McMaster University | HEALTH FORUM

Rapid Evidence Profile #31

(20 July 2022)

Question

What is the current readiness and capacity of Canadian federal, provincial and territorial (FPT) public-health systems to address climate change, and how do they need to adjust their public-health functions and system features to do so?

What we found

To identify the current readiness and capacity of Canadian public-health systems to address climate change and adjustments that are needed, we identified evidence from the searches described in Box 1, as well as experiences from Australia, France, Germany, New Zealand, United Kingdom, select states of the United States (California, Massachusetts, Minnesota, New York and Oregon), and all Canadian provinces and territories (see Box 1 for a description of our approach). We organized our findings using the framework below. We also identified any evidence and experiences that may be relevant to Indigenous peoples (i.e., any evidence or relationships between FPT governments and Indigenous governance and leadership), which can be shared with Indigenous scholars who may do complementary work on the topic.

Organizing framework

- Essential public-health functions
  - Health surveillance
  - Population health assessment
  - Health protection
  - Health promotion
  - Disease and injury prevention
  - Emergency preparedness and response
- Governance arrangements (including governance, leadership, and engagement)
- Financial arrangements (including, but not limited to, financing)
- Delivery arrangements
  - Workforce expertise and human resource capacity
  - Medical and digital health technology
  - Evidence, knowledge and information

Box 1: Our approach

We identified evidence related to the question from the 17,105 documents included in a living evidence synthesis that used machine learning to map the global research on climate change and health. The dataset was last updated in December 2021. We added to the dataset – drawing from Social Systems Evidence and excluding duplicates – systematic reviews, rapid reviews or protocols for systematic reviews that mention Canada or a province in the title or abstract, and/or include at least one study conducted in Canada. Each of the 402 documents that mentioned Canada and/or one or more provinces and territories was assessed by one reviewer to identify those relevant to the question. We also classified each of the included single studies according to the forms of evidence profiled in the Evidence Commission report (data analytics, modelling, evaluation, behavioural/implementation, and/or qualitative insights).

We appraised the methodological quality of full systematic reviews and rapid reviews that were deemed to be highly relevant using AMSTAR. Note that quality appraisal scores for rapid reviews are often lower because of the methodological shortcuts that need to be taken to accommodate compressed timeframes. AMSTAR 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, or to broader social systems. We appraised the quality of the highly relevant guidelines using three domains in AGREE II (stakeholder involvement, rigour of development, and editorial independence) and classified guidelines as high quality if they were scored as 60% or higher on each domain.

This rapid evidence profile was prepared in the equivalent of three days of a 'full-court press' by all involved staff.

- Policy and program interventions

We identified 94 evidence documents relevant to the question, of which we deemed 26 to be highly relevant. The highly relevant evidence documents include:

- three systematic reviews;
- one scoping review; and
- 22 single studies.

Of the evidence syntheses, two systematic and one scoping review have a pan-Canadian focus, while one systematic review was focused on Ontario. We classified the 22 single studies as providing data analytics (n=9), qualitative insights (n=5), modelling (n=3), implementation/behavioural insights (n=3), evaluations (n=1) and technology assessment/cost-effectiveness (n=1). In addition, of the 22 primary studies, 13 have a provincial focus (Quebec=7, Ontario=3, Alberta=1, British Columbia=1, Manitoba=1), and nine have a pan-Canadian focus.

We outline in narrative form below our key findings related to the question from highly relevant evidence documents and based on experiences from the selected countries and Canadian provinces and territories. We provide additional details in Table 1 (the type and number of all documents that were identified). We also provide several appendices with additional details, which include:

- a summary of our methods (Appendix 1);
- the full list of included evidence documents, including those deemed of medium and low relevance (Appendix 2);
- medium- and low-relevance evidence documents included but not profiled in the summary (Appendix 3);
- documents excluded at the last stages of reviewing (Appendix 4);
- a summary of key findings of 48 population-health assessment studies for those who are interested in more detail about the impacts of climate hazards from the documents we identified for this profile (Appendix 4); and
- details about experiences from Canadian provinces and territories (Appendix 5) and from the selected countries (Appendix 6).

Key findings from highly relevant evidence sources

We classified the studies included as addressing one or more of the essential public-health functions as well as relating to adaptations in public-health system arrangements. We identified articles addressing health surveillance (one systematic review and six single studies), population-health assessment (one systematic review, one scoping review and nine single studies), health promotion (two systematic reviews), disease and injury prevention (two single studies), and emergency preparedness and response (one systematic review and eight single studies). With respect to public-health system arrangements, we identified findings addressing governance arrangements (one single study), financial arrangements (one single study), delivery arrangements (three systematic reviews, one scoping review and 13 single studies), and policy and program interventions (two systematic reviews, one scoping review and eight single studies).

While we found articles relevant to five of the six public-health functions and all system arrangements, the richest findings pertaining to public health's capacity to address climate change (and adjustments to public-health functions) are provided within the sections on health promotion, emergency preparedness and response, and policy and program interventions. While the other areas of the framework all have

evidence gaps, we provide insights where available that may have implications for capacity and adjustments that may need to be made to public-health functions.

Health surveillance

While we did not identify any literature related to capacity for health surveillance to address environmental changes as a result of climate change, we did identify examples of how it is currently being operationalized. One medium-quality systematic review reported how Indigenous communities have been monitoring the environment for centuries, and highlighted an opportunity to use both Indigenous and Western knowledge systems to develop a deeper understanding of pressures on the food systems. The review found different approaches that had been used to enable community-based monitoring (e.g., GIS mapping, GPS tracking and use of aerial surveys), and it was predominantly used to monitor wildlife, natural resources and fisheries. Evaluations of the effectiveness of community-based monitoring were relatively sparse and additional research should be undertaken to determine whether this could be an appropriate solution to scale up across the country.

Single studies reported experiences of health surveillance in Vancouver, Alberta, Quebec and among Inuit communities in the Canadian Arctic. In Vancouver, one study mapped the population groups most vulnerable to extreme heat, and authors were able to detect and visualize 105 socio-economically deprived dissemination areas with high vulnerability to extreme heat events. It was noted that this tool might support health authorities, city officials and policymakers to better understand who is at risk during extreme heat events, where they reside, what factors drive the risk, and ultimately what can be done to mitigate it. In Southern Alberta, one study reported on a system of public-health surveillance and assessment of the impacts on health of the flooding that affected approximately 100,000 people in 2013. This surveillance system was implemented for the six-week period after the flood to monitor real-time or near real-time health data using pre-existing sources and indicators. In Quebec, one study described a real-time integrated system for the surveillance and monitoring of extreme heat events implemented on a provincial level. This system is available to health specialists through a secure web information portal and provides access to weather forecasts, historic and real-time indicators (including deaths and hospital admissions), alerts and various cartographic data used for conducting prevention activities and launching emergency measures.

One single study describes policies and programs that are already in place to assess Inuit vulnerability to climate change in Canada, including the International Circumpolar Surveillance System which has collected and shared data on infectious diseases in the Arctic since 1999. This system provides early warning and has led to evidence-based policy interventions, such as a vaccination program against Strepococcus pneumonia. Additionally, the study suggests further adaptation such as enhancing surveillance, monitoring, and early warning systems, evaluating search and rescue capability, strengthening the role of Inuit in decision-making, and adding culturally relevant and locally appropriate materials to school curriculum about climate change.

Population-health assessment

We did not find any literature related to either public health's existing capacity to conduct population-health assessments, nor did we find any evidence related to how population-health assessments may need to change to better capture the effects of climate change. However, findings from highly relevant reviews and studies do point to the effects of climate change on population health that should be considered when undertaking or adapting approaches to population-health assessment. Moreover, we provide a summary of key findings of 48 population-health assessment studies in Appendix 4 for those

who are interested in more detail about the impacts of climate hazards from the documents we identified for this profile.

One low-quality systematic review reported strong evidence for the association between climatic factors and an increase in food- and waterborne diseases, largely because of increased temperatures and increases in precipitation which increases the incidence of these diseases.

Most highly relevant single studies reported the effects of heat and extreme temperatures as well as air pollution on health. One study analyzed retrospective and prospective data to assess differential and combined impacts of extreme temperatures and air pollution on human mortality in south–central Canada and found extreme temperatures associated with roughly 20% of elevated mortality, while air pollution is associated with the remaining 80%. Applying within-weather-group elevated mortality prediction models, heat-related mortality without consideration of population acclimatization to increased heat is projected to be more than double by the 2050s and triple by the 2080s. By the 2050s, cold-related mortality is projected to decrease by approximately 45% for Montreal and Ottawa, and by 60% for Toronto and Windsor. Air pollution-related mortality is projected to increase by about 20–30% by the 2050s and approximately 30–45% by the 2080s. These increases would be largely driven by increases in ozone-related elevated mortality. Another single study using distributed lag modelling for temperature-mortality relationships in 15 Canadian cities, found that most temperature-related mortality will continue to be cold-related. The study models predict that higher temperatures will increase the burden of annual temperature-related mortality in Hamilton, London, Montreal and Regina, and decreased burdens are predicted in another 11 cities (Calgary, Edmonton, Halifax, Ottawa, Quebec City, Saskatoon, Saint John's, Toronto, Vancouver, Winnipeg, and Windsor). One study found that an increase in ambient temperature leads to an increase in social disparities in daily years of life lost (DYLLD) in Montreal. One study performed a health-risk assessment of PM2.5 emissions during congestion periods in the Greater Toronto and Hamilton Area (GTHA). The impact on mortality was of 206 and 119 deaths per year for all-cause and cardiovascular mortality, respectively. The economic impact from daily mortality was estimated at approximately $1.3 billion and $778 million for all-cause and cardiovascular mortality, respectively.

Health promotion

One medium-quality systematic review found that food-monitoring systems can help to reduce the climate-change impacts on food systems through early identification of vulnerable areas and crops, and allow for adaptation strategies to be tested and implemented.

In addition, one medium-quality systematic review found very little research evidence on how public health can effectively communicate the long-term risks of climate change to encourage individuals to adopt appropriate behaviours. However, it highlights the possible opportunity for public health to adapt strategies commonly used for extreme weather events to communicating long-term risks. These include creating messaging that is grounded in local risks and that is inclusive of vulnerable communities (e.g., accessible language, considering economic issues to stated protective actions, considering transportation issues to stated protective actions, and engaging partners with trusted community authorities).

Disease and injury prevention

One single study reported that heat-health campaigns that aim to raise awareness about health risks during extreme temperatures did not lead to successful uptake of desired behaviour changes. Authors suggested that heat warnings need to be locally tailored which could include pointing to local cooling

centres and using local trusted sources to disseminate information (e.g., through doctors, pharmacists, community centres and local newspapers, among others).

Emergency preparedness and response

Three studies address heat-warning systems, heat-resilience plans, and health-response programs identified in Manitoba, Montreal, Quebec city, and Toronto. The scope of most of the warning systems and plans is municipal, with Quebec being the only province with a provincial cold-health watch and warning system. In addition, one study focused on emergency plans during wildfires in Canada and impacts on Indigenous communities, and found that evacuations in these communities have been hampered by poor communication and a lack of well-developed evacuation plans.

Governance arrangements

One single study described the insights of different stakeholders in Ontario, who noted that adaptation practices to climate change are not yet mainstream, but are evolving with newly mandated provincial programs including planned climate-change and health-impact assessment, environment-health surveys, and regional climate-change adaptation strategies. The study also reported that while municipalities use a range of different approaches to address climate change health vulnerabilities, that there is relatively little systematic practice across the province or sharing of approaches. The study notes the need for additional support from higher levels of government in developing standards and guidelines for climate change adaption.

Financial arrangements

In addition to higher-level leadership, participants in one study conducted in Ontario highlighted the need for long-term stable funding for adaption initiatives.

Delivery arrangements

When considering the category of delivery arrangements, we only identified studies providing insights about evidence, knowledge and information. All the relevant evidence, knowledge and information extracted was incorporated into the sections on population-health assessment and emergency preparedness and response. No evidence was identified addressing workforce expertise and human-resource capacity or medical and digital health technology.

Policy and program interventions

One low-quality scoping review identified several strategies that are already in place to adapt to climate change in rural and remote regions, but that could be further expanded. These included:

- introducing local food production systems;
- using experience-based knowledge of local communities to support community resilience;
- developing community-based monitoring programs and research to gather data about environment and health to inform decision-making;
- using Indigenous knowledge and local knowledge regarding the physical environment, to support hazard avoidance and emergency preparedness;
- utilizing a social-development approach, which involves health professionals, social workers, and those in caring professions supporting those directly affected by climate change to strengthen community capacity; and

- fostering protective factors for physical and mental health through connection to land-based activities, cultural arts and crafts, and opportunities for bringing community together.

The same low-quality scoping review suggested some potential adaptation strategies that could be, but have not yet been implemented, which include:

- using local knowledge, Indigenous knowledge, and/or western knowledge to respond to specific local socio-cultural contexts;
- eliminating social barriers to adaptation (e.g., poverty, inequality, etc.) and reducing non-climatic factors (e.g., chronic disease);
- utilizing innovative forms of technology (e.g., telehealth);
- improving public-health surveillance and furthering monitoring programs;
- supporting sustainable-development practices (e.g., clean-energy programs);
- enhancing communication and awareness of risks and responses (e.g., lists of safe spaces);
- expanding knowledge of climate-change impacts on health through research and investment, and sharing best practices for public-health adaptation; and
- developing the capacity of health systems and emergency response to withstand and respond to climate risks (e.g., creating technical guidance and training courses).

From the single studies included, we identified emergency- and health-response programs in Montreal and Toronto, a Montreal heat plan created to ensure the surveillance of weather and health indicators during the summer season, and the Quebec provincial cold-health watch and warning system.

Table 1: Overview of type and number of documents that were identified about the current readiness and capacity of Canadian public-health systems to address climate change and adjustments that are needed

Organizing framework		**All (n=26)**		**National* (n=13)**		**Provincial/territorial** (n=13)**	
		Evidence syntheses (n=4)	Single studies (n=22)	Evidence syntheses (n=4)	Single studies (n=9)	Evidence syntheses (n=0)	Single studies (n=13)
Essential public-health functions	Health surveillance	1	6	-	-	1	5
	Population-health assessment	2	9	2	5	-	4
	Health protection	-	-	-	1	1	-
	Health promotion	2	-	1	-	-	-
	Disease and injury prevention	-	2	-	-	-	2
	Emergency preparedness and response	1	8	1	3	-	5
Governance arrangements (including governance, leadership, and engagement)		-	1	-	-	-	1

Financial arrangements (including, but not limited to, financing)		-	1	-	-	-	1
Delivery arrangements	Workforce expertise and human resource capacity	-	-	-	-	-	-
	Medical and digital health technology	-	-	-	-	-	-
	Evidence, knowledge and information	4	13	3	7	-	6
Policy and program interventions		3	8	1	2	-	6

Key findings from the jurisdictional scan

Our jurisdictional scan captured experiences of Canadian provinces and territories as well as Australia, France, Germany, New Zealand, United Kingdom, and select states of the United States (California, Massachusetts, Minnesota, New York, and Oregon) on these jurisdictions' readiness and capacity to address climate change in their public-health systems. We also identified public-health system adjustments that are being made in some of these jurisdictions to address current and future impacts of climate-related events on public health. The organizational framework was used to organize our narrative summary of these experiences.

Essential public-health functions in Canadian jurisdictions

We identified a wide array of measures being taken by federal, provincial and territorial (FPT) governments in Canada to prepare and adjust essential public-health functions to address climate change. In terms of health surveillance, we found that climate-change metrics on natural systems, physical infrastructure, and economic sustainability are routinely tracked in Saskatchewan. Population-health assessments of climate-change risks to public health have been commissioned by the federal government through two reports, the Health of Canadians in a Changing Climate: Advancing our Knowledge for Action and the National Issues report. Assessment reports have also been released by B.C.'s Ministry of Health, Public Health New Brunswick and researchers in Nunavut that address several important aspects of understanding and adapting vulnerable communities in these jurisdictions to the health impacts of climate change (e.g., rising sea levels, rising temperatures, changes in infectious agents, and extreme weather). Several population-health assessments of climate change impacts have also been conducted in Ontario in the past by regional public-health units and associations. These include: a 2017 report by the Ontario Public Health Association that highlights the health impacts of climate change on Ontarians and government efforts to address them; a 2020 report on Indigenous perspectives in climate adaptation which discusses public-health adaptation interventions; and a presentation released in April 2017 by Public Health Ontario which outlines the impacts of climate change on health, the role of Public Health in mitigating these impacts, as well as adaptation strategies that existed at the time. The provinces of B.C. and Saskatchewan have developed assessment tools to measure hazards, risks, and the health vulnerability of communities, and the Nunavut Climate Change Secretariat has commissioned a research team in Pond Inlet to assess the safety of local fresh-water supplies in light of climate change and its impact on water safety in the north.

We found limited information on health protection, health promotion, disease and injury prevention, and emergency preparedness and response. New Brunswick's City of Fredericton has a Climate Change Adaptation Plan that outlines some actions to protect the health of residents, including minimizing disruptions to municipal services and programs offered to the community, strengthening resilience of natural infrastructure and assets, and empowering communities. In terms of health promotion and emergency preparedness, B.C.'s Ministry of Health and the Provincial Climate Action Secretariat has a resource document that outlines actions for communities to prepare for climate change, while simultaneously promoting better health outcomes. Key examples of actions include partnering and collaborating with the healthcare community in the formal plan referral process, planning and preparing with the healthcare community in climate vulnerability, developing adaptation assessments, emergency plans and protocols, educating public-health communicators, and monitoring and evaluating community-health indicators. The Government of Saskatchewan is also taking action to build health capacity by training local communities to effectively respond in emergency situations, educating the public on vector-borne diseases, diversifying crops to enhance soil health and manage pests, expanding the FireSmart program to ensure resident safety in the event of wildfires, committing to the use of renewable energy sources, and ensuring a waste-management strategy is in place.

Essential public-health functions in other jurisdictions

In the other jurisdictions, we identified several insights under the essential public-health functions category. We have organized these findings by the sub-categories of health surveillance, population-health assessment, health protection, and health promotion, and emergency preparedness and response.

Health surveillance

In terms of health surveillance, we found that some of the jurisdictions have enhanced their surveillance capacity to inform climate change adaptation planning. In New Zealand, the Ministry of Environment has contracted a university to maintain a set of environmental-health indicators to provide policymakers with the most current evidence on the health impacts of climate change. Likewise, the New York Health Department's Climate and Health Program and the California Department of Public Health (CDPH) both conduct surveillance and research through partnerships with academic researchers and experts. Surveillance and evaluation of health risks from extreme climate events in France is conducted by Santé Publique France, which has produced a report about how to develop indicators specifically for climate change adaptation planning for public health, and has also established a syndromic emergency and death surveillance system, SurSaUD® to collect emergency medical service and mortality data. We also found that local public-health departments in Massachusetts report surveillance activities on public-health impacts associated with climate change, and New York State (NYS) staff have created Heat and Health Profile Reports and a mapping application to track heat-vulnerability and heat-stress hospitalization and emergency department visits annually, and to display cooling-centre stations across the state. Finally, a whitepaper on Advancing Health & Disaster Resiliency in Minnesota highlighted that climate-projection data could be useful to inform climate-hazard mitigation and response planning, identify community vulnerabilities, assess the probability of future severe weather events, and determine mitigation actions to reduce damages from future impacts.

Population-health assessment

We found that in Germany, older adults are a particular focus of heat-health assessments. A pilot project is underway to study the burden of heat-related health on older adults living in the city of

Cologne, and the heat-related health perception of people living in care homes. We also identified a few population-health assessment initiatives specific to climate change in U.S. jurisdictions. In California, Climate Change and Health Profile Reports are developed for and provided to counties by the California Department of Public Health (CDPH) to support their climate-change adaptation planning. These reports offer projections and tools specific to county and regional climate impacts, vulnerable local populations, and climate-related health risks. Additional population-assessment tools that we found are being used by the CDPH and its partners include: a Climate Change and Health Vulnerability Assessment Framework that is used to identify where a person's or neighbourhood's susceptibilities to injury or disease exist relative to their distance and sensitivity to climate-related environmental exposures or hazards; CalEnviroScreen, a screening tool that can be used to identify California communities that are disproportionately burdened by multiple sources of pollution; and Community Assessments for Public Health Emergency Response (CASPER), a rapid community needs-assessment method developed by the Centers for Disease Control and Prevention (CDC) for extreme events. A survey commissioned by the Massachusetts Department of Public Health found that only 24% of responding public-health departments identified climate-change preparations as a priority, and only 21% felt they had adequate resources to address climate risks. The survey results highlighted the need for the Department of Health to quantify specific environmental and public-health threats and to develop plans for reducing these impacts. In Minnesota, we found that the Department of Health released the Heat Vulnerability in Minnesota Tool, an interactive website designed to assess community vulnerability to extreme heat, and the Extreme Heat Toolkit that supports communities in streamlining local solutions to protect health and increase climate resilience. Lastly, we found that in Portland, Oregon, a comprehensive climate change and health impact assessment report and a complementary data visualization tool were developed by a regional collaborate of Clackamas County Public Health, Oregon, and multiple neighbouring counties.

Health protection

We identified strategies that aim to protect the public from the impacts of extreme heat events. In Germany, a health heat-warning system calculates the heat load for regions and counties countrywide and issues heat-health warnings to local authorities, health clinics, and care homes so that they can initiate adaptation measures. New York State is increasing the use of cooling centres and supports outreach through the "Be-a-Buddy" Program that promotes green infrastructure, reforestation, and reflective or "cool roofs." These actions will help to moderate the urban heat island effect and reduce the severity and frequency of future projected extreme heat events. In Massachusetts, many local public-health departments reported efforts to increase resiliency to extreme heat events, such as having developed or currently developing plans for siting cooling centres for operation during heat events.

Health promotion

In terms of health promotion, we identified a guidance document for healthcare professionals, managers and staff holding strategic roles in the U.K, about how to be proactive in addressing the impact of climate change on health. Some of the recommendations from the guidance include educating themselves and others about climate change and positive actions that can be taken to have an impact on the environment (e.g., active travel), helping patients and staff reduce exposure to air pollution, ensuring that patients most vulnerable to hot weather know how to keep their homes at a reasonable temperature, encouraging healthy eating habits of foods with smaller carbon footprints, and opting for low-carbon treatments and technologies where appropriate using the National Institute for Clinical Excellence (NICE) patient decision aid. Efforts are also being made in France and

Massachusetts to communicate with the public and especially with vulnerable populations regularly about health risks associated with climate changes, such as severe weather, allergens, and vector-borne diseases.

Emergency preparedness and response

We found that in California and Massachusetts, communication systems have been put in place to enable rapid and efficient responses during public-health emergencies caused by climate-related events. California's PULSE system connects multiple local-data sources from health-information organizations and systems and provides specified volunteer healthcare workers with access to patients' personal health information in the short term during a disaster. Additionally, the California Health and Human Services Agency is required to create a data-exchange framework to facilitate the sharing of real-time health and social-services information across healthcare entities and government agencies during climate-driven emergencies. California state laws also require that health plans ensure that enrollees continue to have access to medically necessary healthcare services during a state of emergency and allows them certain flexibilities (e.g., suspending prescription refill limitations). Finally, in Massachusetts, public-health departments reported communicating with residents via reverse 911, TV news, radio news, police, and other means during public-health emergencies.

Governance arrangements

Governments in Canada and across other jurisdictions have recognized the need to adapt to climate change, and have led the development of frameworks, strategies, and/or plans to direct monitoring and preparedness efforts for climate-change adaptation in public health. At the federal level in Canada, we identified the Government of Canada's Federal Adaptation Policy Framework for Climate Change that aims to generate and share knowledge, build adaptive capacity, and integrate adaptation into federal policy and planning. This framework preceded Canada's 2020 climate plan, A Healthy Environment and a Healthy Economy, describing 64 strengthened and new federal policies, programs, and investments to build a more resilient economy. These investments will support retrofitting for buildings as well as other initiatives that reduce energy use in municipal and community buildings, promote active transport and making zero-emissions cars, trucks, and public transport more affordable and accessible, continuing to put a price on pollution through enhancing the carbon-pollution pricing system, and supporting the production and use of cleaner fuels across the economy. In B.C., Vancouver Coastal Health and Fraser Health have produced a Climate Change and Health Adaptation Framework that outlines recommendations for how various stakeholders can participate in climate change and health adaptation, and the Ministry of Health and the Provincial Climate Action Secretariat have put together a five-part series of backgrounders on the topics of climate change health risks, frontline healthcare, public health, healthcare facilities, and communities that aim to help people working in the community and in public health to prepare for current and future impacts of climate change. Climate change plans have also been developed by the governments of Manitoba, Québec, Saskatchewan, P.E.I., New Brunswick, the Northwest Territories, and the city of Ottawa to guide these provinces' climate change responses over the next few years in the priority areas of climate monitoring, clean energy, sector-emissions reductions, and adaption to extreme weather events.

We also found that provincial and territorial governments (Manitoba, Saskatchewan, New Brunswick, and the Northwest Territories) have led consultations with local organizations and stakeholders to generate ideas and gather feedback on climate change responses at the community level. Specifically in New Brunswick, consultations led to the province recognizing that passing by-laws and allocating staff to develop adaptation policies was the most critical priority. The consultations revealed that this could

be achieved through funding, open communication with municipalities, support for municipalities' plans, and engagement with the federal government to pass legislation that supports municipal plans. It was also recommended that the federal government become a leader in implementation by setting public-policy mandates, providing funding for climate change adaptation development and enforcement, and providing accurate scientific information to the municipalities.

We also found several examples of how governments in other jurisdictions are using governance arrangements as part of efforts to develop climate-adaptation strategies to respond to climate change impacts. 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. With this in mind, the city of Victoria in Australia plans to leverage current interest in public health due to the COVID-19 pandemic and the influence of small and large local organizations to garner support for reducing barriers to climate-change adaptation planning and action, and to lay foundations for transformational adaptation changes (e.g., building climate-resilient infrastructure). Following the release of New Zealand's first national climate change risk assessment, the Government of New Zealand is in the process of developing a national adaptation plan that will outline what needs to be done to respond to the risks of climate change identified in the assessment. The French Government has produced the national guide for preventing and managing health and social impacts related to cold waves and a National Heatwave Plan that uses national meteorologic surveillance to issue heatwave alerts that vary based on the severity of the threat and the level of response needed. In addition, the French High Council on Public Health has produced a report that highlights areas in the national climate change adaptation strategy that may benefit from a closer inspection of potential health impacts, and has put forward recommendations across the domains of governance and interdisciplinarity, territoriality, monitoring and communication, and research. Strategic plans to respond to and adapt to public-health impacts of climate change have also been or are in the process of being developed by governments in Australia, Minnesota and Oregon.

Sustainability reporting guidelines are provided by the National Health Service (NHS) in the U.K. for public-sector organizations, and senior or strategic leaders can help develop or implement a Green Plan which sets out their aims, objectives and delivery plans for carbon reduction. The NHS intends to take a system-wide approach to sustainable commissioning for its healthcare system. In Germany, the German Environment Agency, Umweltbundesamt, leads the development of environmental risk assessments and delivers policy recommendations to the Ministry of Environment, as well as enforces environmental protection laws. California's government prioritizes protection of the vulnerable in its climate change actions through the work of the Climate Change and Health Equity Section (CCHES) of the CDPH to embed health and equity into California's climate change and public-health actions, and through collaboration with the Governor's Office of Planning and Research and Strategic Growth Council to provide technical assistance and monitoring of progress by state agencies toward protecting climate-vulnerable communities. Recommendations were made in a 2022 report for adjustments that are needed for the California Legislature to respond to the impacts of climate change. The recommendations included improving monitoring and analysis of health effects caused by climate change, increasing mechanisms to provide state-level guidance and expertise to support activities at the local level, providing additional funding to local public-health departments to increase expertise and capacity, requiring more training for healthcare providers on emerging conditions and diseases, and targeting state programs in ways that support vulnerable populations.

Financial arrangements

In relation to financial investments in Canada for public-health systems to address climate change, we found that the Government of Canada has invested more than $100 billion since 2015 towards climate action and clean-energy growth, with roughly $53.6 billion being invested towards Canada's green recovery since October 2020. Additionally, since the release of its climate plan in December 2020, the Government of Canada has reported on investments made to reduce the risks of climate change and support climate resiliency actions, including:

- the Canada Greener Homes Grant to provide up to 700,000 Canadian households with grants to make energy efficiency and climate-resilience improvements to their homes;
- the Green and Inclusive Community Buildings program that retrofits, repairs and upgrades new builds;
- a $1.8 million project with Ford Motor Company of Canada to build electric vehicles;
- the first federal fund for building active transportation (e.g., expanded bike lanes, trails, pathways, and pedestrian bridges) throughout Canada;
- the Smart Renewables and Electrification Pathway Program that will support projects investing in clean-energy technologies;
- a Natural Infrastructure Fund to support natural and hybrid infrastructure projects that aim to mitigate the impacts of natural events;
- the Agricultural Clean Technology Program that provides farmers and agri-business with funding to develop and adopt clean technologies to reduce greenhouse emissions and enhance competitiveness; and
- the Indigenous Off-Diesel Initiative that supports the transition of Indigenous communities that are diesel-reliant onto clean energy.

Additionally, the Low Carbon Economy Fund (LCEF) was established as part of the federal government's clean growth and climate action plans – the Pan-Canadian Framework on Clean Growth and Climate Change and the 2030 Emissions Reduction Plan – to support projects that will reduce Canada's greenhouse gas emissions, generate clean growth, and build resilient communities. Under the LCEF, provinces and territories will be provided up to $1.4 billion to implement the Pan-Canadian Framework on Clean Growth and Climate Change, and up $500 million for businesses, municipalities, not-for-profits, and Indigenous communities and organizations.

In Ontario, the provincial government is committing $324 million to the Green Investment Fund for projects that will assist homeowners and businesses to use less energy and reduce emissions, retrofit social housing, support more electric-vehicle charging stations across the province, and provide assessments for Indigenous communities on their vulnerabilities to climate change and support for development of adaptation plans. Funding has been provided for the Observatoire québécois de l'adaptation aux changements climatiques (OQACC) (Québec Observatory for Adaptations to Climate Change) by the Government of Québec and Université Laval to disseminate knowledge on many themes in climate change adaptation, including those related to major health issues (i.e., pollen allergies, Lyme disease).

Financial investments to adapt public-health systems to climate change have also been made in several of the other jurisdictions we reviewed. The government of Victoria, Australia will invest $40 million in energy upgrades for public-health facilities, including solar power and high-efficiency LED lights, which will deliver energy cost savings for public hospitals as well as lower emissions for Victoria. In New

Zealand's Budget 2021, funding was allocated to several climate-change initiatives, including $67.4 million to support the country's transition to a carbon-neutral public sector by the year 2025, a significant funding increase for the State Sector Decarbonisation Fund to support the replacement of coal boilers with clean-energy alternatives in schools, hospitals, and other government buildings, and increased funding of $41.8 million for the 'electric vehicle first' policy for leasing of low emissions vehicles across the public sector. In the following year's Budget 2022, a Climate Emergency Response Fund (CERF) of $4.5 billion was established, sourced from Emissions Trading Scheme revenue, to enable the costs of pollution to be directly recycled back into projects that reduce emissions. The Government of New Zealand is also in the process of deciding how emissions from agriculture should be priced, and the Climate Change Commission has advised the government to look at what financial assistance should be provided to farmers participating in any emissions-pricing schemes and to assess the readiness of farmers for a farm-level system for agricultural emissions pricing. A green private finance pilot has also begun in New Zealand with participating financiers to help businesses in New Zealand get financing for big decarbonisation projects depending on the types of sustainable products and services they offer.

In the U.S., the Governor of California, Gavin Newsom, signed a $15 billion package in 2021 to address the climate change risks faced in California, and signed 24 bills in July 2021 focused on climate and clean energy, drought, and wildfire preparedness. The package included a $3.7 billion Climate Resilience Package focusing on vulnerable front-line communities, $4.6 billion for drought and water resilience activities, and $988 million to address wildfire and forest resilience. California's Emergency Medical Services Authority (EMSA) was also allocated $36 million of funding in the 2021-22 state budget to increase the authority's capacity to surge medical staff, store and maintain equipment, respond to regional disasters, and develop a statewide emergency services data resources system. The California Environmental Protection Agency's (CalEPA) Environmental Justice Small Grants Program offers funding opportunities to assist eligible non-profit organizations and federally recognized Tribal governments in addressing environmental justice issues in areas disproportionately affected by environmental pollution and hazards. In Massachusetts, communities that complete the Municipal Vulnerability Preparedness (MVP) program, which aims to protect natural resources, infrastructure, public health, and the economy from climate change impacts, become certified as an MVP community and are eligible for MVP Action Grant funding and other financial support opportunities. Lastly, federal funding for mitigation actions that reduce climate risks has been made available to Oregon after including extreme heat as a health risk in its 2020 Natural Hazard Mitigation plan, and to Seneca Nation of Indians in New York for incorporating health into existing collaborative climate work focused on flooding and vector-borne diseases.

Delivery arrangements

In terms of enhancing public-health system delivery arrangements in Canada, the federal government established the Canadian Centre for Climate Services to help the public increase resilience to climate change by building local capacity, teaming up with regional climate organizations to build locally relevant information, and offering training and support to provinces and territories. The federal government also funded and developed the Climate Change Toolkit for Health Professionals to support health professionals and students in healthcare advocating for climate change mitigation policies and programs in their workplaces and communities.

In Manitoba, the International Institute for Sustainable Development and the University of Winnipeg co-launched the Prairie Climate Centre, which provides many organizations (including businesses, non-governmental organizations, and the government) with credible and up-to-date data and information to

help guide informed decision-making processes related to climate change management. In a series of climate-preparation plans from B.C.'s Ministry of Health and Provincial Climate Action Secretariat, several groups of actions that healthcare facility managers, administrative leadership, operations and maintenance staff can take to prepare for climate change are provided. These include planning and preparing climate-risk assessments, monitoring and evaluating results, and supporting local sustainability initiatives. Additionally, the Pacific Institute for Climate Solutions in B.C. published a report titled Climate, Health and COVID-19 in British Columbia that argues for virtual health and telemedicine as aids for reducing the carbon footprint of the health sector by reducing travel-related emissions. The authors propose that there is a window of opportunity to explore telemedicine as part of the province's climate-mitigation strategy given the investments made during the COVID-19 pandemic.

We also identified some experiences of other jurisdictions with enhancing public-health system delivery arrangements. In the U.K., health organizations can use the Sustainability in Quality Improvement resources to help monitor and evaluate sustainable change in healthcare, and in France, Santé Publique France maintains the 'réserve sanitaire', a volunteer reserve of health professionals, non-medical hospital staff, and health agency workers who can respond rapidly to health situations that exceed the capacities of local institutions. The Emergency Preparedness Office of California's Department of Health coordinates emergency planning and preparedness by operating and managing California's health alert network, planning for public health disasters, and providing resources for counties, local healthcare facilities, and state entities to prepare for catastrophic health threats. Training is provided to local health professionals in Minnesota, and to public health and emergency response personnel, community health workers, partner state agencies, and the general public in Oregon, on the health impacts of climate change, health equity, and strategies for reducing health impacts and building resilience.

Policy and program interventions

We found that policy and program interventions to adapt public-health systems to climate change impacts are continually being developed and built upon in Canada and in other jurisdictions. Health Canada coordinated a multi-year capacity-building program, HealthADAPT, to help the Canadian health sector prepare for and respond to the impacts of climate change by supporting increased understanding of climate change, local and regional climate change health adaptation plans, and monitoring of those programs. An investment of up to $3.6 million has been provided by the program, in partnerships with 10 health authorities in five provinces and territories, to support them in addressing climate-driven health risks. Canada also has an internationally recognized carbon-pollution pricing system that has been established by the federal government to place a national minimum price on pollution. The carbon-pollution pricing system gives provinces and territories the flexibility to implement the system that makes the most sense for their jurisdiction as long as benchmark minimum criteria are being met.

On 1 January 2019, the Government of Saskatchewan enacted the Oil and Gas Emissions Management Regulation, which regulates flared and vented methane emissions with the aim of reducing yearly emissions by 40-45% by 2025 in the oil and gas sector. In 2016, the Ontario Government established the Harmonized Heat Warning and Information System (HWIS) to mitigate health vulnerability of the population to heat-related illnesses, and the Eastern Ontario Health Unit implemented a Heat Event Response Program that provides education and raises awareness of heat-related illness to those at risk so that they can take appropriate precautions. Toronto, in particular, has a Heat Health Alert System that includes a three-day forecast outlook that is used by the Toronto Medical Officer of Health to determine when to issue a "Heat Alert" when the likelihood of excess weather-related mortality exceeds

65%, and an "Extreme Health Alert" when the likelihood is 90%. Toronto Public Health (TPH) conducts an annual review of Toronto's hot weather response and is also developing a mapping tool to visualize human vulnerability to extreme heat to help TPH identify and prioritize geographic hotspots for delivering resources during a heat alert. The City of Toronto is also actively working to reduce health risks from climate change and contribute to greenhouse gas mitigation through programs such as "A Commitment to Double the Tree Canopy", a project designed to provide shade and lessen the urban heat island effect, and "Building Green Roofs" that required the construction of a green roof on all new developments to reduce the negative effects on the urban heat island effect of large flat roofs.

The Institut national de santé publique du Québec (National Institute of Public Health of Québec) established a program, 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. In Prince Edward Island, the University of PEI's Climate Research Lab provided key recommendations for the provincial government related to public health, such as supporting the public to adapt to climate change, evaluate knowledge gaps, support interdisciplinary research, monitor and map environmental factors, and reduce non-climate factors (e.g., preventing chronic disease). Newfoundland and Labrador has a number of policy and program interventions in place, including the Muskrat Falls hydroelectric generating facility to generate hydroelectric power from three dams in the lower Churchill River that supply water to four power generating units, and the Home Energy Savings Program (HESP) which provides non-repayable grants up to $5,000 for energy efficiency upgrades in electrically heated homes. Additionally, the provincial government developed the Turn Back the Tide Campaign which provides a range of guidelines for households, businesses or communities to enhance climate resilience (e.g., building energy-efficient homes and businesses, assessing climate change vulnerability within communities, and managing municipal infrastructure).

The Artic Institute of Community-Based Research (AICBR) was established to link the health research capacity in the northern regions of Yukon, Northwest Territories, and Nunavut. The AICBR has worked with communities in Yukon to train youth as champions for climate change adaptation in their communities through the Yukon Indigenous Community Climate Change Champions Project, and to develop two inventory maps of climate change and food-systems initiatives in the territory through the Linking a Changing Climate with Changing Traditional Diet project. The Fire Smarting program in Yukon makes communities, buildings and homes less prone to damage from wildland fires, and other climate-adaptation initiatives taking place in Yukon include flood proofing, having support networks, enhancing access to health services during climate change-related emergencies, and improving energy conservation.

In terms of public-health policy and program interventions in other jurisdictions, we found that the New Zealand Government's Energy Efficiency and Conservation Authority (EECA) State Sector Decarbonisation Fund co-funded a pilot project in 2021 to enable the Crown agency, Kainga Ora, to use electric vehicles in their corporate vehicle fleet. At the cost of $1.6 million, the pilot project involved providing 24 people across 17 locations with home charging for their electric vehicles and routine engagement with participants, ultimately saving Kainga Ora an estimated 208 T carbon over three years, which is approximately 3,250 Auckland to Wellington flights. Santé Publique France maintains a program of work dedicated to heat waves and their health consequences, and NHS England has developed The Heatwave Plan for England to prepare, alert and prevent people from preventable health impacts from severe heat. We also found a briefing for directors of public health in the U.K. on air quality that was produced by a local association to help Directors of Public Health and local authorities consider appropriate public-health responses to air pollution in their area.

In the U.S., the CDPH's Licensing and Certification Program ensures the safety and continuity of care for patients/residents at the California facilities it licenses during heat-related emergencies, and the New York City Climate and Health Program (NYC CHP) has produced the NYC Heat Vulnerability Index, which provides an assessment of how the risk of dying during a heat emergency varies across neighbourhoods. Community initiatives to mitigate environmental impact were reported in a survey conducted by the Massachusetts Department of Public Health. Community initiatives that were reported included evacuating vulnerable populations during hazardous weather, implementing requirements for future developments in flooded zones, setting location and operational hours of cooling centres, and defining when to open a cooling centre. Finally, climate change resiliency programs in Massachusetts and New York are providing support to make buildings, systems and infrastructure in these states more sustainable and resilient.

Vélez CM, Waddell K, Bain T, Bhuiya A, Al-Khateeb S, Alam S, DeMaio P, Mehta V, Sharma K, Soueidan S, Alam S, Lavis JN, Wilson MG. Rapid evidence profile #31: What is the current readiness and capacity of Canadian public-health systems to address climate change, and how do they need to adjust their public-health functions and system features to do so? Hamilton: McMaster Health Forum, 20 July 2022.

To help health- and social-system leaders as they respond to pressing challenges related, the McMaster Health Forum prepares rapid evidence profiles like this one. This rapid evidence profile was commissioned by the Office of the Chief Science Officer, Public Health Agency of Canada. The opinions, results, and conclusions are those of the McMaster Health Forum and are independent of the funder. No endorsement by the Public Health Agency of Canada is intended or should be inferred.

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Appendices for Rapid Evidence Profile #31
(20 July 2022)

Appendix 1: Methodological details

Identifying research evidence

To identify evidence about the current readiness and capacity of Canadian federal, provincial and territorial (FPT) public-health systems to address climate change, and how they need to adjust their public-health functions and system features to do so, we used data from a living evidence synthesis that identified 17,105 documents as of the end of 2021. Of these documents, 402 mentioned Canada and/or one or more province in the title or abstract, and/or included at least one study conducted in Canada. Each of the 402 documents were assessed by a single reviewer to identify those relevant to the question. In addition, each of the included single studies were categorized by one reviewer according to the forms of evidence profiled in the Evidence Commission report (data analytics, modelling, evaluation, behavioural/implementation, and/or qualitative insights).

We supplemented this dataset by drawing on Social Systems Evidence and excluding duplicates that had already been included from the living evidence synthesis. In Social Systems Evidence, we used filters under programs and services for "climate action," "environmental conservation," "food safety and security," and "natural resources." We combined these with key words searches for "climate change" AND (health OR public health) and required that the documents mentioned Canada and/or one or more studies was conducted in Canada. A single reviewer assessed these documents for inclusion to ensure they related to the question.

Assessing relevance and quality of evidence

We assess the relevance of each included evidence document as being of high, moderate or low relevance to the question. We then use a colour gradient to reflect high (darkest blue) to low (lightest blue) relevance.

Two reviewers independently appraised the methodological quality of systematic reviews and rapid reviews that are deemed to be highly relevant. Disagreements are resolved by consensus with a third reviewer if needed. AMSTAR rates overall methodological quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. High-quality reviews are those with scores of eight or higher out of a possible 11, medium-quality reviews are those with scores between four and seven, and low-quality reviews are those with scores less than four. 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 health-system arrangements or to economic and social responses. 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.

Preparing the profile

Each included document is hyperlinked to its original source to facilitate easy retrieval. For all included guidelines, systematic reviews, rapid reviews and single studies (when included), we prepare declarative headings that provide a brief summary of the key findings and act as the text in the hyperlink. Protocols and titles/questions have their titles hyperlinked given that findings are not yet available. We then draft a brief summary that highlights the total number of different types of highly relevant documents identified (organized by document), as well as their key findings, date of last search (or date last updated or published), and methodological quality.

Appendix 2: Key findings from evidence documents that address the question, organized by document type and sorted by relevance

Type of document	Relevance to question	Key findings	Recency or status
Guidelines	None identified		

Full systematic reviews	• Essential public-health functions
	  ○ Health protection
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge and information
	  ○ Policy and program interventions
		• Communicating risk to the public can be particularly challenging for public health as individuals tend to pay more attention to their past experience with a weather event than to scientific assessments of risk
		• Risk communication tends to focus on short-term messaging to address immediate needs, though climate change communication requires long-term proactive strategies to motivate adaptive changes
		• In 2015, Ontario Public Health standards were updated to require effective communication with the public around climate change – this review was undertaken to inform local approaches that may be used
		• Very little research evidence exists on how to effectively communicate the long-term risks of climate change, however some promising practices include community engagement, initiatives that aim to enhance self-efficacy, and bi-directional communication with leaders and stakeholders
		• The review highlights that there is a possible opportunity for public health to adapt strategies commonly used for extreme weather events such as creating messaging that is grounded in local risks and is inclusive of vulnerable communities (e.g., accessible language, considers economic issues to stated protective actions, considers transportation issues to stated protective actions, partners with trusted community authorities)
		Source (AMSTAR rating 4/9)
			Literature last searched 2013

	• Essential public-health functions
	  ○ Health surveillance
	  ○ Health promotion
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge and information
		• Community-based monitoring is considered a promising strategy to improve the monitoring and local adaptation of food systems to climactic change, yet this has not been adopted in Indigenous communities, which are likely to feel significant effects in the upcoming years from changing climates
		• A food monitoring system can help to reduce the climate change impacts on food systems through early identification of
			Literature last searched March 2018

	○ Policy and program interventions	vulnerable areas and crops, and allow for adaptation strategies to be tested and implemented • Existing approaches to monitoring food security are typically done through population-based surveys at the national level which fail to provide a nuanced understanding of the effects among particular populations; further they do not adequately engage or collaborate with Indigenous peoples and are not appropriate for understanding the importance of specific foods to certain populations • In addition, measures of attributing food security challenges to climate change are still in development and clear attribution models are not yet in place • Community-based monitoring is thought to be a potential solution to these challenges, whereby groups collaborate to track and respond to issues of common concern and can vary from community-directed interests and undertaking of monitoring to community involvement in data collection • As Indigenous communities have been monitoring the environment for centuries, there is an opportunity to use both Indigenous and western knowledge systems to develop a deeper understanding of pressures on the food systems • The review of the literature found that a range of approaches had been used to enable community-based monitoring (e.g., GIS mapping, GPS tracking and use of aerial surveys), and it was predominantly used to monitor wildlife, natural resources and fisheries, but rarely included a focus on climate change indicators (those that did were from Nunavik and Alaska and tracked ice conditions) • Evaluations of the effectiveness of community-based monitoring was relatively sparse and additional research should be undertaken to determine whether this could be an appropriate solution to scale up across the country Source (AMSTAR rating 4/9)	
	• Essential public-health functions ○ Population-health assessment • Public-health system features ○ Delivery arrangements	• The review examined the association between climactic factors and infectious disease in the arctic and sub-arctic regions • Strong evidence was found for the association between climactic factors for food- and waterborne diseases, largely because of	Literature last searched May 2013

	▪ Evidence, knowledge and information	increased temperature and increased precipitation which increases the incidence of these diseases • Some evidence was found for an expected increase in vector- and rodent-borne diseases as climate changes in temperature, precipitation, and changes to the length of seasons change the suitability, reproduction, distribution and abundance of vectors and rodents • The review noted that because of the frequently aggregated, population-level data used in the included studies, it was difficult to draw conclusions regarding which populations were most vulnerable to climatic factors • Additional gaps in knowledge include surveillance mechanisms to ensure risk of disease is appropriately and reliably calculated, and additional studies focused on confounding and intermediate factors, particularly for climatic effects of vector- and rodent-borne diseases Source (AMSTAR rating 2/9)	
	• Essential public-health functions o Population-health assessment • Public-health system features o Delivery arrangements ▪ Evidence, knowledge and information o Policy and program interventions	• Changing climate conditions are negatively affecting the health and well-being of individuals in rural and remote regions, including: increased prevalence and severity of extreme weather events, changes to sea ice, vegetation, fish, and wildlife and weather and environmental uncertainties • Based on a synthesis of the literature from this scoping review, key health concerns in rural and remote areas include: o challenges with access to and quality of food and water o exacerbation of chronic illness and infectious disease o potential unintentional injury and death o intensified challenges with mental health and well-being o Indigeneity, age, gender, and socioeconomic status as key factors influencing individual and community vulnerability to climate change in rural and remote regions • Authors describe adaptation strategies that are already in place: o Introducing local food production systems o Using experience-based knowledge of local communities to support community resilience o Developing community-based monitoring programs and research to gather data about environment and health to inform decision-making	Literature last searched 2019

		○ Using Indigenous knowledge and local knowledge regarding the physical environment, to support hazard avoidance and emergency preparedness ○ Utilizing a social development approach, which involves health professionals, social workers, and those in caring professions supporting those directly affected by climate change to strengthen community capacity ○ Fostering protective factors for physical and mental health through connection to land-based activities, cultural arts and crafts, and opportunities for bringing community together • Additional details for the implementation or evaluation of these adaption strategies were not provided • Authors also suggest some potential adaptation strategies that should be implemented: ○ Using local knowledge, Indigenous knowledge, and/or western knowledge to respond to specific local socio-cultural contexts ○ Eliminating social barriers to adaptation (e.g., poverty, inequality, housing concerns, etc.) and reducing non-climatic factors (e.g., chronic disease) ○ Utilizing innovative forms of technology (e.g., telehealth, mobile monitoring applications; satellite imagery) ○ Improving public-health surveillance and furthering monitoring programs ○ Supporting sustainable development practices (e.g., clean-energy programs) ○ Enhancing communication and awareness of risks and responses (e.g., lists of safe spaces, pamphlets regarding disease outbreaks, developing outreach strategy) ○ Expanding knowledge of climate change impacts on health through research and investment, and sharing best practices for public-health adaptation ○ Developing the capacity of health systems and emergency response to withstand and respond to climate risks (e.g., creating technical guidance and training courses; integrating climate change into medical and public-health training) Source (AMSTAR rating 2/9)	
Rapid reviews			

Protocols for reviews that are already underway			
Titles and questions for reviews being planned			

Single studies	• Essential public-health function
	  ○ Disease and injury prevention
	• Public-health system features
	  ○ Policy and program interventions
		• Recent models predict an increase in extreme heat and heat waves which are correlated with hospitalization and risk of mortality, particularly among those from lower socio-economic backgrounds, those who live alone, and those over 65
		• However, many current heat-health campaigns that aim to raise awareness report a disconnect between the communication strategy and behaviours performed
		• Relatively little research has been undertaken to determine how public health should best communicate the risk associated with increased temperatures to seniors
		• Participants in the study reported having varied experiences with extreme heat and its consequences as well as varied perceptions of the potential consequences
		• Participants suggested that heat warnings needed to be locally tailored with resources such as local cooling centres
		• They also identified trusted sources of information that could be used to further disseminate information, including doctors, pharmacists, community centres and local newspapers
		• Different communication strategies should be used for those who have access to appropriate resources and those who do not – this would avoid the dismissal of public-health communication as irrelevant
		• Another strategy could be to use peer-based approaches as these communications tend to destigmatize the discussion and increase the efficacy of information by increasing openness to discussion
		Source
			Published July 2020

	• Essential public-health functions
	  ○ Health surveillance
	  ○ Disease and injury prevention
	  ○ Emergency preparedness and response
		• Climate risks will require public-health systems in Canada to adapt, and in Ontario this may be exacerbated by an increase in vulnerable populations
		• Study aims to provide a baseline understanding of the status of adaption in the Ontario public-health sector	

	• Public-health system features
	  ○ Governance arrangements
	  ○ Financial arrangements
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• Participants in the study noted that they felt local public health was well-poised to handle the acute effects, for example, one off extreme events, but reported greater concern about the creeping effects of climate change on food and water safety as well as vector-borne diseases
		• Participants noted that adaptation practices are not entirely mainstream, but were evolving with newly mandated provincial programs including planned climate change and health-impact assessment, environment health surveys, and regional climate change adaptation strategy
		• Municipalities use a range of different approaches to address climate change health vulnerabilities, but there is relatively little systematic practice across the province or sharing of approaches
		• Current constraints to adaptation include inadequate resourcing and knowledge gaps across the three main areas of information, science and technology; infrastructure; and human resources and institutions
		• When asked to prioritize development needs, participants highlighted the need for increased roles by the provincial and federal government in developing standards and guidelines for climate change adaption, as well as providing long-term stable funding for adaption initiatives
		Source	

	• Essential public-health functions
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
	  ○ Policy and program interventions
		• Initial emergency response for climate hazards rest with the municipal government, or in the case of First Nations with the band council
		• The number of wildfires in Canada have significantly increased and Indigenous communities in close proximity have been severely affected; further recent studies have found that evacuations in these communities have been hampered by poor communication and a lack of well-developed evacuation plans
		• This was further evidenced in an Auditor General of Canada report which found that emergency plans were lacking in many First Nations communities and inadequate funding was being provided by other levels of government for their development
		• Recommendations for how to improve evacuation practices include: the widespread use of emergency plans, hiring personnel	

		in the event of a future wildfire, designating communities to host evacuees that have appropriate accommodation and resources available Source	

	• Essential public-health functions
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Policy and program interventions
		• Extreme heat events have already led to morbidity and mortality and are expected to increase in the coming years; as a result Health Canada is working on a Heat Resilience Program
		• The study examines different temperature indices relevant for the public-health sector as existing methods don't often take into consideration the many different vulnerabilities, daytime and night-time temperatures, and diversity of communities
		• Using temperature projections from the Canadian Regional Climate Model, the study used a quantile-based statistical correction to reduce model biases and account for error in existing models
		• The analysis found that the greatest increase in extreme daytime temperatures using an adapted model took place in southern Manitoba, where accounting for the additional climate variables led to an increase in the projected heat extremes
		• In addition, the model projected significant increases in night-time heat in communities surrounding the Great Lakes, which may require adaptation to ensure vulnerable communities get reprieve from heat
		Source
			Published December 2013

	• Essential public-health functions
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Policy and program interventions
		• A Montreal heat plan has been created to ensure the surveillance of weather and health indicators during the summer season
		• A plan had been put in place, with the municipality leading the response
		• Despite significant monitoring and interventions made in response to the increased temperatures, 304 deaths were reported over six days in 2010
		• In response, the city updated its heat plan to focus on indicators such as Info-Sante, pre-hospital transports and community deaths as these are rapidly available
		• In addition, it was decided that two instead of three days of predicted threshold temperature (33 degrees C) would be used to determine onset of intervention
			Published 2013

		• Chart reviews from the heat wave indicated that individuals with mental illness in Montreal and those who use drugs and alcohol should be added to the list of vulnerable individuals, and communications should be tailored to these populations as well Source	

	• Essential public-health functions
	  ○ Health surveillance
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Policy and program interventions
		• Following a significant heat wave in Europe, Montreal developed a heat action plan in 2004 with important interventions including: triggering an active watch when temperatures exceed 30 degrees C, issuing public advisories via media about preventive measures, intensifying surveillance and implementation of preventive measures in health facilities (e.g., increased monitoring of in-patients, transfer of patients to common areas with air conditioning, daily contact with home-care patients), extended operations of public pools and opening of cooling (or air-conditioned) shelters
		• The study found some evidence that the heat action contributed to reductions in mortality on hot days and may have had a positive effect on reducing some inequities in heat-related health impacts, particularly among elderly people and those living in low-socio-economic neighbourhoods
		Source
			Published November 2016

	• Essential public-health functions
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Policy and program interventions
		• Heat waves are projected to increase in frequency and intensity and will raise heat-related premature mortality among the elderly and urban poor
		• Concerns have prompted the Canadian governments to initiate campaigns to educate the public, develop heat-warning systems and create emergency response programs, but as of 2007 only two major Canadian cities (Montreal and Toronto) had health response programs in place
		• In Toronto this plan is triggered by a spatial synoptic classification system which works to identify air masses and weather systems associated with increases in mortality, which is advantageous as it is locally tailored, but challenging as it relies on complex and large amounts of data
		• Other communities rely on humidex thresholds compounded over several days, however this approach fails to take into
			Published December 2011

		consideration the variability of responses to heat and different acclimatation of populations • The difference in measurement approaches and inconsistencies in heat-emergency responses (including the responsibility for issuing warnings) create significant challenges in responding to and preparing the population for heat-related climactic events • A survey of households in five major Canadian cities undertaken as part of the study demonstrates that individuals are well aware of heat spells, but were relatively less aware of government mitigation efforts (i.e., establishment of cooling centres) through the heat-related action plans, and indicates the need to increase outreach initiatives and communication efforts on how individuals can limit exposure to hot and humid conditions Source	

	• Essential public-health functions
	  ○ Emergency preparedness and response
	• Public-health system features
	  ○ Policy and program interventions
		• Following the development of the heat action plan, Quebec followed suit with a provincial cold-health watch and warning system
		• The system proposes a combined threshold and indicator approach which uses temperature thresholds of between -15 and -29 degrees C, combined with hospital admissions to declare a cold-weather warning
		• Though the system is not yet in place, it is a first effort to develop similar plans to those that have been used for heat warnings and adapt them to other climactic events
		Source
			Published November 2020

	• Essential public-health functions
	  ○ Health surveillance
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
	  ○ Policy and program interventions
		• In the context of the Government of Quebec's 2006-2012 Action Plan on Climate Change, a real-time integrated system for the surveillance and monitoring of extreme heat events has been implemented on a provincial level
		• The system is a component of a broader approach that would also monitor the public-health impacts of all types of extreme meteorological events
		• Authors reported how the Quebec National Institute for Public Health developed and implemented an integrated web application for the real-time Surveillance and Prevention of the impacts of Extreme Meteorological Events on public health, called the SUPREME system
			Published in 2011

		• This decision-support system is based on open-source software and is composed of four modules: data acquisition and integration; risk analysis and alerts; cartographic application; and information dissemination - climate change and health portal (initially only including heat) • The system is available to health specialists through a secure web information portal and provides access to weather forecasts, historic and real-time indicators (including deaths and hospital admissions), alerts, and various cartographic data used for conducting prevention activities and launching emergency measures • Authors mentioned how the SUPREME system was implemented and used during the summer of 2010, and served as an important decision-making tool during the July 2010 heat wave in the province of Quebec Source	

	• Essential public-health functions
	  ○ Health surveillance
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
	  ○ Policy and program interventions
		• This study described the process put in place for public-health surveillance and assessment of the impacts on health for the southern Alberta area that experienced flooding that affected approximately 100,000 people in 2013
		• Public-health surveillance was implemented for the six-week period after the flood to detect anticipated health events, including injuries, mental health problems and infectious diseases
		• Authors found an increase in injuries was detected through emergency-department visits among Calgary residents (rate ratio [RR] 1.28, 95% confidence interval [CI]: 1.14-1.43) and was supported by a 75% increase in the average weekly administration of post-exposure prophylaxis against tetanus
		• Mental health impacts in High River residents were observed among females through a 1.64-fold (95% CI: 1.11-2.43) and 2.32-fold (95% CI: 1.45-3.70) increase in new prescriptions for anti-anxiety medication and sleep aids respectively
		• An increase in sexual assaults presenting to emergency departments (RR 3.18, 95% CI: 1.29-7.84) was observed among Calgary residents
		• No increases in infectious gastrointestinal disease or respiratory illness were identified
			Published in 2016

		• Timely identification and communication of surveillance alerts allowed for messaging around the use of personal protective equipment and precautions for personal safety • Authors concluded that a strength of Alberta's post-flood surveillance was the ability to monitor real-time or near real-time health data using pre-existing sources and indicators; this surveillance made possible comparisons with pre-flood baseline counts and rates • Authors suggested this capability is often missing from post-disaster surveillance, which tends to be retrospective and include post-event data only which makes it difficult to assess whether an increase was temporarily associated with the event • Challenges emerged in integrating the results found in multiple datasets, using different indicators, populations and baseline periods Source	

	• Essential public-health functions
	  ○ Health surveillance
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• This study mapped the population groups most vulnerable to extreme heat in Vancouver; authors overlaid multiple layers of socio-economic, environmental, and infrastructural data
		• By superimposing multiple disparate data layers, authors were able to detect and visualize 105 socio-economically deprived dissemination areas with high vulnerability to extreme heat events
		• The three dissemination areas found to be most vulnerable to heat varied from the rest of the sample in terms of environmental and infrastructural variables; these areas also have relatively low vegetation cover as well as relatively hot surface temperatures, and are far from cooling and health infrastructure
		• Authors concluded that this effort is a preliminary step toward the development of tools that support health authorities, city officials and policymakers to better understand who is at risk during extreme heat events, where they reside, what factors drive the risk, and ultimately what can be done to mitigate it
		Source
			Published in 2016

	• Essential public-health functions ○ Population-health assessment • Public-health system features	• This paper presents an adaptation index to high summer heat whose validity was tested by correlating it with self-reported adverse health impacts to heat	Published in 2015

	○ Delivery arrangements ▪ Evidence, knowledge, and information	• The data comes from a 2011 cross-sectional study conducted in the most deprived areas in nice cities of 100,000 or more inhabitants in Quebec • This individual-level adaptation index summarizes a range of 14 easy-to-use and energy-efficient solutions for cooling off or protecting oneself against the sun, both at home and in other places, whether indoors or out • Authors consider this tool can help health authorities, city officials, and policymakers better understand who is at risk during extreme heat events, where these people reside, and what factors drive their local risk • Authors suggest that tools like this help with the successful implementation of short-term emergency management efforts and longer-term urban planning interventions to reduce health effects of extreme heat events Source	
	• Essential public-health functions ○ Population-health assessment • Public-health system features ○ Delivery arrangements ▪ Evidence, knowledge, and information	• This paper forms the first part of an approach to assess differential and combined impacts of extreme temperatures and air pollution on human mortality in south–central Canada, focusing on historical analysis • Authors found annual mean elevated mortality (when daily mortality exceeds the baseline) associated with extreme temperatures and acute exposures to air pollution • Based on 1954–2000 data, elevated mortality was 1,082 [95% confidence interval (CI) of 1,017–1,147] for Montreal, 1,047 (CI 994–1,100) for Toronto, 462 (CI 438–486) for Ottawa, and 327 (CI 311–343) for Windsor • Of this annual mean elevated mortality, extreme temperatures are usually associated with roughly 20%, while air pollution is associated with the remaining 80% • Three pollutants (ozone, sulfur dioxide, and nitrogen dioxide) are associated with approximately 75% of total air pollution-related mortality across the study area • The remaining 25% is almost evenly associated with suspended particles and carbon monoxide	Published in 2008

		• Of the five pollutants, ozone is most significantly associated with elevated mortality, making up one-third of the total air pollution-related mortality • Authors found that, based on daily mortality risks, extreme temperature-related weather presents a much greater risk to human health during heat waves and cold spells than air pollution • Authors concluded that this study provides decision-makers with scientific information needed for public policy risk identification and assessment, information necessary to help them develop better policies on health protection and to balance policy decisions Source	

	• Essential public-health functions
	  ○ Population-health assessment
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• This paper forms the second part of an approach to assess differential and combined impacts of extreme temperatures and air pollution on human mortality, focusing on future estimates
		• A statistical downscaling approach was used to downscale daily five general circulation model (GCM) outputs (three Canadian and two U.S. GCMs) and to derive six-hourly future climate information for the selected cities (Montreal, Ottawa, Toronto, and Windsor) in south–central Canada
		• Two independent approaches, based on comparing future and historical frequencies of the weather groups and applying within-weather-group elevated mortality prediction models, were used to assess climate change impacts on elevated mortality for two time windows (2040–2059 and 2070–2089)
		  ○ Heat-related mortality without consideration of population acclimatization to increased heat is projected to be more than double by the 2050s and triple by the 2080s
		  ○ When the population acclimatization to the increased heat was taken into account, projected future heat-related mortality could be reduced by 40%; by the 2050s, heat-related mortality is projected to increase by 70–90% and by the 2080s, by 120–140%
		  ○ By the 2050s, cold-related mortality is projected to decrease by about 45% for Montreal and Ottawa, and by 60% for Toronto and Windsor; by the 2080s, the percentage decrease could be more similar across the study area (60–70%)
			Published in 2008

		○ Air pollution-related mortality is projected to increase by about 20–30% by the 2050s and about 30–45% by the 2080s; this increase would be largely driven by increases in ozone-related elevated mortality • It is most likely that the estimate of future extreme temperature- and air pollution-related mortality from this study could represent a bottom-line figure since many of the factors (e.g., population growth, age structure changes, and adaptation measures) were not directly considered in the analyses • Authors concluded that given the results of this study, a national strategy on human health impacts should be given careful consideration, since the healthcare system in Canada could become further stressed by climate change in the middle and late part of this century • Authors suggested that results of this study might be helpful in providing scientific information for the development of a national strategy on human health adaptation policies in response to projected global warming Source	
	• Essential public-health functions ○ Population-health assessment • Public-health system features ○ Delivery arrangements ▪ Evidence, knowledge, and information	• This study identifies the characteristics and perceptions related to the individual, the dwelling and the neighbourhood of residence associated with the prevalence of self-reported adverse health impacts, and an adaptation index when it is very hot and humid in summer in the most disadvantaged sectors of the nine most populous cities of Québec • The study uses a cross-sectional design and a stratified representative sample; 3,485 people (individual-level) were interviewed in their residences • Multilevel analysis was used to perform 3-level models nested one in the other to examine individual impacts as well as the adaptation index • Authors found four building-level and dissemination areas (DA-level) covariables that strengthen the importance of the role of buildings and the environment as risk (or prevention) factors of self-reported health impacts and adaptation to heat ○ The prevalence of self-reported negative health impacts when it is very hot and humid in summer	Published 2016

		○ Poor physical or mental health is a powerful indicator of risk to heat ○ Residential neighbourhoods considered somewhat or very polluted due to high urban traffic density are likely more paved and therefore hotter ○ Highly paved and thus more impermeable neighbourhoods contribute to the negative health impacts of heat and result in the deployment of various adaptations • Authors suggested the establishment of a framework would be very useful for research and public-health surveillance, for clarifying the kind of links between covariables Source	
	• Essential public-health functions ○ Population-health assessment • Public-health system features ○ Delivery arrangements ▪ Evidence, knowledge, and information	• This study examined vulnerability in the relationship between heat and years of life lost and apply to neighbourhood social disparities in Montreal and Paris • Authors used historical data from the summers of 1990 through 2007 for Montreal, and from 2004 through 2009 for Paris to estimate daily years of life lost social disparities (DYLLD), summarizing social inequalities across groups • Authors also used 30 climate scenarios of daily mean temperature to estimate future temperature distributions (2021–2050) • Authors found that an increase in ambient temperature leads to an increase in social disparities in daily years of life lost • The impact of climate change on DYLLD attributable to temperature was 2.06 (95% CI: 1.90, 2.25) in Montreal and 1.77 (95% CI: 1.61, 1.94) in Paris • Heat-related neighbourhood socioeconomic status disparities were larger in Montreal than in Paris in both historical (1981–2010) and future (2021–2050) periods Source	Published in 2015
	• Essential public-health functions ○ Population-health assessment • Public-health system features ○ Delivery arrangements ▪ Evidence, knowledge, and information	• This study performed a health risk assessment of PM2.5 emissions during congestion periods in the Greater Toronto and Hamilton Area (GTHA) • Authors used a micro-level approach that combines the Stochastic User Equilibrium Traffic Assignment Algorithm with a MOVES emission model to estimate emissions considering congestion conditions	Published in 2017

		• Authors found that traffic congestion has a substantial impact on human health and the economy in the GTHA, especially at the most congested period (7 a.m.) • Considering daily mortality, results showed an impact of 206 (boundary test 95%: 116; 297) and 119 (boundary test 95%: 67; 171) deaths per year (all-cause and cardiovascular mortality, respectively) • The economic impact from daily mortality is approximately $1.3 billion (boundary test 95%: 0.8; 1.9), and $778 million (boundary test 95%: 478; 981), for all-cause and cardiovascular mortality, respectively • Authors concluded that this study expanded the scientific knowledge on the impacts of traffic congestion, which should be of interest to policymakers to create future strategies related to environmental health and transportation infrastructure • Reliable projections of transportation and air-pollution levels will improve the capability of the medical community to prepare for future trends Source	

	• Essential public-health functions
	  ○ Population-health assessment
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• This study used distributed lag modelling to characterize temperature-mortality relationships in 15 Canadian cities (Calgary, Edmonton, Halifax, Hamilton, London, Montreal, Ottawa, Quebec City, Regina, Saskatoon, Saint John's, Toronto, Vancouver, Winnipeg, and Windsor)
		• The study also examined historical trends in temperature variation across Canada and developed city-specific general linear models to estimate change in high- and low-temperature-related mortality using dynamically downscaled climate projections for four future periods centred on 2040, 2060 and 2080
		• Authors found that the minimum mortality temperature is frequently located at approximately the 75th percentile of the city's temperature distribution, and that Canadians currently experience greater and longer lasting risk from cold-related than heat-related mortality
		• Authors did not find evidence that temperature variation is increasing in Canada; however, the projected increased
			Published in 2012

		temperatures are sufficient to change the relative levels of heat- and cold-related mortality in some cities • While most temperature-related mortality will continue to be cold-related, study models predict that higher temperatures will increase the burden of annual temperature-related mortality in Hamilton, London, Montreal and Regina, and decreased burdens are predicted in the other 11 cities (Calgary, Edmonton, Halifax, Ottawa, Quebec City, Saskatoon, Saint John's, Toronto, Vancouver, Winnipeg, and Windsor) Source	

	• Essential public-health functions
	  ○ Population-health assessment
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• The healthcare sector itself contributes to pollutant emissions, both directly from facility and vehicle emissions and indirectly through the purchase of emissions-intensive goods and services
		• This study estimated the extent of healthcare-associated life cycle emissions as well as the public health damages they cause using a linked economic-environmental-epidemiological modelling framework to quantify pollutant emissions and their implications for public health, based on Canadian national healthcare expenditures over the period 2009-2015
		• Authors found that Canada's healthcare system was responsible for 33 million tonnes of carbon dioxide equivalents (CO2e), or 4.6% of the national total, as well as >200,000 tonnes of other pollutants
		• These emissions were linked to a median estimate of 23,000 disability-adjusted life years (DALYs) lost annually from direct exposures to hazardous pollutants and from environmental changes caused by pollution, with an uncertainty range of 4,500-610,000 DALYs lost annually
		• A limitation of this national-level study is the use of aggregated data and multiple modelling steps to link healthcare expenditures to emissions to health damages; while informative on a national level, the applicability of these findings to guide decision-making at individual institutions is limited, And uncertainties related to national economic and environmental accounts, model representativeness, and classification of healthcare expenditures are discussed
		• The study conclusion indicates findings corroborate similar estimates for the United Kingdom, Australia and the United
			Published in 2018

		States, with emissions from hospitals and pharmaceuticals being the most significant expenditure categories • Authors suggested this work can guide efforts by Canadian healthcare professionals toward more sustainable practices • For example, the International Monetary Fund (IMF) has estimated that implementation of nationally appropriate energy prices that incorporate health impacts could cut ambient air pollution deaths by approximately one-third and reduce GHG emissions by more than 20% Source	

	• Essential public-health functions
	  ○ Population-health assessment
	• Public-health system features
	  ○ Delivery arrangements
	  ▪ Evidence, knowledge, and information
		• In this commentary, the authors present a new assessment of evidence from a scoping review of literature published during 2000-2017, and highlight factors that influence the capacity to adapt to the mental health consequences of a changing climate
		• Findings from this assessment reveal eleven key factors that influence the capacity to adapt:
		  ○ Social capital (helps to reduce social isolation, loneliness, and feelings of abandonment)
		  ○ Sense of community;
		  ○ Government assistance (for instance, Alberta responded to the 2013 Southern Alberta floods by allocating $50 million to specifically support the current and future mental health needs of Albertans affected by the flood, along with the creation of the first Chief Mental Health Officer)
		  ○ Access to care: financial (mental health services vary by province and many are not covered under Canada's universal healthcare program; services not covered by universal healthcare will require private insurance to cover these expenses or they will need to pay for these services, which can make them inaccessible for many Canadians)
		  ○ Access to care: healthcare facilities
		  ○ Community preparedness
		  ○ Intersectoral/transdisciplinary collaboration ("a multi-sector approach that involves communities as well as agencies is the best way to promote wellbeing and recovery")
		  ○ Vulnerability and adaptation assessments;
		  ○ Communication and outreach (The United Nations Office for Disaster Risk Reduction (UNISDR) suggests that clear, early-
			Published in 2019

		warning communication efforts can save lives during extreme weather events, and can increase community resilience by supporting people to assess risks and respond before an extreme weather event occurs) ○ Mental health literacy ○ Culturally relevant resources • Authors concluded that attention to these factors by Canadian decision-makers can support proactive and effective management of the mental health consequences of climate change Source	
	• Essential public-health functions ○ Health protection • Public-health system features ○ Delivery arrangements ▪ Evidence, knowledge, and information	• Adaptation can direct attention to the root causes of climate vulnerability and emphasize the importance of traditional knowledge regarding environmental change and adaptive strategies; in this study, authors addressed determinants of health vulnerability to climate change in Canada to propose key considerations for adaptation decision-making in an Inuit context • Adaptation refers to policies, measures, and strategies designed to reduce climate change impacts and support resilience; adaptation is synonymous with prevention • These can be broadly categorized as focusing on better management of existing climatic risks, identifying opportunities to enhance cultural and institutional capacity to respond to changes in existing risks, or transformational change to manage future conditions that are projected to be quite different from today • In this article, authors focused on the first two categories, in which adaptation is about doing things we should already be doing, but better –tackling pathways that lead to ill health, building upon traditional knowledge and cultural values, and targeting the social determinants of health that are the root causes of many climate-related health vulnerabilities • Adaptation is about enhancing current management of climate-related health risks ○ Potential policies for adaptation include: – Enhance surveillance, monitoring, and early warning systems	Published in 2014

		– Evaluate search and rescue capability, and public-health and surveillance systems – Emergency preparedness education – Recognize and promote traditional health systems o One example of successful actions is the International Circumpolar Surveillance System which has collected and shared data on infectious diseases in the Arctic since 1999; this system leverages existing surveillance systems to provide early warning and has led to evidence-based policy interventions, such as a vaccination program against Strepococcus pneumonia • Adaptation is about tackling the root causes of vulnerability o Potential policies for adaptation – Poverty alleviation initiatives – Strengthen role of Inuit in decision-making – Enhance the determinants of health: access to food, clean water, safe shelter, family support networks, employment opportunities, strong physical, mental, emotional and spiritual health – Provide culturally appropriate health services and programming o In British Columbia, epidemiological research by Chandler and Lalond demonstrates a positive correlation between indicators of self-determination, including self-government and local control over health delivery services, and reduced youth and adult suicide rates • Adaptation is about leveraging and building on socio-cultural strengths o Potential policies – Add culturally relevant and locally appropriate materials to school curriculum – Strengthen land-based learning – Document, preserve, and promote traditional knowledge – Increase Elder and youth knowledge sharing – Create cultural programming • Adaptation is about integrating a climate change lens into policy programming	

		○ Potential policies – Apply climate change screening lens to policy programs at multiple levels – Educate local and regional health practitioners about potential climate-related health impacts ○ The Upagiaqtavut: Setting the Course framework, released by the Department of Environment of the Government of Nunavut in 2011, provides strategic direction for adaptation to climate change in Nunavut rooted in Inuit societal values; it incorporates a climate change screening lens for territorial-level policy Source	

Appendix 3: Medium and low relevance evidence documents included but not profiled in the summary

Hyperlinked document title
Effects of diurnal variations in temperature on non-accidental mortality among the elderly population of Montreal, Quebec, 1984-2007
Hospitalizations from Hypertensive Diseases, Diabetes, and Arrhythmia in Relation to Low and High Temperatures: Population-Based Study
Air Pollution and Emergency Department Visits for Mental Disorders among Youth
Air Pollution and Emergency Department Visits for Conjunctivitis: A Case-crossover Study
Exposure to urban air pollution and emergency-department visits for diseases of the ear and mastoid processes
Air Pollution and Emergency Department Visits for Otitis Media: A Case-Crossover Study in Edmonton, Canada
Air Pollution and Emergency Department Visits for Disease of the Genitourinary System
Air Pollution and Daily Emergency Department Visits for Depression
Outdoor air pollution and emergency department visits for asthma among children and adults: A case-crossover study in northern Alberta, Canada
Extreme heat and paediatric emergency department visits in Southwestern Ontario
Pollutant sex-specific differences in respiratory hospitalization and mortality risk attributable to short-term exposure to ambient air pollution
Ambient air pollution exposure and emergency department visits for substance abuse
Extreme ambient temperatures and cardiorespiratory emergency room visits: assessing risk by comorbid health conditions in a time series study
Air pollution and daily ED visits for migraine and headache in Edmonton, Canada
Temperature and place associations with Inuit mental health in the context of climate change
Upper gastrointestinal bleeding due to peptic ulcer disease is not associated with air pollution: a case-crossover study
Summer outdoor temperature and occupational heat-related illnesses in Quebec (Canada)
Effects of climate and fine particulate matter on hospitalizations and deaths for heart failure in elderly: A population-based cohort study
Comparison of transient associations of air pollution and AMI hospitalisation in two cities of Alberta, Canada, using a case-crossover design
Associations between ambient air pollution and daily mortality among elderly persons in Montreal, Quebec
Risk of Asthmatic Episodes in Children Exposed to Sulfur Dioxide Stack Emissions from a Refinery Point Source in Montreal, Canada
The use of Bayesian inference to inform the surveillance of temperature-related occupational morbidity in Ontario, Canada, 2004-2010
Ambient air pollution and daily emergency department visits for headache in Ottawa, Canada
Short-term effects of ambient air pollution on stroke: Who is most vulnerable?
Associations between meteorological factors and emergency department visits for unintentional falls during Ontario winters
Heat and pregnancy-related emergencies: Risk of placental abruption during hot weather
Respiratory hospital admissions in young children living near metal smelters, pulp mills and oil refineries in two Canadian provinces
Evaluation of a Wildfire Smoke Forecasting System as a Tool for Public Health Protection
Health risk of air pollution on people living with major chronic diseases: a Canadian population-based study

Three Measures of Forest Fire Smoke Exposure and Their Associations with Respiratory and Cardiovascular Health Outcomes in a Population-Based Cohort
The Heat Exposure Integrated Deprivation Index (HEIDI): A data-driven approach to quantifying neighbourhood risk during extreme hot weather
Evaluating the potential public health impacts of the Toronto cold-weather program
Evaluating the association between extreme heat and mortality in urban Southwestern Ontario using different temperature data sources
Increasing urban albedo to reduce heat-related mortality in Toronto and Montreal, Canada
Systematic identification and prioritization of communities impacted by residential woodsmoke in British Columbia, Canada
Long-term exposure to air pollution and the incidence of multiple sclerosis: A population-based cohort study
Do acute changes in ambient air pollution increase the risk of potentially fatal cardiac arrhythmias in patients with implantable cardioverter defibrillators?
Air quality in Canadian port cities after regulation of low-sulphur marine fuel in the North American Emissions Control Area
The potential impact of climate change on annual and seasonal mortality for three cities in Quebec, Canada
The short-term influence of weather on daily mortality in congestive heart failure
A Data-driven Approach to Setting Trigger Temperatures for Heat Health Emergencies
Birth outcomes, pregnancy complications, and postpartum mental health after the 2013 Calgary flood: A difference in difference analysis
Establishing Heat Alert Thresholds for the Varied Climatic Regions of British Columbia, Canada
Effects of cold temperature and snowfall on stroke mortality: A case-crossover analysis
Development and Validation of a Behavioural Index for Adaptation to High Summer Temperatures among Urban Dwellers
Cold Weather Conditions and Risk of Hypothermia Among People Experiencing Homelessness: Implications for Prevention Strategies
Extreme Heat and Risk of Early Delivery Among Preterm and Term Pregnancies
Associations between Ambient Fine Particulate Levels and Disease Activity in Patients with Systemic Lupus Erythematosus (SLE)
Air pollution removal by urban forests in Canada and its effect on air quality and human health
Health and Climate Incentives for the Deployment of Cleaner On-Road Vehicle Technologies
The heterogeneity of vulnerability in public health: a heat wave action plan as a case study
Association between quantity and duration of snowfall and risk of myocardial infarction
Elevated outdoor temperatures and risk of stillbirth
Municipalities' Preparedness for Weather Hazards and Response to Weather Warnings
Adoption of flood-related preventive behaviours by people having different risks and histories of flooding
Out of Sight, Out of Mind? Geographic and Social Predictors of Flood Risk Awareness
Looking for Evidence of Public Health's Role for Long-Term Evacuees
Workplace heat exposure, health protection, and economic impacts: A case study in Canada
Motivation and implementation of traffic management strategies to reduce motor vehicle emissions in Canadian cities
An effective public health program to reduce urban heat islands in Quebec, Canada
Elevated ambient temperatures and risk of neural tube defects
Aggregating the response in time series regression models, applied to weather-related cardiovascular mortality
Climate change influences on environment as a determinant of Indigenous health: Relationships to place, sea ice, and health in an Inuit community

Dry times: hard lessons from the Canadian drought of 2001 and 2002
A First Nation Framework for Emergency Planning: A Community-Based Response to the Health and Social Effects from a Flood
Nature-Based Equity: An Assessment of the Public Health Impacts of Green Infrastructure in Ontario Canada
When do climate policies work? A systematic review of experiences from low-carbon technology promotion and water management
The psychosocial impacts of wildland fires on children, adolescents and family functioning: A scoping review
What makes climate change adaption effective? A systematic review of the literature

Appendix 4: Evidence documents excluded at the last stage of reviewing

Hyperlinked document title
Climate Change and Occupational Health and Safety in a Temperate Climate: Potential Impacts and Research Priorities in Quebec, Canada
Life cycle human health and ecosystem quality implication of biomass-based strategies to climate change mitigation
Preparing for the health impacts of climate change in Indigenous communities: The role of community-based adaptation
Associations between long-term PM2.5 and ozone exposure and mortality in the Canadian Census Health and Environment Cohort (CANCHEC), by spatial synoptic classification zone
Disinfection and removal of human pathogenic bacteria in arctic waste stabilization ponds
The association between ambient air quality and cardiac rate and rhythm in ambulatory subjects
Health impact analysis of PM2.5 from wildfire smoke in Canada (2013-2015, 2017-2018)
Acute impacts of extreme temperature exposure on emergency room admissions related to mental and behaviour disorders in Toronto, Canada
Association between Kawasaki Disease and Prenatal Exposure to Ambient and Industrial Air Pollution: A Population-Based Cohort Study
Seasonal ambient particulate matter and population health outcomes among communities impacted by road dust in British Columbia, Canada
Ambient Sulphur Dioxide Exposure and Emergency Department Visits for Migraine in Vancouver, Canada
A spatial analysis of heat stress related emergency room visits in rural Southern Ontario during heat waves
The Air Quality Health Index as a predictor of emergency department visits for ischemic stroke in Edmonton, Canada
Time series analysis of fine particulate matter and asthma reliever dispensations in populations affected by forest fires
Associations between grass and weed pollen and emergency department visits for asthma among children in Montreal
Associations between meteorological factors and number of emergency department visits due to unintentional falls during Ontario winters
Delineation of Spatial Variability in the Temperature-Mortality Relationship on Extremely Hot Days in Greater Vancouver, Canada
Temporal and spatial variation of heat-related illness using 911 medical dispatch data
SOS! Summer of Smoke: a retrospective cohort study examining the cardiorespiratory impacts of a severe and prolonged wildfire season in Canada's high subarctic
Canadian Forest Fires and the Effects of Long-Range Transboundary Air Pollution on Hospitalizations among the Elderly
Comparison of hospitalization and mortality associated with short-term exposure to ambient ozone and PM2.5 in Canada
Air Conditioning and Heat-related Mortality A Multi-country Longitudinal Study
The association between farming activities, precipitation, and the risk of acute gastrointestinal illness in rural municipalities of Quebec, Canada: a cross-sectional study
Temporal trends in associations between ozone and circulatory mortality in age and sex in Canada during 1984-2012
Evaluation of a spatially resolved forest fire smoke model for population-based epidemiologic exposure assessment
Sub-Daily Exposure to Fine Particulate Matter and Ambulance Dispatches during Wildfire Seasons: A Case-Crossover Study in British Columbia, Canada
Ambient Heat and Sudden Infant Death: A Case-Crossover Study Spanning 30 Years in Montreal, Canada
Health impacts of the July 2010 heat wave in Quebec, Canada

"From this place and of this place": Climate change, sense of place, and health in Nunatsiavut, Canada
An ecological analysis of long-term exposure to PM2.5 and incidence of COVID-19 in Canadian health regions
Spatial variability of climate effects on ischemic heart disease hospitalization rates for the period 1989-2006 in Quebec, Canada
Ambient Temperature and the Risk of Renal Colic: A Population-Based Study of the Impact of Demographics and Comorbidity
Active and uncontrolled asthma among children exposed to air stack emissions of sulphur dioxide from petroleum refineries in Montreal, Quebec: A cross-sectional study
Elucidating long-term trends, seasonal variability, and local impacts from 13 years of near-road particle size data (2006-2019)
Risk and protective factors for heat-related events among older adults of Southern Quebec (Canada): The NuAge study
Health Cost Estimation of Traffic-Related Air Pollution and Assessing the Pollution Reduction Potential of Zero-Emission Vehicles in Toronto, Canada
Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation
Psychosocial adaptation to climate change in High River, Alberta: implications for policy and practice
Spatio-temporal analysis of particulate matter intake fractions for vehicular emissions: Hourly variation by micro-environments in the Greater Toronto and Hamilton Area, Canada
A spatio-temporal index for heat vulnerability assessment
Increased coronary heart disease and stroke hospitalizations from ambient temperatures in Ontario
Use of residential wood heating in a context of climate change: a population survey in Quebec (Canada)
Differences in heat-related mortality across four ecological regions with diverse urban, rural, and remote populations in British Columbia, Canada
Measuring the impact of sea surface temperature on the human incidence of Vibrio sp. infection in British Columbia, Canada, 1992-2017
Estimation of local daily PM2.5 concentration during wildfire episodes: integrating MODIS AOD with multivariate linear mixed effect (LME) models
Risk and Protective Factors for Mental Health and Community Cohesion After the 2013 Calgary Flood
Weather, Water Quality and Infectious Gastrointestinal Illness in Two Inuit Communities in Nunatsiavut, Canada: Potential Implications for Climate Change
"We're people of the snow:" Weather, climate change, and Inuit mental wellness
The relationship between temperature and ambulance response calls for heat-related illness in Toronto, Ontario, 2005
Climate and the eye: Case-crossover analysis of retinal detachment after exposure to ambient heat
Waterborne outbreaks: a public health concern for rural municipalities with unchlorinated drinking water distribution systems
Hot weather and risk of drowning in children: Opportunity for prevention
The short-term influence of temperature on daily mortality in the temperate climate of Montreal, Canada
Correlation of ambient temperature and COVID-19 incidence in Canada
Public versus expert knowledge and perception of climate change-induced heat wave risk: a modified mental model approach
The reported incidence of campylobacteriosis modelled as a function of earlier temperatures and numbers of cases, Montreal, Canada, 1990-2006
Ambient volatile organic compounds (VOCs) in two coastal cities in western Canada: Spatiotemporal variation, source apportionment, and health risk assessment
Association Between High Environmental Heat and Risk of Acute Kidney Injury Among Older Adults in a Northern Climate: A Matched Case-Control Study
Intergovernmental relations for public-health adaptation to climate change in the federalist states of Canada and Germany

Short-Term Acute Exposure to Wildfire Smoke and Lung Function among Royal Canadian Mounted Police (RCMP) Officers
Associations of five food- and waterborne diseases with ecological zone, land use and aquifer type in a changing climate
The Influence of Climate and Livestock Reservoirs on Human Cases of Giardiasis
Association of elevated ambient temperature with death from cocaine overdose
Effect of summer outdoor temperatures on work-related injuries in Quebec (Canada)
A Population-Based Cohort Study of Respiratory Disease and Long-Term Exposure to Iron and Copper in Fine Particulate Air Pollution and Their Combined Impact on Reactive Oxygen Species Generation in Human Lungs
A study on the effects of meteorological and climatic factors on the COVID-19 spread in Canada during 2020
Predictors of child resilience in a community-based cohort facing flood as natural disaster
Perceptions of Mental Health and Well-being Following Residential Displacement and Damage from the 2018 St. John River Flood
Intra-urban variability of air pollution in Windsor, Ontario - Measurement and modelling for human exposure assessment
Risk of hospitalization for fire-related burns during extreme cold weather
Prevalence of risk and protective factors associated with heat-related outcomes in Southern Quebec: A secondary analysis of the NuAge study
Maternal Exposure to Aeroallergens and the Risk of Early Delivery
Protective factors for mental health and well-being in a changing climate: Perspectives from Inuit youth in Nunatsiavut, Labrador
Estimating age-specific influenza-associated asthma morbidity in Ontario, Canada
The association between climate, geography and respiratory syncitial virus hospitalizations among children in Ontario, Canada: a population-based study
Community vulnerability to climate change in the context of other exposure-sensitivities in Kugluktuk, Nunavut
Risk of Congenital Heart Defects after Ambient Heat Exposure Early in Pregnancy
Climate change adaptation planning in remote, resource-dependent communities: an Arctic example
Ambient Ozone and Emergency Department Visits for Cellulitis
Associations between extreme precipitation and acute gastrointestinal illness due to cryptosporidiosis and giardiasis in an urban Canadian drinking water system (1997-2009)
Threats to Mental Health and Well-Being Associated with Climate Change
Association between outdoor ozone and compensated acute respiratory diseases among workers in Quebec (Canada)
Trace metal exposure is associated with increased exhaled nitric oxide in asthmatic children
Associations between personal exposure to air pollutants and lung function tests and cardiovascular indices among children with asthma living near an industrial complex and petroleum refineries
Community-based Participatory Process - Climate Change and Health Adaptation Program for Northern First Nations and Inuit in Canada
Using the theory of planned behaviour to identify key beliefs underlying heat adaptation behaviours in elderly populations
Role of season, temperature and humidity on the incidence of epistaxis in Alberta, Canada
Public perceptions of Lyme disease and climate change in southern Manitoba, Canada: making a case for strategic decoupling of climate and health messages
Characterizing the Effects of Extreme Cold Using Real-time Syndromic Surveillance, Ontario, Canada, 2010-2016
"It depends…": Inuit-led identification and interpretation of land-based observations for climate change adaptation in Nunatsiavut, Labrador
Respiratory Outcomes of Firefighter Exposures in the Fort McMurray Fire: A Cohort Study From Alberta Canada
Weather and chinook winds in relation to spontaneous pneumothoraces

Monitoring the evolution of individuals' flood-related adaptive behaviours over time: two cross-sectional surveys conducted in the Province of Quebec, Canada
Food Insecurity among Inuit Women Exacerbated by Socio-economic Stresses and Climate Change
Household access to capital and its effects on drought adaptation and migration: a case study of rural Alberta in the 1930s
"The best scientists are the people that's out there": Inuit-led integrated environment and health monitoring to respond to climate change in the Circumpolar North
Effects of Absolute Humidity, Relative Humidity, Temperature, and Wind Speed on Influenza Activity in Toronto, Ontario, Canada
Advancing adaptation planning for climate change in the Inuvialuit Settlement Region (ISR): a review and critique
Evidence-based communication on climate change and health: Testing videos, text, and maps on climate change and Lyme disease in Manitoba, Canada
Relationship Between Ambient Temperature and Humidity and Visits to Mental Health Emergency Departments in Quebec
Neighbourhood and dwelling characteristics associated with the self-reported adverse health effects of heat in most deprived urban areas: A cross-sectional study in nine cities
Cardiovascular Health Peaks and Meteorological Conditions: A Quantile Regression Approach
Effects of seasonal changes in temperature and humidity on incidence of necrotizing soft tissue infections in Halifax, Canada, 2001-2015
Social, Economic and Health Effects of the 2016 Alberta Wildfires: Pediatric Resilience
Climate change and mental health: an exploratory case study from Rigolet, Nunatsiavut, Canada
Mental Health Effects in Primary Care Patients 18 Months After a Major Wildfire in Fort McMurray: Risk Increased by Social Demographic Issues, Clinical Antecedents, and Degree of Fire Exposure
How Do Non-Catastrophic Natural Disasters Impact Middle-Aged-to-Older Persons? Using Baseline Canadian Longitudinal Study on Aging Data to Explore Psychological Outcomes Associated with the 2013 Calgary Flood
Winter Storms and Fall-Related Injuries: Is It Safer to Walk than to Drive?
Inuit vulnerability and adaptive capacity to climate change in Ulukhaktok, Northwest Territories, Canada
Frequent Flooding and Perceived Adaptive Capacity of Subarctic Kashechewan First Nation, Canada
Criteria for the prioritization of public-health interventions for climate-sensitive vector-borne diseases in Quebec
Seasonal variation of acute gastrointestinal illness by hydroclimatic regime and drinking water source: a retrospective population-based study
Baseline Air Monitoring of Fine Particulate Matter and Trace Elements in Ontario's Far North, Canada
Transfer of climate knowledge via a regional climate-change management body to support vulnerability, impact assessments and adaptation measures
Community Perspectives on the Impact of Climate Change on Health in Nunavut, Canada
Injuries in the North - analysis of 20 years of surveillance data collected by the Canadian Hospitals Injury Reporting and Prevention Program
Ambient Temperature and Risk of Preeclampsia: Biased Association?
Machine Learning Approach To Estimate Hourly Exposure to Fine Particulate Matter for Urban, Rural, and Remote Populations during Wildfire Seasons
Evaluation of the Impacts of a Phone Warning and Advising System for Individuals Vulnerable to Smog. Evidence from a Randomized Controlled Trial Study in Canada
Association of Influenza Activity and Environmental Conditions With the Risk of Invasive Pneumococcal Disease
Prevalence Rates and Correlates of Probable Major Depressive Disorder in Residents of Fort McMurray six Months After a Wildfire
Health and climate benefits of Electric Vehicle Deployment in the Greater Toronto and Hamilton Area
EMD-regression for modelling multi-scale relationships, and application to weather-related cardiovascular mortality

Linking disaster risk reduction and human development
A latent process model for forecasting multiple time series in environmental public-health surveillance
Ecology of Arctic rabies: 60 years of disease surveillance in the warming climate of northern Canada
Prevalence Rates and Predictors of Generalized Anxiety Disorder Symptoms in Residents of Fort McMurray Six Months After a Wildfire
"Like the plains people losing the buffalo": perceptions of climate change impacts, fisheries management, and adaptation actions by Indigenous peoples in coastal British Columbia, Canada
"A Return to and of the Land": Indigenous Knowledge and Climate Change Initiatives across the Canadian Prairies
Snowfall, Temperature, and the Risk of Death From Myocardial Infarction: A Case-Crossover Study
Windsor, Ontario Exposure Assessment Study: Design and Methods Validation of Personal, Indoor, and Outdoor Air Pollution Monitoring
Physiological and perceived health effects from daily changes in air pollution and weather among persons with heart failure: A panel study
Nurturing Spiritual Resilience to Promote Post-disaster Community Recovery: The 2016 Alberta Wildfire in Canada
It's Only Water - Triple Bottom Line Analysis for Planners and Policymakers about Direct Potable Reuse in Canada
The state of climate change adaptation in the Arctic
Addressing Mental Health in a Changing Climate: Incorporating Mental Health Indicators into Climate Change and Health Vulnerability and Adaptation Assessments

Appendix 5: Summary of key findings of 48 population-health assessment studies

Fourteen studies assessed the impact of one or more climate hazards on **mortality** (four in the elderly, and 10 in general population). Thirteen of those studies reported statistically significant associations of increased mortality with particulate matter (n=5), extreme weather events (n=3), cold and extreme temperatures (n=3), emissions (n=1), general climate change regarding temperatures (n=2), and heat (n=1). One study did not identify an association between mortality and heat. From the 14 studies, six were conducted in Quebec, three in Ontario, one in British Columbia, and four studies have a pan-Canadian focus.

Twelve studies assessed and found a statistically significant association between one or more climate hazards and **emergency-department visits** (eight included information on children). Nine studies reported association between particulate matter (air pollution) and an increase in emergency-department visits due to conjunctivitis (n=1), diseases of the ear and mastoid processes (n=1), otitis media (n=1), asthma (n=1), genitourinary diseases (n=1), migraine and headache (n=2), substance use (n=1), and depression (n=1). The three remaining studies identified an association between extreme weather events and unintentional falls, heat and pediatric diseases, and cold and both extreme temperatures and cardiorespiratory diseases. Seven studies were conducted in Ontario, three in Alberta, and one had a pan-Canadian focus.

Seven studies evaluated the association of climate hazards and **hospitalizations**. Six studies reported statistically significant associations between cold and extreme temperatures and hospitalizations by cardiovascular diseases (n=2), particulate matter and hospitalizations by respiratory diseases and cardiovascular diseases (n=2), emissions and hospitalizations in children due to respiratory diseases (n=1), and wildfires and hospitalizations by cardiovascular diseases (n=1). One study did not identify an association between particulate matter and hospitalizations by acute myocardial infarction. Two studies were performed in Ontario, two in Quebec, one in Alberta, one in British Columbia and one with a pan-Canadian focus.

Sixteen studies explored if climate hazards were a **risk factor** for some diseases, and 13 found a statistically significant association. Four studies found an association between particulate matter and mental disorders, upper gastrointestinal bleeding due to peptic ulcer disease, neoplasms, and stroke. Four studies found an association between heat and pregnancy disorders (i.e., placental abruption, neural tube defects, early delivery and stillbirth). Three studies reported an association between general climate change and infectious diseases, mental disorders, and cardiovascular diseases. One study explored the association between emissions and asthma, while another study explored the association between cold and extreme temperatures and hypothermia. Three studies did not find a statistically significant association, one between emissions and multiple sclerosis, one between particulate matter and fatal cardiac arrhythmias, and one between flood and pregnancy complications. Six studies were performed in Quebec, four in Ontario, three in Alberta, and three with a pan-Canadian focus.

The remaining 12 studies explored different **health impacts** (e.g., years of life lost, DALY's lost, disease activity health and well-being), of different climate hazards in general or specific population groups (e.g., deprived neighbourhoods, Inuit communities, long-term evacuees, rural areas, children, adolescents and families). All 12 studies found an association between climate change and negative health impacts.

Appendix 6: Experiences in Canadian provinces and territories on current readiness and capacity of public-health systems to address climate change and adjustments that are needed

Province	Summary of experiences
Pan-Canadian	**Essential public-health functions** • The Government of Canada has commissioned assessments of climate change risks to public health in recent years, such as the *Health of Canadians in a Changing Climate: Advancing our Knowledge for Action* report and the *National Issues report* **Governance arrangements** (including governance, leadership, and engagement) • 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 • In December 2020, the Government of Canada released Canada's climate plan, A Healthy Environment and a Healthy Economy, which described 64 strengthened and new federal policies, programs, and investments to build a more resilient economy by: o Supporting home, commercial, and large-scale building retrofits, and initiatives that reduce energy use in municipal and community buildings o Promoting active transport and making zero-emissions cars, trucks, and public transport more affordable and accessible o Financing actions to phasing out the use of coal, o Continuing to put a price on pollution through enhancing the carbon-pollution pricing system o Supporting the production and use of cleaner fuels across the economy **Financial arrangements** (including, but not limited to, financing) • The Government of Canada has invested more than $100 billion since 2015 towards climate action and clean-energy growth, with roughly $53.6 billion being invested towards Canada's green recovery since October 2020 • Since the release of its climate plan in December 2020, the Government of Canada has reported on investments made to reduce the risks of climate change and support climate resiliency actions, including: o The Canada Greener Homes Grant to provide up to 700,000 Canadian households with grants to make energy efficiency and climate resilience improvements to their homes o The Green and Inclusive Community Buildings program that retrofits, repairs and upgrades new builds o A $1.8 million project with Ford Motor Company of Canada to build electric vehicles o The first federal fund for building active transportation (e.g., expanded bike lanes, trails, pathways and pedestrian bridges) throughout Canada o The Smart Renewables and Electrification Pathway Program that will support projects investing in clean-energy technologies o A Natural Infrastructure Fund to support natural and hybrid infrastructure projects that aim to mitigate the impacts of natural events o The Agricultural Clean Technology Program that provides farmers and agri-business with funding to develop and adopt clean technologies to reduce greenhouse emissions and enhance competitiveness o The Indigenous Off-Diesel Initiative that supports the transition of Indigenous communities that are diesel-reliant onto clean energy

	• New mandatory sales targets of 100% new light-duty vehicle and passenger trucks in Canada were announced by the Government of Canada in June 2021, and a 50% corporate sales tax cut was introduced for small- and medium-sized businesses that manufacture zero-emission vehicles and components in Canada • The Low Carbon Economy Fund (LCEF) was established as part of the federal government's clean growth and climate action plans, including the Pan-Canadian Framework on Clean Growth and Climate Change and the 2030 Emissions Reduction Plan – Canada's Next Steps for Clear Air and a Strong Economy to support projects that will reduce Canada's greenhouse gas emissions, generate clean growth, and build resilient communities o The LCEF has two parts: ▪ The Low Carbon Economy Leadership Fund will provide up to $1.4 billion to provinces and territories to implement the Pan-Canadian Framework on Clean Growth and Climate Change ▪ The Low Carbon Economy Challenge will provide $500 million to recipients, including provinces and territories, businesses, municipalities, not-for-profits, and Indigenous communities and organizations **Delivery arrangements** • The Canadian Centre for Climate Services has been established by the Canadian government to help the public increase resilience to climate change by building local capacity and offering training and support to provinces and territories • The Government of Canada has funded the development of the Climate Change Toolkit for Health Professionals to support health professionals and students in healthcare advocating for climate change mitigation policies and programs in their workplaces and communities, by providing education and actions that can be taken in healthcare facilities to mitigate and adapt to climate change **Policy and program interventions** • HealthADAPT, a multi-year capacity-building program coordinated by Health Canada, helps the Canadian health sector prepare for and respond to the impacts of climate change by supporting increased understanding of climate change, local and regional climate change health adaptation plans, and monitoring of those programs o The program has provided an investment of up to $3.6 million in partnerships with 10 health authorities in five provinces and territories to support them in addressing climate-driven health risks • Canada has an internationally recognized carbon-pricing approach that has established a national minimum price on pollution of $20 per tonne in 2019 to start, and increasing at $10 per tonne increments annually to $50 in 2022 o The Government of Canada's carbon-pricing strategy gives provinces and territories the flexibility to implement the system that makes the most sense for their jurisdiction as long as they meet benchmark minimum criteria
British Columbia	**Essential public-health functions** • The B.C. Ministry of Health and the Provincial Climate Action Secretariat backgrounder about climate change health risks identifies three key climate change hazards for B.C., as well as several primary impacts of these hazards o Sea level rise which can have an impact on storm surges and flooding o Rising temperatures which can have an impact on heat waves, changes in infectious agents, and increased production of pollens and spores o Extreme weather which can have an impact on the frequency and intensity of storms as well as bring about droughts and wildfires

	• The B.C. Ministry of Health and the Provincial Climate Action Secretariat backgrounder about climate change health and communities outlines actions (and examples of specific actions) that communities can take to prepare for climate change while simultaneously promoting better health outcomes
	  ○ Partner and collaborate: involve and consult with the healthcare community in the formal plan referral process as well as partner with neighbouring communities
	  ○ Plan and prepare: involve the healthcare community in climate vulnerability and adaptation assessments, work with the healthcare community to develop climate emergency plans and protocols, and include health data and considerations in plans, policies and programs
	  ○ Educate: integrate public-health and climate change messaging in public communications, support public outreach and educations, and support internal education and capacity building
	  ○ Monitor and evaluate: include community health indicators in place and program monitoring
	• The B.C. Ministry of Health and the Provincial Climate Action Secretariat backgrounder about climate change and public health outlines several groups of actions (and examples of specific actions) that medical officers of health, environmental health officers, research and surveillance groups, and other public-health practitioners can take to prepare for climate change and promote health outcomes
	  ○ Plan and prepare: mainstream climate adaptation, conduct vulnerability assessments, and embed an adaptive management lens
	  ○ Educate: support public outreach and education as well as internal education and capacity building
	  ○ Surveillance and monitoring: expand and enhance observation programs
	  ○ Partner, collaborate and support: support local government adaptation and mitigation planning
	• The Pacific Institute for Climate Solutions published a report titled 'Climate, Health and COVID-19 in British Columbia' that assesses B.C.'s vulnerability to climate change from a public-health perspective, puts forward lessons from COVID-19 that can assist with preparing for climate change, and provides commentary about the following three health and climate-related topics:
	  ○ Virtual health and telemedicine
	  ○ Green infrastructure and urban design
	  ○ Food security
	• Vancouver Coastal Health, Fraser Health, Health Emergency Management B.C. , and Facilities Management produced a community health and climate change visualization tool to identify the vulnerability of communities within the Vancouver Coast Health and Fraser Health area to four groups of climate hazards:
	  ○ Higher summer temperatures
	  ○ Coastal and riverine flooding
	  ○ Wildfire smoke events
	  ○ Ozone air pollution
	  ○ Community vulnerability (calculated as a function of exposure to hazards, sensitivity to hazards, and a community's adaptive capacity)
	• Vancouver Coastal Health and Fraser Health have produced a 'Climate Change and Health Vulnerability and Capacity Assessment' that considers the impact of climate change related-hazards on population health, healthcare facilities, and health services

	○ The following climate change-related hazards were considered: extreme heat, air quality, storms and flooding, ecosystem changes, and infectious diseases ○ For each hazard, current and future population health impacts were considered, and an inventory of adaptation initiatives and capacities was assembled **Governance arrangements** (including governance, leadership, and engagement) • The B.C. Ministry of Health and the Provincial Climate Action Secretariat have put together a five-part series of backgrounders that aim to help people working in the community and in public health to prepare for current and future impacts of climate change ○ The topics covered in this series include: climate change health risks, frontline healthcare, public health, health care facilities, and communities • The 2019 Preliminary Strategic Climate Risk Assessment for B.C. included consideration of health consequences (loss of life and morbidity, injury, disease, or hospitalization) for 15 distinct climate risk events/scenarios • Vancouver Coastal Health and Fraser Health's 'Climate Change and Health Vulnerability and Capacity Assessment' includes a section dedicated to health-system vulnerability and resilience to climate change ○ Health-system impacts and vulnerabilities are discussed alongside critical infrastructure interdependencies ○ Essential adaptive capacities are identified and key health-system stakeholders' potential roles in adaptation are described ○ Health-system climate resilience indicators are introduced and a list of such indicators is presented • Alongside the 'Climate Change and Health Vulnerability and Capacity Assessment', Vancouver Coastal Health and Fraser Health produced a 'Climate Change and Health Adaptation Framework' that outlines recommendations for how various stakeholders can participate in climate change and health adaptation; recommendations are organized across six pillars: ○ Emergency preparedness and response ○ Risk assessment, epidemiology, and research ○ Communications ○ Leadership and advocacy ○ Health equity ○ Facilities **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • The B.C. Ministry of Health and the Provincial Climate Action Secretariat backgrounder about climate change and health facilities outlines several groups of actions (and examples of specific actions) that healthcare facility managers, administrative leadership, operations and maintenance staff can take to prepare for climate change ○ Plan and prepare: climate risk assessments, climate adaptation plans, and green buildings and infrastructure ○ Lead: take the 2020 Health Care Climate Challenge ○ Educate: involve staff in climate change adaptation actions, engage staff to promote sustainability and resiliency in the workplace ○ Monitor and evaluate: track results of actions taken ○ Support: identify and support local sustainability initiatives

	• The B.C. Ministry of Health and the Provincial Climate Action Secretariat backgrounder about climate change and front-line healthcare outlines several groups of actions (and examples of specific actions) that frontline health care providers can take to prepare for climate change and promote better health outcomes
	  ○ Plan and prepare: understand local vulnerabilities, emergency preparedness, and climate-health impact preparedness
	  ○ Patient care: educate patients and mainstream climate-health impacts in care processes
	  ○ Organizational and professional care: work with professional associations and support climate-health education
	  ○ Lead and support: leverage the role and support local sustainability initiatives
	• The Pacific Institute for Climate Solutions published a report 'Climate, Health and COVID-19 in British Columbia' that includes a section dedicated to the connection between climate change and virtual health and telemedicine
	  ○ The report argues that virtual health and telemedicine can aid in reducing the carbon footprint of the health sector by reducing travel-related emissions
	  ○ The authors also posit that there is a window of opportunity to explore telemedicine as part of the province's climate mitigation strategy given the investments made during the COVID-19 pandemic
	  ○ The section concludes with several equity-related considerations connected to the establishment of telemedicine services in B.C.
	Policy and program interventions
	• *None identified*

Alberta	**Essential public-health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement) • *None identified* **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • *None identified*

Saskatchewan	**Essential public-health functions**
	• The Government of Saskatchewan is building:
	  ○ Absorptive capacity by training local communities to respond effectively in emergency situations and educating the public on vector-borne diseases
	  ○ Adaptive capacity through diversifying crops to enhance soil health and manage pests, maintaining zero-tillage practices, and expanding the FireSmart program to ensure resident safety in the event of wildfires
	  ○ Transformative capacity by committing to the use of renewable energy sources and ensuring a waste management strategy is in place

	• The Hazard, Risk and Vulnerability Analysis (HRVA) tool can be used to help communities make risk-based decisions to address vulnerabilities, mitigate hazards, and prepare for a response to and recovery from hazard-related events, while ensuring the health and safety of its residents **Governance arrangements** (including governance, leadership, and engagement) • In December 2017, the Government of Saskatchewan released Prairie Resilience: A Made-in Saskatchewan Climate Change Strategy, which is a comprehensive strategic document that aims to make the province more resilient in relation to the climatic, economic, and policy impacts of climate change ○ Key features included within the document are the principles of readiness, their goals of reducing greenhouse gas emissions, and collectively adapting to changing weather conditions • In November 2018, the Government of Saskatchewan published the Climate Resilience Measurement Framework to highlight its improved climate change readiness ○ This framework was created in collaboration with 14 ministry branches and agencies, and routinely tracks metrics surrounding five key focus areas: natural systems, physical infrastructure, economic sustainability, community preparedness, and human well-being ○ To date, there have been three updates on this framework, with reporting occurring in 2019, 2020, and 2021 (the latest report had 17 of the 25 resilience measures in "good standing", with the remaining eight listed as "fair") • The Government of Saskatchewan has facilitated a number of engagement opportunities (100+ presentations and 50+ sessions) to seek further input on its regulatory approaches and in the development of its Climate Resilience Measurement Framework ○ Key stakeholders involved in the consultations include 200+ leaders from academia, municipalities, industry, non-governmental organizations, and Indigenous communities (19 Métis communities in specific) **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • As of 1 January 2019, the Government of Saskatchewan enacted the Oil and Gas Emissions Management Regulation, which regulates flared and vented methane emissions with the aim of reducing yearly emissions by 40-45% by 2025 in the oil and gas sector
Manitoba	**Essential public-health functions** • *None identified* **Governance arrangements** • In 2017, the Manitoba government published the Made-in-Manitoba Climate and Green Plan to help guide its climate change response over the next decade ○ Under the "climate" pillar, key priority areas include: 1) clean energy; 2) carbon pricing; 3) sector emissions reductions; and 4) adaptations ○ Within the "clean energy" keystone, actionable actions include implementing green heating, the electrification of the Winnipeg transit, and generating community energy plans

	○ Within the "sector emissions reductions" keystone, the province will be committing to the development of energy efficient homes and buildings by working with federal, provincial, and territorial partners to improve building codes and standards. The province also plans on recommissioning 80% of buildings that are not currently meeting energy standards, and redeveloping 60% of buildings to meet its high-performance standards • The Manitoba government involved the International Institute for Sustainable Development to lead climate change consultations for the development of Manitoba's Climate Change and Green Economy Action Plan ○ This consisted of nine consultation groups and 67 meetings taking place from 2013 to 2015 **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • The International Institute for Sustainable Development and the University of Winnipeg co-launched the Prairie Climate Centre, which provides many organizations (including businesses, non-governmental organizations, and the government) with credible and up-to-date data and information to help guide informed decision-making processes related to climate change management ○ Over $400,000 has already been invested in this project by the Manitoba government **Policy and program interventions** • *None identified*
Ontario	**Essential public-health functions** • Public Health Ontario released a presentation on 18 April 2017 titled "Climate change adaptation: Is there a role for Public Health," which outlines the impacts of climate change on health, the role of public health in mitigating these impacts, as well as current adaptation strategies • A report by the Ontario Public Health Association from March 2017 highlights the health impacts of climate change, government efforts to tackle climate change, and the rationale behind why public health units can address the issue, as well as provide recommendations for future dialogue • Southwestern Public Health is in the framing and scoping phase of completing a climate change and health vulnerability and adaptation assessment for the region, focusing on extreme temperature, extreme weather events and natural hazards, air quality, water- and food-borne diseases, infectious diseases, and stratospheric ozone depletion • The Public Health Agency of Canada, Ontario Region, Simcoe Muskoka District Health Unit, and Cambium Indigenous Professional Services collaborated to release a report in December 2020 on Indigenous perspectives in climate adaptation and the strategies to assist public authorities in doing so ○ The report discusses public-health adaptation interventions in health communications, health promotions, environmental adaptation policy, planning/decision-making surveillance, guidelines/frameworks, and alerts/advisories and warnings • The Ontario Ministry of Health's website outlines how the province planned to adapt to climate change through developing a new climate change organization, undertaking provincial climate change risk assessments, raising public awareness on the effects of climate change, and the steps taken to aid in Ontario's adaptation to climate change ○ However, this webpage was archived and last updated on 29 July 2021 **Governance arrangements** (including governance, leadership, and engagement)

	• The Ontario Ministry of Health developed the Ontario Climate Change and Health Toolkit report in August 2016 that includes health and vulnerability adaptation guidelines, and climate change and health modelling to anticipate, address, and mitigate the impacts of climate change
	  ○ The report describes vulnerabilities and capacities of the health system (e.g., estimate relationships between weather patterns and health outcomes, historical environmental trends, vulnerability of exposed communities and effectiveness of policies and programs to manage current vulnerabilities), projects future health risks, and prioritizes policies and programs to manage health risks
	• The City of Ottawa's Air Quality and Climate Change Management Plan, published on 13 May 2014, outlined the goals, objectives, and recommendations to address climate change over five years
	  ○ The plan aimed to reduce the risk to public health by communicating health risks to Ottawa residents and businesses, disease surveillance, education and prevention programs for vector-borne diseases, increasing the ratio of vegetated to impermeable surfaces in order to reduce the urban heat island effect, and continuing to invest resources to combat illnesses associated with extreme weather
	• The city of Ottawa approved a new Climate Change Master Plan in January 2020 that identified eight priority actions for the next five years (2020 to 2025) that will be embedded into the city's business, including developing an energy transition strategy and a vulnerability assessment, exploring the feasibility of setting corporate carbon budgets, applying a climate lens to city projects, and encouraging private action through education, incentives and advocacy
	• The Grey and Bruce Health Unit outlines key strategies to address, manage, and respond to the public-health effects of a changing climate by adapting existing programs, including education and capacity building (e.g., promoting the "Know your Neighbour" campaign to build community resiliency during extreme weather events), surveillance and monitoring (e.g., monitoring water quality), promotion of programs with health and environmental co-benefits (e.g., developing a campaign to encourage homeowners to regularly test their drinking water), advocacy for policies and program to support climate change mitigation, and support for multi-jurisdictional and multidisciplinary approaches
	Financial arrangements (including, but not limited to, financing)
	• Through Ontario's Green Investment Fund, 40 Indigenous communities are collecting traditional ecological knowledge, leading the assessment of their communities' vulnerabilities to climate change, and developing adaptation plans
	  ○ The funding will also create a Northern Ontario climate change impact study
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• The Eastern Ontario Health Unit implemented a Heat Event Response Program that aims to reduce the risks of exposure to extreme heat by educating and raising awareness about heat-related illness and alerting those at risk of heat-related illness that hot weather conditions are imminent or to take precautions
	• The City of Toronto is actively working to reduce health risks from climate change and contribute to greenhouse gas mitigation, and has so far exceeded its initial target of a 6% reduction by 2012
	  ○ The estimated greenhouse gas emissions in 2012 were about 25% below 1990 levels

	○ Examples of programs to mitigate public-health risks in Toronto include "A Commitment to Double the Tree Canopy", a project designed to provide shade and lessen the urban heat island effect, and "Building Green Roofs" to reduce the negative effects on the urban heat island effect of large flat roofs through its Green Roof Bylaw that requires the construction of a green roof on all new developments • Toronto's Heat Alert System is designed to protect the city's most vulnerable populations from climate change-related health risks such as extremes of heat and cold ○ The Toronto Medical Officer of Health issues a "Heat Alert" when the likelihood of excess weather-related mortality exceeds 65% and an "Extreme Health Alert" when the likelihood is 90% ○ Toronto Public Health is also developing a mapping tool to visualize human vulnerability to extreme heat to help it identify and prioritize geographic hotspots for delivering resources during a heat alert • The Harmonized Heat Warning and Information System (HWIS) was established in 2016 to reduce health vulnerability to heat and heat-related illnesses
Québec	**Essential public-health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement) • The Ministère de la Santé et des Services Sociaux (MSSS) is responsible for health and social services, with the public-health responsibilities including agenda setting, policy development and implementation, the development of a provincial public-health plan, resource allocation and stewardship, service coordination between different regions and sectors, appointment of provincial and regional director of public health, and province-wide evaluations • Public health entities include the Institut national de santé publique du Québec (INSPQ; Québec's national public-health institute), the Institut national d'excellence en santé et en services sociaux (INESSS; Québec's national institute of excellence in health and social services), and the Health and Welfare Commissioner (HWC; in French: Commissaire à la santé et au bien-être) • In 2012, the Québec 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) ○ The government plans to develop climatological monitoring networks, which will include partners such as public health, agriculture, forestry, transportation, and land-use planning ○ The government plans to support research in adaptation, with an emphasis on public health • The Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) provides leadership on how to address climate change and support environmental protection and conservation, and has legislative responsibility for environmental health regulations related to municipal wastewater treatment as well as drinking and pool-water sanitation **Financial arrangements** (including, but not limited to, financing) • The Observatoire québécois de l'adaptation aux changements climatiques (OQACC) (Québec Observatory for Adaptations to Climate Change) is largely funded by the Québec government and Université Laval, and it describes, explores and disseminates knowledge regarding many themes in climate change adaptation in Québec , including those related to major health issues (i.e., pollen allergies, Lyme disease) **Delivery arrangements** • *None identified*

	Policy and program interventions
	• In 2012, the Québec 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)
	  ○ The government has prioritized the following program interventions: enhancement of air quality, prevention of the impact of heatwaves (e.g., telephone alert systems and personalized automated internet services), prevention and elimination of heat islands, reductions in psycho-social impact
	• The Institut national de santé publique du Québec (National Institute of Public Health of Québec) has 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
	  ○ Québec residents can also get involved in other ways

New Brunswick	**Essential public-health functions**
	• The City of Fredericton Climate Change Adaptation Plan summarizes climate change impacts and potential actions in six goal areas: maintaining health and safety, minimizing disruptions to municipal services and programs offered to the community, minimizing risks to buildings and properties, strengthening resilience of natural infrastructure and assets, strengthening resilience of core municipal infrastructure, and creating partnerships and empowering the community
	Governance arrangements (including governance, leadership, and engagement)
	• Public Health New Brunswick released a report on New Brunswick's Climate Change and Health Vulnerability & Adaptation Assessment Project in April 2021 discussing how climate change affects health in New Brunswick, various different climate change and health vulnerability and adaptation assessment frameworks, and recommendations for developing a New Brunswick-focused framework
	• The Climate Change Adaptation Collaborative, formed in 2013, brought together municipal leaders, regional planners, government representatives, non-profits, researchers and academics, industry representatives, and others to advance climate change adaptation across sectors in support of the New Brunswick Climate Change Action Plan 2014-2020
	  ○ The collaborative's priorities include maintaining a network to support climate change adaptation, encouraging the development and updating of adaptation policies, supporting education and communication approaches focused on adaptation, and promoting green infrastructure
	• In 2010, the province released a report called Capacity for Climate Change Adaptation in New Brunswick Municipalities, compiling feedback from municipalities about climate change adaptation
	  ○ On the municipal level, passing by-laws and allocating staff to develop adaptation policies was the most critical priority, achieved through funding, open communication with municipalities, leadership by showing support for municipalities' plans, and working with the federal government to pass legislation that supports municipal plans
	  ○ It was also recommended that the federal government become a leader in implementation by setting public policy mandates, providing funding for climate change adaptation development and enforcement, and providing accurate scientific information to the municipalities
	  ○ Municipalities have also implemented training sessions for local communities, amendments to local statutes and zoning policies, and have improved conservation and developed strategic transportation and tourism plans
	Financial arrangements (including, but not limited to, financing)
	• *None identified*

	Delivery arrangements • *None identified* **Policy and program interventions** • *None identified*
Nova Scotia	**Essential public-health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement) • The Government of Nova Scotia established the Climate Adaptation Leadership program, which supports government departments such as Health and Wellness and industry partners to prepare for climate-related public-health and health-infrastructure risks **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • *None identified*
Prince Edward Island	**Essential public-health functions** • *None identified* **Governance arrangements (including governance, leadership, and engagement)** • Health PEI is responsible for the delivery of publicly funded health services, which also includes the Chief Public Health Office within the department ○ The health promotion unit works with partners to facilitate community development and action, foster healthy public policy, reorient health services, and generate public education • The government has developed a five year Climate Change Action Plan (2018-2023) that focuses on adaptations, reduction of greenhouse gas emissions, carbon sequestration, education and capacity building, research and knowledge building **Financial arrangements (including, but not limited to, financing)** • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • The University of PEI's Climate Research Lab provided key recommendations for the government related to public health, such as supporting the public to adapt to climate change, evaluate knowledge gaps, support interdisciplinary research, monitor and map environmental factors, and reduce non-climate factors (e.g., preventing chronic disease)
Newfoundland and Labrador	**Essential public-health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement)

	• The Government of Newfoundland and Labrador released its climate change action plan, The Way Forward on Climate Change in Newfoundland and Labrador, which has eight focus areas that outline the government's approach to reducing greenhouse gas emissions, building resilience to the impacts of climate change, and supporting clean economic growth
	  ○ The eight focus areas are green economy, carbon pricing, transportation, agriculture and fisheries, energy use in homes and buildings, infrastructure planning and development, health and well-being, and education and outreach
	  ○ Some of the initiatives mentioned in the action plan that the Government has undertaken include introducing carbon pricing in 2019, developing a Vehicle Efficiency and Cost Calculator to help consumers make informed choices when making purchases, establishing a hurricane season flood-alert system and a coastal-erosion monitoring and mapping program, and requiring health emergency planning officials to consider extreme heat and air-quality issues in planning for population healthcare needs
	• In a mid-term update on the progress of the action plan, the progress in three key areas – carbon pricing, the Low Carbon Economy Leadership Fund (LCELF), and building resilience to climate change – is described
	  ○ The carbon-pricing system is being reviewed in anticipation of a carbon tax rate increase that the government has committed to starting in 2023, as well as an increase in the percentage of fossil fuels regulated by carbon pricing
	  ○ Funding from the shared federal-provincial Low Carbon Economy Leadership Fund is being allocated to upgrade public buildings and improve the energy efficiency of fuel oil-heated homes and buildings
	  ○ The provincial government published guidance about coastal erosion and sea-level rise, and supports the development of flood-risk mapping in municipalities provincewide
	Financial arrangements (including, but not limited to, financing)
	• *None identified*
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• After beginning construction in 2013, the Muskrat Falls hydroelectric generating facility based on the lower Churchill River generates hydroelectric power from three dams that supply water to four power generating units
	• Since 2017, the province's Home Energy Savings Program (HESP) has been providing non-repayable grants up to $5,000 for energy-efficiency upgrades in electrically heated homes
	  ○ The province has expanded the program through the Low Carbon Economy Leadership Fund to include households that rely on fuel oil for space heating
	• The Government of Newfoundland and Labrador developed the Turn Back the Tide Campaign which provides a range of guidelines for households, businesses or communities to enhance climate resilience, such as building energy-efficient homes, greenhouse-gas management for small businesses, assessing climate change vulnerability in your community, and managing municipal infrastructure in a changing climate

Yukon	**Essential public-health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement) • *None identified*

	Financial arrangements (including, but not limited to, financing) • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • The Artic Institute of Community-Based Research (AICBR) has worked with communities in Yukon to understand the implications of changing environmental conditions on health and facilitate strategy development for climate change adaptation and food security ○ Initiatives conducted by the AICBR include the Yukon Indigenous Community Climate Change Champions Project, which trained youth as champions for climate change adaptation in their communities, and the Linking a Changing Climate with Changing Traditional Diet, which is another project where the AICBR has developed two inventory maps of climate change and food-systems initiatives in the territory to help communities and policymakers find information about climate change adaptation • This report released by the provincial government in May 2019 outlines actions that could be taken in the province to reduce health impacts of climate change in Yukon, such as implementing Fire Smarting (a program to make communities, buildings, and homes less prone to damage from wildland fires), flood proofing, having support networks, enhancing access to health services during climate change-related emergencies, and improving energy conservation

Northwest Territories	**Essential public-health functions**
	• *None identified*
	Governance arrangements (including governance, leadership, and engagement)
	• On 1 May 2018, the Government of the Northwest Territories (GNWT) released its 2030 NWT Climate Change Strategic Framework
	  ○ The province is shifting its efforts to focus on three long-term goals: 1) transitioning to a healthier economy which uses fewer fossil fuels and will be able to reduce greenhouse gas emissions by 30% below those in 2005 by the year 2030; 2) improve public awareness and knowledge of the impacts of climate change; and 3) build resilience and adapt to a changing climate
	• In 2016 and 2017, GNWT engaged a number of community, government, and Indigenous stakeholders in the regions of Inuvik, Norman Wells, Fort Simpson, Hay River, Fort Smith, and Yellowknife to seek input on its strategic framework and strategy plan
	  ○ Key takeaways from the consultation process included the government making sure it has a greater focus on setting greenhouse gas emission targets, reducing the use of fossil fuels, improving community involvement and engagement with Indigenous communities, and investing in further community capacity efforts
	Financial arrangements (including, but not limited to, financing)
	• *None identified*
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• *None identified*

Nunavut	**Essential public-health functions**

	• The Nunavut Climate Change Secretariat has identified that climate change can have the following impacts on health and disease in the territory:
	  ○ Diseases transmitted from animals to human are expected to rise, and previously unconnected animal species may begin to interact as physical barriers (such as snow and ice) disappear
	  ○ Unpredictable and extreme weather patterns may cause more accidents and interfere in the operation of search and rescue missions
	• The Nunavut Climate Change Secretariat maintains a directory of projects related to health, disease and climate change in the north
	• A research team in Pond Inlet is building capacity for studying the safety of local fresh-water supplies in light of climate change and its impact on water safety in the north
	• Researchers have published 'Health Impacts of Climate Change in Canada's North', which addresses several important aspects of understanding and adapting to the health impacts of climate change in Nunavut (and other northern regions) with the following topics:
	  ○ Northern demographics and health status
	  ○ Impacts and exposures to climate change
	  ○ Northern adaptations and adaptive capacity
	  ○ Key vulnerabilities
	  ○ Knowledge gaps and research recommendations
	Governance arrangements (including governance, leadership, and engagement)
	• *None identified*
	Financial arrangements (including, but not limited to, financing)
	• *None identified*
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• *None identified*

Appendix 7: Experiences in selected jurisdictions on current readiness and capacity to address climate change and adjustments that are needed

Country	Summary of experiences
Australia	**Essential public health functions** • *None identified* **Governance arrangements** (including governance, leadership, and engagement) • 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: • Victoria released Health and Human Services Climate Change Adaptation Action Plan 2022-2026 for consultation, 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, reduce barriers to adaptation planning and action, and lay the foundations for transformational adaptation o Strategic actions outlined in the Action Plan include supporting local government to tackle climate change and its impact on health, embedding climate resilience into health infrastructure, and improving public housing thermal comfort and energy efficiency o Climate change opportunities for the Health and Human Services System include: ▪ Leverage current interest in public health due to COVID-19 to support increased action on climate change ▪ Strengthen public-health surveillance systems and increasing climate change and health impact-data availability ▪ Leverage COVID-19 infrastructure investments to improve health outcomes for those most vulnerable to climate change impacts, such as improving thermal comfort for social housing ▪ Leverage Victoria's Health and Human Services system to increase health and well-being resilience to climate change impacts through the influence of large and small organizations, and contact between service providers and patients and clients • The Queensland Government developed a Human Health and Well-being Climate Change Adaptation Plan, which outlines specific public-health measures among other priority adaptation measures o Public-health measures will include evaluating specific vulnerabilities in the population and implementing appropriate measures to reduce avoidable mortality **Financial arrangements** (including, but not limited to, financing) • The Victorian Government will invest $40 million in energy upgrades for public-health facilities, including solar power and high-efficiency LED lights, as part of the goal for a clean-energy economy proposed in Victoria's 2021 Climate Change Strategy o Additionally, the investment will deliver energy cost savings for public hospitals as well as lower emissions for Victoria **Delivery arrangements** • *None identified* **Policy and program interventions** • *None identified*

New Zealand	**Essential public-health functions**
	• New Zealand's Ministry for the Environment contracts Massey University to maintain a set of environmental health indicators that describe the cause-and-effect relationships between the environment and health, and provide evidence to help decision-makers make policy decisions for climate change action
	Governance arrangements (including governance, leadership, and engagement)
	• The New Zealand government is developing a national adaptation plan that will outline what needs to be done to respond to the risks of climate change identified in the country's first national climate change risk assessment
	  o The government has consulted with the public on the draft adaptation plan in April and May 2022
	Financial arrangements (including, but not limited to, financing)
	• The New Zealand Government's Budget 2021 allocated funding to several climate change initiatives
	  o $67.4 million will be provided to support the country's transition to a carbon-neutral public sector by the year 2025
	  o A significant funding increase has been allocated to the State Sector Decarbonisation Fund to support the replacement of coal boilers with clean-energy alternatives in schools, hospitals, and other government buildings
	  o The Government's 'electric vehicle first' policy will be boosted by increased funding of $41.8 million for the leasing of low-emissions vehicles across the public sector
	• In Budget 2022, a Climate Emergency Response Fund (CERF) of $4.5 billion has been established from Emissions Trading Scheme revenue, meaning that the costs of pollution will be directly recycled back into projects that reduce emissions
	  o The CERF provides financial security over the long term to ensure that climate objectives remain a priority in future budgets
	• The Minister of Energy and Resources announced on 7 July 2022 that the government has begun a green private finance pilot with participating financiers to help businesses in New Zealand get financing for big decarbonization projects
	  o The support offered by each of the participating financiers for applicants to the Government Investment in Decarbonising Industry (GIDI) Fund depends on the types of sustainable products and services they offer
	• The Government of New Zealand is in the process of deciding how emissions from agriculture should be priced, according to the Climate Change Commission
	  o The Commission has advised the government on looking at what financial assistance should be provided to farmers participating in any emissions-pricing schemes and on assessing the readiness of farmers for a farm-level system for agricultural emissions pricing
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• The Energy Efficiency and Conservation Authority (EECA) State Sector Decarbonisation Fund co-funded a pilot project in 2021 to enable the Crown agency, Kainga Ora, to use electric vehicles in its corporate vehicle fleet
	  o At the cost of $1.6 million, the pilot project involved providing 24 people across 17 locations with home charging and engaging with the group regularly to build knowledge around the project
	  o Replacement of 24 petrol vehicles with electric vehicles would save Kainga Ora an estimated 208 T carbon over three years, which is approximately 3,250 Auckland to Wellington flights

Germany	**Essential public health functions**

	• Germany has a health heat warning system which calculates the heat load for regions and counties countrywide and issues heat health warnings when high levels of heat are forecasted for at least two consecutive days ○ When a heat warning has been issued, local authorities, health clinics, and care homes initiate adaptation measures via specific communication channels based on the level of the heat warning issued • A pilot project has been started to study the burden of heat-related health on the elderly living in the city of Cologne, and the heat-related health perception of people living in care homes • Germany has a Strategy for Adaptation to Climate Change plan that was first adopted in December 2008, but the adaptation strategy does not report on any actions or recommendations on enhancing the capacity of the country's public-health system **Governance arrangements** (including governance, leadership, and engagement) • The German Environment Agency, Umweltbundesamt, is responsible for making environmental risk assessments and delivering policy recommendations to the Ministry of Environment, as well as enforcing environmental protection laws, including approvals for CO_2 trading **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • *None identified* **Policy and program interventions** • *None identified*

France	**Essential public-health functions**
	• Santé Publique France has studied and produced a report about how to develop indicators that can facilitate public-health considerations when planning climate change-adaptation policies
	• Surveillance and evaluation of health risks from extreme climate events is conducted by Santé Publique France
	  ○ This includes surveillance of vector-borne diseases in France that are becoming more important given the impacts of climate change
	  ○ Epidemiologic surveillance during extreme climate events, such as heat waves, is being conducted using the syndromic emergency and death surveillance system SurSaUD® which collects and centralizes emergency medical service and mortality data
	• Santé Publique France also participates in a number of collaborations to conduct surveillance and evaluation about health risks associated with changing climate parameters, air quality and its connection to climate change, as well as the effectiveness of existing alert systems
	• The French Ministry of Ecological Transition maintains a webpage with resources about health risks associated with climate changes and their connections with the national climate change adaptation plan
	  ○ The health risks identified include frequent and severe heatwaves, natural disasters, prevalent environmental allergens, and mosquitoes
	Governance arrangements (including governance, leadership, and engagement)
	• Several French government ministries collaborated to produce the national guide for preventing and managing health and social impacts related to cold waves, which has three strategic axes:

	○ Prevent, anticipate and protect populations against the effects of cold waves ○ Inform and communicate ○ Capitalizes on experiences • France has established a National Heatwave Plan that uses national meteorologic surveillance to issue heatwave alerts (ranging from level one to level four) that vary based on the severity of the threat and the level of response needed ○ The plan requires the participation of several named national and local organizations and agencies to participate in the surveillance of and response to heatwaves • The French High Council on Public Health has produced a report that outlines the potential health impacts of the national climate change adaptation strategy, highlights areas in the strategy that may benefit from a closer inspection of potential health impacts, and puts forward recommendations across four domains: ○ Governance and interdisciplinarity ○ Territoriality ○ Monitoring and communication ○ Research **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • Santé Publique France maintains the 'réserve sanitaire', a volunteer reserve of health professionals, non-medical hospital staff, and health agency workers that can respond rapidly to health situations in France and abroad that exceed the capacities of local institutions **Policy and program interventions** • Santé Publique France maintains a program of work dedicated to heat waves and their health consequences, with a focus on monitoring, implementing risk-reduction measures, and preventing health risks
United Kingdom	**Essential public-health functions** • The U.K. government published guidance for health and care professionals, managers and staff holding strategic roles about how to address the impact of climate change on health, which includes calls for health and care professionals to: ○ Educate themselves and others about climate change ○ Connect with colleagues and patients about how to have a positive impact on the environment, such as through active travel ○ Help patients and staff reduce exposure to air pollution ○ Identify patients most vulnerable to hot and cold weather, and ensure they know how to keep their homes at a reasonable temperature ○ Encourage healthy eating habits that prioritize foods with smaller carbon footprints ○ Encourage patients and staff to increase their use of green spaces ○ Opt for low-carbon treatments and technologies where appropriate using the National Institute for Clinical Excellence (NICE) patient decision aid **Governance arrangements** (including governance, leadership, and engagement) • Senior or strategic leaders can help develop or implement their health organization's Green Plan and establish or join Green Champion networks and Green Impact teams

	• The NHS recommends the use of sustainability reporting guidelines for public-sector organizations • The NHS aims to take a system-wide approach to sustainable commissioning of its healthcare system • Public Health England published an evidence-based framework, *Everybody Active, Every Day,* highlighting walking and cycling as some of the easiest ways to build activity into daily life to improve physical and mental health and contribute to better air quality **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • To help monitor and evaluate sustainable change in healthcare, health organizations can use the Sustainability in Quality Improvement resources to design, measure and report changes to clinical practice **Policy and program interventions** • The Local Government Association produced a briefing for directors of public health on air quality to help Directors of Public Health and local authorities consider appropriate public-health responses to air pollution in their areas, including several local case studies of initiatives that have taken place across the U.K. • To help prepare for the negative health impacts of climate change, NHS England has developed The Heatwave Plan for England to prepare, alert and prevent people from preventable health impacts from severe heat

California – U.S.	**Essential public-health functions**
	• The California Department of Public Health (CDPH) Climate Change and Health Equity Section (CCHES) 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
	  ○ The assessment data can be used to screen and prioritize where to focus deeper analysis and plan for public-health actions to increase resilience
	• The goals of the CalBRACE project are to enhance the capability of the CDPH to plan for and reduce health risks associated with climate change, and to provide 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 CalBRACE Project produced the Climate Change and Health Vulnerability Assessment Framework to help to identify where a person's or neighbourhood's susceptibilities to injury or disease exist relative to their distance and sensitivity to climate-related environmental exposures or hazards
	• CalEnviroScreen is a screening tool that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution
	  ○ The screening tool maps indicators such as pesticide use, drinking-water quality, and toxic exposures (e.g., ozone levels) that will likely be exacerbated by higher temperatures associated with climate change
	• 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), for extreme events
	  ○ This tool is used to assess local jurisdictions' preparedness for Zika, wildfire, earthquakes and drought, as well as to assess mental health impacts after such events

	• CDPH also supports many research efforts focused on climate, including epidemiologic studies on heat, the health impacts of wildfire smoke exposure, and the life-cycle assessment and co-benefits of cool pavements
	• The PULSE system has been activated during recent years' wildfires to provide specified volunteer healthcare workers access to patients' personal health information in the short term
	  ○ PULSE connects multiple local data sources from health information organizations and systems during a disaster
	• The California Health and Human Services Agency is required to create a data-exchange framework to facilitate the sharing of health and social services information across healthcare entities and government agencies
	  ○ This effort will enable sharing of real-time health information during climate-driven emergencies
	• Climate Change and Health Profile Reports with projections for county and regional climate impacts, vulnerable local populations, and the climate-related health risks, are developed for and provided to counties by the CDPH to support their climate change adaptation planning
	• State law requires that health plans ensure that enrollees continue to have access to medically necessary healthcare services during a state of emergency and allows them certain flexibilities (e.g., suspending prescription refill limitations)
	  ○ Medi-Cal program rules are also allowed to be waived during and after state emergencies
	Governance arrangements (including governance, leadership, and engagement)
	• 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
	• The CCHES works to embed health and equity in California climate change and public-health actions by working with local, state, and national partners to assure that climate change mitigation and adaptation activities do not exacerbate already existing unfair and preventable differences in health status of some groups
	  ○ CCHES also provides health equity considerations when California's climate change laws and executive orders are being implemented
	• In a 2022 report published by the Legislative Analyst's Office, recommendations for adjustments that are needed for the Legislature to respond to the impacts of climate change include:
	  ○ Improving monitoring and analysis of health effects caused by climate change
	  ○ Increasing mechanisms to provide state-level guidance and expertise to support activities at the local level
	  ○ Providing additional funding to local public-health departments to help local agencies fill some of their existing expertise and capacity deficiencies
	  ○ Requiring that providers receive more training on emerging conditions and diseases
	  ○ Targeting state programs in ways that support vulnerable populations in order to reduce the inequitable distribution of impacts
	Financial arrangements (including, but not limited to, financing)
	• The California Environmental Protection Agency (CalEPA) Environmental Justice Small Grants Program offers funding opportunities to assist eligible non-profit organizations and federally recognized Tribal governments in addressing environmental justice issues in areas disproportionately affected by environmental pollution and hazards

	• Governor Gavin Newsom signed a $15 billion package last year to address the climate change risks faced in California, and signed 24 bills in July 2021 focused on climate and clean energy, drought, and wildfire preparedness ○ The package includes a $3.7 Billion Climate Resilience Package focusing on vulnerable front-line communities, $4.6 billion for drought and water resilience activities, and $988 million to address wildfire and forest resilience • California's Emergency Medical Services Authority (EMSA) has been allocated $36 million of funding in the 2021-22 state budget to increase the authority's capacity to surge medical staff, store and maintain equipment, respond to regional disasters, and to plan and develop a statewide emergency services data-resources system **Delivery arrangements** • CDPH's Emergency Preparedness Office coordinates emergency planning and preparedness by operating and managing California's health-alert network, planning for public-health disasters, and providing resources for counties, local healthcare facilities, and state entities to prepare for catastrophic health threats **Policy and program interventions** • 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

Massachusetts – U.S.	**Essential public-health functions**
	• Most local public-health departments focused on vulnerable population outreach to the elderly and, to a lesser extent, those with mobility challenges, to address climate change-related health risks
	• Many local public-health departments reported efforts to increase resiliency to extreme heat events, such as having developed or currently developing plans for siting cooling centres for operation during heat events
	• Local health departments reported communicating to the general public about health risks related to climate change via community websites, emails, local newspaper, mail, email, information sessions, and other websites, among other strategies
	• During public-health emergencies (including severe weather events and other climate change-related events), local public health departments reported communicating with residents via reverse 911, TV news, radio news, police, and other means
	• Local public-health departments reported surveillance activities on public-health impacts associated with climate change, including vector-borne and food-borne diseases, drinking-water quality, safety of recreational water bodies, weather events (e.g., flooding and extreme heat), outdoor air quality, respiratory issues, and indoor environment
	• The Massachusetts Department of Public Health conducted a survey assessing the capacity of local public-health departments to respond to the public-health impacts associated with climate change, and developing plans for reducing these impacts
	  ○ Only 24% of responding public-health departments identified climate change preparations as a priority, and only 21% felt they had adequate resources to address climate risks
	  ○ The Department of Public Health should create region-specific maps to identify vulnerabilities by quantifying specific environmental and public-health threats
	Governance arrangements (including governance, leadership, and engagement)
	• *None identified*
	Financial arrangements (including, but not limited to, financing)

	• As part of the Municipal Vulnerability Preparedness program, which aims to protect natural resources, property, infrastructure, public health, and the economy from climate change impacts, communities who complete the program become certified as an MVP community and are eligible for MVP Action Grant funding and other financial support opportunities **Delivery arrangements** • *None identified* **Policy and program interventions** • The recommendations from the survey conducted by the Massachusetts Department of Public Health can be used in combination with Massachusetts' Environmental Public Health Data Tracking (EPHT) portal to help communities prepare for health risk associated with climate change • Community initiatives to mitigate environmental impact reported in the survey included energy efficiency in government buildings, increasing sustainable/renewable energy in the community, and increasing energy efficiency requirements for residential and commercial buildings • To reduce public-health impacts of climate change, communities reported a variety of initiatives including evacuation of vulnerable populations during hazardous weather, implementing requirements for permitting future developments in flooded zones, setting location and operational hours of cooling centres, and defining when to open cooling centres • The Municipal Vulnerability Preparedness program provides support for cities and towns in Massachusetts to begin the process of planning for climate change resiliency

Oregon – U.S.	**Essential public-health functions**
	• A comprehensive climate change and health-impact assessment report and a complementary data visualization tool for the Portland metropolitan region was developed by a regional collaborate of Clackamas County Public Health, Oregon and multiple neighbouring counties
	Governance arrangements (including governance, leadership, and engagement)
	• The State of Oregon issued a 2021 State Agency Climate Change Adaptation Framework to plan for and respond to climate change impacts in a coordinated and efficient manner that minimizes redundant effort
	  ○ Part Three of the Framework describes adaptation strategies and approaches within six themes, one of which is public health
	• Oregon Health Authority (OHA) is in the process of developing an updated State Health Improvement Plan and a new Environmental Public Health Modernization Plan, both of which prioritize integration of climate change, equity, and social justice into public-health programming and policy
	  ○ OHA also contracted climate equity consultants to provide climate equity training participants of their Climate Equity Workgroup within the Climate Change Adaptation Framework (CCAF) interagency
	Financial arrangements (including, but not limited to, financing)
	• Inclusion of extreme heat as a health risk in Oregon's 2020 Natural Hazard Mitigation plan made the state eligible for Federal Emergency Management Agency funding for mitigation actions that reduce identified risks
	Delivery arrangements
	• The Oregon Public Health Division (OPHD) has provided training on the health impacts of climate change, health equity, and strategies for reducing health impacts and building resilience to trained public-health and emergency-response personnel, as well as community health workers, partner state agencies, and the general public

	○ In addition to training, the OPHD has provided funding and technical assistance to five local health jurisdictions to understand and prioritize the health effects of a changing climate in their communities, and to develop and implement strategies for building resilience **Policy and program interventions** • *None identified*
Minnesota – U.S.	**Essential public-health functions** • The Minnesota Department of Health released a Heat Vulnerability in Minnesota Tool, an interactive website designed to assess community vulnerability to extreme heat • The Extreme Heat Toolkit helps identify communities' vulnerability and acts as a launching point to streamline local solutions to protect health and increase climate resilience • The Whitepaper Advancing Health & Disaster Resiliency in Minnesota: Co-producing Climate & Health Information for the Emergency Management Sector provides insights about stakeholders' perceptions and intentions about using climate-projection data to inform emergency-management planning and preparedness efforts ○ Respondents reported intentions to integrate data into hazard-mitigation and response plans (78.1%), engage key partners in local planning and projects (52.1%), and inform training and exercises related to emergencies (42.5%) ○ For those who indicated their intention to integrate data into hazard-mitigation and response plans, respondents planned to use it to identify community vulnerabilities (94.6%), determine mitigation actions to reduce damages from future impacts (82.1%), assess the probability of future severe weather events (78.6%), and inform the planning process to make sure plans are climate change ready (50%) **Governance arrangements** (including governance, leadership, and engagement) • The Minnesota Department of Health's Minnesota Climate & Health Program produced a Strategic Plan to build resiliency to mitigate, plan for and respond to climate change, including by working with local public-health agencies to increase their capacity to respond to and adapt to public-health impacts of climate change **Financial arrangements** (including, but not limited to, financing) • *None identified* **Delivery arrangements** • Climate Change 101 Training for local health professionals in Minnesota highlights observed climate change impacts, climate change-related public-health challenges, and public-health strategies to mitigate and adapt to climate change **Policy and program interventions** • *None identified*
New York – U.S.	**Essential public-health functions** • To better understand the impacts of climate change on health in New York, the New York Health Department's Climate and Health Program conducts surveillance and research through partnerships with academic researchers and experts • New York State (NYS) is increasing its use of cooling centres and supports outreach through the Be-a-Buddy Program to promote green infrastructure, reforestation, and reflective or "cool" roofs in order to moderate the urban heat island effect and reduce the severity and frequency of future projected extreme heat events

	• NYS has implemented adaptation strategies to address climate hazards, including developing Heat and Health profile reports that summarize extreme heat exposure and vulnerability, and revising thresholds for issuing heat advisories
	  ○ NYS staff have also created a mapping application to track heat-stress hospitalization and emergency-department visits annually, and display cooling centre stations across the state
	Governance arrangements (including governance, leadership, and engagement)
	• *None identified*
	Financial arrangements (including, but not limited to, financing)
	• Seneca Nation of Indians in New York has received funding through the CDC to incorporate health into existing collaborative climate work focused on flooding and vector-borne diseases
	Delivery arrangements
	• *None identified*
	Policy and program interventions
	• The New York Health Department participates in multi-agency planning efforts that use policies and programs to make buildings, systems and infrastructure in the state more sustainable and resilient in order to protect public health from the impacts of climate change
	• The New York City Climate and Health Program (NYC CHP) focuses on the health impacts of current and future climate-related hazards and prioritizes local communities for climate mitigation and adaption investments
	  ○ One example of the program's work is the NYC Heat Vulnerability Index, which provides an assessment of how the risk of dying during a heat emergency varies across neighbourhoods