Jurisdiction studied:</i> Ontario <i>Methods used:</i> Mixed-methods - Semi-structured interviews, literature review, and jurisdictional scan	In Ontario, health powers and responsibilities are outlined in the Health Protection and Promotion Act (1990), providing legislative mandate for 36 regional boards of health and associated standards for the provision of mandatory public-health programs and services. The focus is on public-health managers implementing policy at the provincial and regional levels. At the federal level, both Health Canada and the Public Health Agency of Canada (PHAC) are involved in climate change, although municipalities, provinces/territories, and the federal government share roles significant to climate change adaptation in water quality, food safety, infectious-disease control, air quality, natural hazards, and	Semi-structured interviews were conducted, four with federal and provincial health officials and 49 with actors in public-health and health-relevant sectors at the municipal level, including senior level staff, researchers and policy analysts. Interview respondents were selected through purposive sampling of government officials in public health (federal, provincial, regional), emergency management, planning, water, and environmental/conservation at the regional or municipal level. Interviews were conducted in person or by telephone, lasting 45-90 minutes and recorded in full. Seven main themes were used as a guide to characterize the	Interview responses showed that Ontario public officials are most concerned about extreme weather and air quality, identifying extreme heat, storms and floods, and poor air quality as the most pressing climate change health risks. In addition, associated with these risks were concerns about aging populations, urban expansion, and the heat island effect. Public health officials identified that climate change is not addressed as a stand-alone issue, and there are several activities relevant to managing climate change health risks, most of which are provincially mandated programs. Among these programs, there are those that address extreme temperatures and air quality, vector-borne diseases, water, public-health emergency management, and some are explicit climate change adaptation initiatives or plans implemented in the health department. Respondents indicated that adaptation efforts rely on local political will and federal support, multi-disciplinary partnerships, and local leaders that can act as enablers to provide support and legitimacy for climate change adaptation. To prioritize developments needed for adaptation, public-health respondents suggested top-down

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
		general health promotion and disease prevention.	adaptation initiative carried out by departments and municipalities in addressing one or more health vulnerabilities of climate change: 1) general information, aimed to identify areas of responsibility, including number of staff, population base, and governance structure; 2) climate change priority and health risks of concern; 3) characterization of adaptation actions, including motivation, process, resources, stakeholders, targeted population, and monitoring; 4) adequacy of top-down support to facilitate local climate change adaptation; 5) perceptions of local level agencies' capacity to adapt to health risks of climate change; 6) roles and responsibilities for climate change adaptation; and 7) suggestions for opportunities to improve adaptation capacity. A literature review of public-health adaptation in Canada complemented the interviews, along with a scan of government websites relevant to climate change and public health.	support by provincial and federal governments. In addition, they noted that adaptation constraints include limited resources (short-term funding, human resources, lack of data), perceived lack of urgency, and communication barriers.

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
Vulnerability of Aboriginal health systems in Canada to climate change (26)	<i>Publication date:</i> October 2010 <i>Jurisdiction studied:</i> Canada <i>Methods used:</i> Descriptive study with theoretical framework	Focuses on Canada's aboriginal population (First Nations Métis, and Inuit)	Broad characteristics and determinants of Aboriginal health systems that may be vulnerable to climate change include poverty, information deficit, constrained and institutional capacity, limited technological capacity, and socio-political inequality	The literature review found that key determinants (economic poverty, low household income/unemployment, technological capacity, constraints to healthcare access, limited early warning and surveillance, socio-political values and inequality, marginalization, constrained institutional capacity, jurisdictional conflict, information deficit, limited vulnerability assessments) that could increase sensitivity and constrain adaptive capacity of Aboriginal health systems to climate change. The authors concluded with key trends such as material conditions and behaviours associated with poverty increasing, limited surveillance and early warning of capacity in remote regions, lack of comprehensive and culturally relevant health-assessment measures, insufficient access to health information and treatment, inequalities in human rights, and challenges due to jurisdictional challenges. The authors provided the following recommendations based on their findings: 1) the need for interdisciplinary scientific research (e.g., local and regional levels to identify priority needs); 2) health sector leadership to integrate climate change into health planning and adaptation; 3) effective communication with frontline health professionals to increase capacity to climate change effects on health; 4) government action to address inequalities and coordinate climate change adaptation planning across departments; 5) institutional reform to improve healthcare access and delivery; 6) international cooperation for knowledge transfer; 7) coordination and collaboration between stakeholders; and 8) partnerships with Indigenous peoples and organizations to identify health needs, generate knowledge, prioritize adaptations, and improve health systems.



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