

Climate Change Toolkit for Health Professionals

April 2019



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Preface

This toolkit consists of eight modules which have been prepared as stand-alone documents that can be read by themselves, but they have also been prepared to complement one another. It has been designed as a tool for health professionals and students in the health care and public health sectors who want to engage more directly on the issue of climate change as educators with their patients, peers and communities, and/or as advocates for the policies, programs and practices needed to mitigate climate change and/or prepare for climate change in their workplaces and communities.

Module 1 – Climate Change – Science, Drivers & Global Response provides an introduction to climate science and discusses the human activities that are contributing to climate change, the international commitments that have been made to address it, and where we are in terms of complying with those commitments.

Module 2 – Global Health Impacts of Climate Change summarizes the direct and indirect health impacts that are occurring, and are predicted to result from, climate change, on a global scale.

Module 3 – Climate Change Health Impacts across Canada summarizes the direct and indirect health impacts that are occurring, and that are predicted to occur, in the different regions of Canada.

Module 4 – Greenhouse Gas Emissions in Canada by Sector and Region discusses the volume of greenhouse gases emitted, and the trends in those emissions, from different sectors in Canada at a national, provincial and territorial scale.

Module 5 – Climate Change Solutions with Immediate Health Benefits discusses es climate solutions that can produce fairly immediate health co-benefits for the jurisdictions that implement them.

Module 6 – Taking Action on Climate Change at Health Care Facilities discusses the climate mitigation and adaptation policies, programs and practices that can be adopted and implemented by health care institutions to reduce their greenhouse gas emissions and prepare for climate change.

Module 7 – Preparing for Climate Change in our Communities discusses the climate adaptation policies and programs that can be developed by public health units or municipalities to minimize the health impacts associated with climate change.

Module 8 – Engaging in Climate Change as Health Professionals discusses the different ways in which health professionals can educate and engage their patients, the public, their peers, and their communities on the health impacts of climate change, and the policies and programs needed to mitigate climate change and prepare for it.

Letter from the Executive Director

Over the last several years, we at CAPE have been inundated with requests from doctors, medical students, public health staff, and other health professionals: "Tell me what I can do to help fight climate change?" People are anxious about climate change; worried about the future we are creating for our children; and saddened by what we are doing to our planet and ecosystems. This toolkit has been created as a resource that can be used by CAPE members and other health professionals who want to become move actively engaged in the issue.

The modules in the Toolkit have been created to provide a solid foundation on climate science and international agreements, global health impacts and the health impacts being experienced in Canada, and the sources of and trends in climate emissions across Canada. It also provides a good base of information on the immediate health co-benefits associated with a number of climate solutions, the actions that can be taken in health care facilities to mitigate and adapt to climate change, the actions that can be taken in our communities to minimize the health impacts associated with climate change, and ideas about how health professionals can engage in the issue.

I would like to thank the seven contracted experts who prepared the eight modules on an extremely tight timeline with very modest funds. We were very lucky to find people who brought a great deal of relevant expertise and experience to their respective tasks. I would also like to thank the nine project advisors, many of whom are CAPE Board Members, for taking the time to review and comment on the modules. I would also like to make a nod to CAPE's Digital Communications Director who formatted the eight modules and seven fact-sheets in both English and French with very little time.

We see the Toolkit as an evolving resource. We plan to supplement the eight modules and seven factsheets with other resources, such as PPT presentations, over time. We would ask those of you who use the modules to let us know which module(s) you used, when you used them, and how, by dropping us a line at info@cape.ca. We would like to hear what elements worked well for you and any suggestions you have for improvements or additions to the Tool-kit over time.

At CAPE, we agree with the World Health Organization that climate change is "the greatest health threat of the 21st century" but we also agree with the Lancet Commissions on Climate Change that "tackling climate change can be the greatest global health opportunity of the 21st century". As health professionals, we have an important role to play in the debate on climate change; we can help build support for action among the public and decision-makers by focusing attention on the health impacts associated with climate change and on the significant health co-benefits that can result from the actions needed to fight it.

~ Semilto

Kim Perrotta, MHSc CAPE Executive Director

Module 1

Climate Change Toolkit for Health Professionals Climate Change – Science, Drivers & Commitments April 2019



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Module 1: Climate Change – Science, Drivers & Commitments

Introduction

This module describes the science of climate change – what it is, what causes it, and how human activities contribute to it. It also presents an overview on the global response to climate change. It describes the commitments that have been made by our leaders globally and whether we are on track to meet these obligations. It further depicts the scenarios we will likely face in decades to come if we do not take sufficient action. Based on the most up-to-date evidence, this module outlines what we need to do to achieve our global warming targets. All of this



Air pollution. Photo by Patrick Hendry on Unsplash.

background will help place the action that Canadians are taking on the local and national stage into the global context.

The Greenhouse Effect

The greenhouse effect makes life on Earth possible. Greenhouse gases (GHGs) insulate our planet from the temperature vacuum of space and maintain a stable surface temperature on Earth 32°C warmer than it would otherwise be – a level that is compatible with life.

Solar energy travels through the Earth's atmosphere and surface. This energy is partially reflected back into space and partially absorbed by the surface, some of which is re-radiated as heat into the atmosphere. GHGs absorb a great deal of the re-radiated energy, and over time, release it back into the atmosphere and surface. Atmospheric aerosols (solid particles and liquid droplets suspended in the air) further contribute to the absorption and release of energy. The combined effects of GHGs and aerosols absorbing and releasing energy into the atmosphere that otherwise would be reflected back into space is known as net radiative forcing.

GHGs are the largest contributor to radiative forcing. The most abundant GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and water vapour (H_2O) (Cleugh et al., 2011). Over the past few centuries, atmospheric concentrations of all of these gases, except for water vapor, have increased as a result of human activity. In addition, human activity has increased the concentration of fluorinated gases (i.e. chlorofluorocarbons and hydrofluorocarbons) in the atmosphere, further increasing the capture of energy cycled through radiative forcing.

Anthropogenic climate change is the result of increased radiative forcing due

Carbon dioxide is the most produced GHG from human activities, however a single CH_4 molecule is around 30 times more effective at trapping heat (known as global warming potential) than a CO_2 molecule (US EPA, 2017).

So, to calculate the overall contribution of each human activity to climate change and to identify the most important mitigation interventions, GHG emissions are often presented as carbon dioxide equivalents (CO_2eq).

to human activity. Cumulatively, human activity has added an estimated 2,220 gigatons of CO_2 to the atmosphere since 1876 (Rogelj et al., 2018). GHGs have increased the concentration of CO_2 eq in the atmosphere by almost 100 parts per million (ppm) in 60 years, from 315 ppm in 1958 to around 410 ppm at the end of 2018 (US Dept of Commerce, 2019). So far, climate change has generated, on average, 1°C of global warming since pre-industrial time (Allen et al., 2018).

Anthropogenic Greenhouse Gas Emissions

In terms of human activity increasing the atmospheric concentrations of GHGs, the most common emissions are carbon dioxide (CO₂) from fossil fuel combustion and by-products of industrial processes (76%), methane (CH₄) (16%), nitrous oxide (N₂O) (6.2%) and fluorinated gases (2%) (Blanco et al., 2014).

By sector, the greatest contributors to GHG emissions globally are electricity and heat production (25%); agriculture, forestry, and other land use (24%); industry (21%); and transport (14%):

- Emissions from electricity and heat production come mostly from the combustion of fossil fuels, with coal having the highest carbon intensity.
- GHG emissions from agriculture, forestry and other land use largely come from deforestation as well as methane produced by livestock and nitrous oxide produced from agricultural soils.
- Different types of industries produce emissions at all steps in the supply chain. Extraction industries, materials industries and manufacturing and construction produce GHGs through energy use and also through different processes.
- The transport and storage of products can also produce emissions. The greatest share of emissions from

transport comes from the combustion of gasoline and diesel for fuel in passenger cars and trucks, but aviation is becoming an increasingly important contributor to emissions.

 The contribution of each sector varies for different country income groups. For example, agriculture, forestry and other land use contributes almost all of the global emissions from low-income countries, whereas energy contributes around 40% of global emissions from high-income countries ((IPCC, 2014a).

Observed Changes in our Climate System

The Earth's climate system is comprised of interactions between the atmosphere (air and suspended particles) hydrosphere (oceanic, terrestrial, and atmospheric water), the cryosphere (ice and snow), the biosphere (plants and animals), the pedosphere (soil), and the lithosphere (the upper mantle and crust). Anthropogenic climate change impacts will be felt in all of these spheres, with the exception of the lithosphere (IPCC, 2013).

Over the past two centuries, human-induced climate change has raised the global mean surface temperature on Earth by approximately 1°C. Although natural forces have contributed some uncertainty to climate change estimates, the overall difference between total warming and human-induced warming is demonstrably small, in the range of +/- 0.1°C between 1890 to 2010 (Allen et al., 2018). Currently, the rate of global warming is an increase of 0.2°C average temperature per decade (Allen et al., 2018).

Anthropogenic climate change is having disproportionate effects in populated regions with 20 to 40% of the world's population living in areas which have experienced greater than 1.5°C average warming over at least one set of seasonal temperatures (Allen et al., 2018). Although the global surface temperature of the Earth has warmed by 0.3°C since the early 2000s, temperatures in populated regions have increased by an average of 0.8°C during that time (Watts et al., 2018).

The Intergovernmental Panel on Climate Change (IPCC) has stated with high certainty in its Fifth Assessment Report that the number of cold days and nights has decreased and the number of warm



Storm over a city harbour. Photo by Dejan Zakic on Unsplash.

days and nights has increased on a global scale (IPCC, 2013). Moreover, heatwaves have become more common in large parts of Europe, Asia, and Australia (IPCC, 2013). While the frequency and/or intensity of extreme precipitation events has increased in most regions since the 1970s, in the Mediterranean and West Africa droughts have worsened, and in the North Atlantic the most energetic tropical cyclones have increased in number, strength, and duration (IPCC, 2013).

Future Changes Predicted

The IPCC described the scientific consensus on projected impacts of 1.5°C and 2°C warming from pre-industrial baselines to 2100 in its Special Report on Global Warming of 1.5°C released in October 2018. The values of 1.5°C and 2°C were chosen as depicting two temperature scenarios to



Hurricane from space. Photo by Nasa.

which all nations committed in the 2015 Paris Agreement. The IPCC found impacts associated with 1°C, 1.5°C and 2°C global warming will not necessarily present a linear gradation of impacts from one mean temperature scenario to the next.

The IPCC found that global warming of 1.5° C by 2100 would result in:

- approximately13.8% of the world's population being exposed to severe heatwaves at least once every five years;
- a global increase in the frequency and intensity of hot days and nights, and a similar decrease in cold days and nights, with the largest changes occurring in the hot temperature extremes experienced in tropical regions;
- a global increase in the frequency and intensity of heavy precipitation, strong tropical cyclones, and flood hazards, but also a higher prevalence of droughts in some regions.
- It further found that global warming of 2°C by 2100 would result in:
- over a third of the world's population being exposed to severe heatwaves at least once every five years; nearly three times the population exposed in the 1.5°C scenario;
- a greater risk for drought, heavy precipitation events, and strong tropical cyclones, as well as more land area exposed to flood hazards;
- a global mean sea level rise of 0.1 m greater than expected in the 1.5°C scenario, affecting 10.4 million more

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people by the end of the century.

Future Impacts on Ecosystems and Humans

The IPCC found that both 1.5°C and 2°C of warming would increase the number of species at risk of extinction, but 2°C of warming could be expected to nearly double the proportion of insect, plant, and vertebrate species losing half their geographic range, relative to the 1.5°C scenario. It further predicted great risks to our planetary oceans, with 70 to 90% of warm water coral reefs disappearing with 1.5°C of warming, and ecosystem damage, reduced fisheries production, and higher levels of acidification, hypoxia, and dead zones accompanying warming of 2°C. The IPCC also concluded that 2°C compared to 1.5°C of global warming would be associated with greater risks of food and water scarcity, including smaller yields of maize, rice, and wheat, and an up to 50%



Community on Hudson Strait-Nunavik. Photo by Dan Tobias.

increase in climate-induced water stress.

As discussed in Module 2, the climate change risks to human health, including poverty and disadvantage, under-nutrition, vector-borne diseases, heat-related morbidity and mortality, and ozone-related mortality are all greater in the 2°C as compared to 1.5°C scenario. Climate change is also anticipated to impact several economic sectors and services, particularly energy, transport, and tourism. The IPCC projects a doubling of risk from the 1.5°C to 2°C scenarios, with impacts on energy industries, changing land use, water scarcity, drought, and stress, exposure to heatwaves, species habitat degradation, and lower crop yields accumulating across multiple segments of the economy (Hasegawa and Slade, 2018) (See Figure 1).

Regional Tipping Points

Regional "tipping points" – key events that can be associated with major shifts in the climate system - are also at a greater risk with 2°C versus 1.5°C of warming. Ice-free Arctic passages in the summer, reduction in permafrost, and loss of rainforests and boreal forests, may contribute to accelerating concentration of GHGs in the atmosphere as less solar energy is reflected or absorbed at the surface. Even with the stabilization of global mean surface temperatures, some changes will continue beyond 2100, specifically rising sea levels and thawing per-

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mafrost (Hasegawa and Slade, 2018).

Previously, the IPCC has issued reports projecting the likely impacts of additional scenarios, including global warming of greater than 4°C by 2100. It predicted that warming of 3°C to 4°C would severely threaten humanity and ecosystems. Anticipated impacts would include the loss of infrastructure, livelihoods, and economic stability in many different regions of the world, destruction of coastal settlements, large risks to regional and global food security, spread of vector-borne diseases, heat-related human mortality, greater frequency and intensity of wildfires, increased risk of heavy precipitation and floods, worsening of drought in dry regions, and greater habitat fragmentation and loss of geographic range for more species (IPCC, 2014b)(See Figure 1).

United Nations Framework Convention on Climate Change

Over three decades have passed since the world began to first formulate its response to the global threat of climate change. Negotiations to create a Framework Convention on Climate Change in December 1990. Between then and 1992 when the United Nations Framework Convention on Climate Change was finalised and opened for signature at the Rio Earth Summit, over 150 states negotiated what such a convention would involve: binding commitments, targets



Flooding in an urban area. Photo by jim gade on Unsplash.

and timetables for emissions reductions, financial mechanisms, technology transfer, and 'common but differentiated responsibilities of developed and developing countries (UNFCCC, 2019c).

The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994, with 196 countries signing on as Parties. The annual Conference of the Parties (COP), where Parties of the UNFCCC meet to negotiate multi-lateral responses to climate change, began in Berlin, Germany in 1995, with the most recent, COP23, concluding in Katowice, Poland in 2018.

Kyoto Protocol

The Kyoto Protocol, as the world's first emissions reduction treaty, was adopted in 1997. The fifteen then-members of the European Union and ten other countries committed to changing the trajectory of their GHG emissions with targets ranging from -8% (then European Union) to -6% (Canada) +10% (Iceland) of 1990 levels compared with the first commitment period of 2008 to 2012 (UNFCCC, 2019a). These targets were not considered to be enough to mitigate climate change, nor did they include two of the world's biggest emitters (China and India) or other low- and middle-income countries. Although it agreed to a commitment of -7%, the United States did not ratify the Kyoto Protocol domestically. Canada withdrew from the Kyoto Protocol in 2011.

In 2009, the Copenhagen Accord was adopted at COP15. The Copenhagen Accord included provisions to incorporate emissions reporting from developing countries; however, unlike the Kyoto Protocol, it was not considered to be legally binding, and did not have the ambitious objective of limiting global warming to 2°C, let alone 1.5°C, this century (Meyer, 2010).

In 2011 at COP17 in Durban, South Africa, the Parties committed to establishing a new universal climate change agreement



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A dead zone. Photo by redcharlie on Unsplash.

for the period beyond 2020 by 2015. In 2012 at COP18 in Doha, Qatar the parties adopted the Doha Amendment to the Kyoto Protocol, providing space for the Parties to signify their commitments in the period up until 2020. Following up on the commitment to a new agreement established in 2011 at COP17 in Durban, in 2015 the Parties adopted the Paris Agreement at COP21 in Paris, France.

The Paris Agreement

The Paris Agreement is the first climate change agreement including all nations as signatories, requiring them to commit to climate change mitigation and adaptation. By the start of 2019, 184 of the 197 parties to the UNFCCC have domestically ratified the Paris Agreement (UNFCCC, 2019b). In terms of its provisions, Parties to the Paris Agreement have committed to: "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" with the peaking of GHG emissions as soon as possible and achieve "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century" (UNFCCC, 2015).

In order to achieve its stated goals, the Paris Agreement requires each Party to submit Nationally Determined Contributions (NDCs), which include each Party's commitments to emissions reductions targets that contribute to the global goals of the Paris Agreement. The Parties are required to report on their progress in achieving these NDCs every five years, with an option for Parties to increase the scope of their ambitions with regard to reducing GHG emissions within their NDCs. The Paris Agreements stipulates that a "Global Stocktake" will occur in 2023 and every five years thereafter, in order to review whether Parties' actions are consistent with achieving their NDC goals.

Parties also committed to support developing country efforts to mitigate and adapt to climate change, by financing a Green Climate Fund comprising US \$100 billion in annual contributions by 2020. Other key provisions in the Paris Agreement include statements on fostering sustainable development through adaptation, minimizing risk and mechanisms of compensation for losses and damages, developed country leadership in climate finance, facilitating technology transfer and capacity-building support, cooperation in providing education and training, as well as affirming the importance of public awareness, participation, and access to information, aligning with various movements within global climate negotiations (UNFCCC, 2019c).

The Nationally Determined Contributions

As of April 2016, 161 strategies for achieving Nationally Determined Contributions (NDCs) had been submitted by key stakeholders to the Paris Agreement, covering 189 Parties to the Convention and representing 99% of global GHG emissions (UNFCCC, 2016). Each NDC submission includes emissions reduction targets (with some including conditional as well as unconditional targets) presenting a significant progression in commitments beyond current undertakings.

Additionally, the majority of NDC contributions include an adaptation component, commonly featuring human health as a

It is predicted that warming of 3 Degrees Celsius to 4 Degrees Celsius would severely threaten humanity and ecosystems. priority, in conjunction with strategies to address water security and impacts in the agriculture sector. Further, many Parties discuss the impacts of climate change in areas that cannot be avoided as loss and damages in both economic and non-economic terms, such as the percentage of land or agricultural production lost, or the proportion of a population affected.

The Carbon Budget and Necessary Steps to Achieve 1.5°C

With global temperatures increasing by about 0.2°C per decade, human-induced climate change reached 1.0°C above pre-industrial levels around 2017, and at the current rate of emissions, is expected to reach 1.5°C by 2040 (IPCC, FAQs, 2018). (See Figure 2).

In the IPCC Special Report on Global Warming of 1.5°C, the authors modelled over 200 possible pathways that global warming might take over the course of the 21st century (Rogelj et al., 2018). These pathways included limiting warming to below 1.5°C throughout the century, temporarily overshooting 1.5°C but returning to 1.5°C by 2100, and limiting warming to below 2°C throughout the century.

Translating these pathways into targets that are consistent with the strategies and timelines set out in the Paris Agreement and operationalized in the NDCs, global annual CO₂ emissions must

The Different Paths to Action on Climate Change (Babiker et al., 2018)

Climate Mitigation- Climate change requires a multi-pronged approach necessitating many different paths to action. Firstly, measures to minimize climate change and global warming primarily require mitigation, that is reducing anthropogenic GHG emissions through concerted action to enact systemic transformation of industrial and consumer behaviour across all sectors.

Carbon Dioxide Removal Measures - Another set of measures to offset GHG emissions and associated global warming are defined by the IPCC as CO_2 removal (CDR) measures. These CDRs can include activities such as bioenergy produced by living organisms ingesting CO_2 , carbon capture and storage technologies, and planting trees to achieve reforestation and afforestation. CO_2 emoval can also be undertaken remedially to temporarily reduce or offset warming, including measures like solar radiation modification to increase the amount of solar energy reflected from Earth's surface back into space.

Climate Adaptation - Third, adaptation measures are intended to minimise the exposure and effects of unavoidable impacts due to climate change we cannot prevent. One such adaptation measure is disaster risk management, which involves understanding disaster risk and improving disaster preparedness, response and recovery. Sharing and spreading financial risk can help serve as a financial buffer against impacts from climate hazards. Building awareness and educating communities on the risks of climate change, as well as learning from Indigenous knowledge of agro-ecological and forest management systems, social memory and experience are also important adaptation measures. And health adaptation measures, such as improving access to safe water and improved sanitation, strengthening health systems and strengthening surveillance and early warning systems are very important and will be discussed in detail in Module 6 and Module 7.

Respond and Recover - Finally, measures have been developed to respond and recover from losses and damages – addressing climate change impacts that cannot be avoided through mitigation and adaptation. Losses and damages are largely considered in economic terms; however, there are many situations in which remedies may need to address consequences that extend beyond the reach of financial compensation. Climate change can result in loss of good health, loss of life, loss of livelihood, loss of home, loss of country and loss of culture. Working to ensure equitable processes for public awareness, participation, and access to information is one way to help vulnerable populations facing climate change losses and damages to respond and recover, by promoting their voice in decision-making for arenas impacting their health.

To attempt to address the financial and non-financial losses and damage resulting from climate change, the Warsaw International Mechanism for Loss and Damage was formed in 2013. The Loss and Damage Mechanism promotes implementation of approaches to address loss and damage, including enhancing knowledge and understanding of comprehensive risk management approaches, strengthening dialogue and coordination among relevant stakeholders, and enhancing action and support to address loss and damage through finance, technology and capacity-building (UNFCCC, 2019d).



Figure 2: Human-induced climate change reached 1.0° C above pre-industrial levels around 2017, and at the current rate of emissions, is expected to reach 1.5° C by 2040 Figure taken from (IPCC, FAQs, 2018).

be reduced to 25 to 30 Gt CO_2 per year by 2030, corresponding with a 45% reduction from 2010 levels. By 2050, the target for CO_2 emissions would need to be net zero. Achieving a limit of $1.5^{\circ}C$ warming would further require reductions in non- CO_2 emissions. While some of these non- CO_2 targets would simultaneously be tackled alongside CO_2 reduction measures in sectors such as energy and transport, others would requiring sector-specific measures, such as targeting agricultural nitrous oxide (N₂O) and methane (CH₄) emissions (Rogelj et al., 2018).

To limit global warming to 1.5°C, we need transformative systemic change to

occur alongside of sustainable development. In order to limit global warming to 1.5°C, a detailed analysis of the changes required across all sectors, within all levels of government, and for every non-state actor is provided in Chapter 4 of the IPCC's Special Report on Global Warming of 1.5°C (Babiker et al., 2018).

The Pathway to 1.5°C

All pathways for achieving the 1.5°C global warming scenario model a large change in the energy mix:

 By 2050, renewable energy should account for 52 to 67% of primary energy production and coal-fired generation should account for only 1 to 7% of production, with much of that production combined with carbon capture and storage technologies to offset emissions;

- From 2020 to 2050, oil consumption should decline by 39 to 77%, and gas consumption by 13 to 62%;
- The agricultural sector would require improved food production efficiency and closure of yield gaps; changes in consumer behaviours are needed to minimize food loss and waste; and consumption of meat and other livestock products would have to be decreased (particularly in excess of national food guidelines);
- Carbon dioxide removal (CDR) technologies will be required in all pathways with little or no overshoot of 1.5°C global warming in order to offset any remaining CO₂ emissions and achieve carbon neutrality (Babiker et al., 2018); however, most of these technologies remain largely unproven (particularly at scale) and pose concern for their impacts on environmental and social sustainability.

The longer that mitigation strategies for curbing CO_2 emissions are delayed, the

Global annual CO_2 emissions must be reduced to 25 to 30 Gt CO_2 per year by 2030, corresponding with a 45% reduction from 2010 levels. By 2050, the target for CO_2 emissions would need to be net zero. greater will be our reliance on the yet uncertain potential of CDR technologies to try to remain below a 1.5°C threshold of global warming from pre-industrial times to 2100 (Rogelj et al., 2018).

Linking Climate Change to Sustainable Development Agendas

Three months before the adoption of the Paris Agreement, countries committed to the Sustainable Development Goals (SDGs). The SDGs build on the Millennium Development Goals, which aimed to promote a global end to poverty that would help ensure peace, prosperity and protection of the planet (UNDP, 2015).

Sustainable development is most commonly described as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). As the definition suggests, global action on climate change and sustainable development go hand in hand.Limiting global warming to the 1.5°C as opposed to 2°C scenario would provide a much simpler context for achieving sustainable development, reducing inequalities, and eradicating poverty (Roy et al., 2018). Despite many synergies between climate change action and the SDGs, however, if improperly managed, there could be trade-offs made between prioritizing mitigation and adapIt's easy to get lost in all the numbers and terms when talking about climate change. Essentially, what the evidence is telling us is that we're already experiencing the impacts of global warming and climate change and every increase in temperature above where we're already at will cause greater impacts. This means, in order to make the impacts as small as possible, we need to stop increasing global emissions (achieving "peak emissions") as soon as possible and from there reduce emissions as quickly as possible.

tation strategies on the one hand, and the SDGs on the other (Roy et al., 2018).

The Emissions Gap

UN Environment publishes an annual Emissions Gap Report immediately prior to the COP each year providing an independent scientific assessment of national progress toward achieving mitigation targets. In its 2018 report, United Nations (UN) Environment stated that in order to achieve the Paris Agreement, global emissions must peak by 2020. However global emissions are not even estimated to peak at 2030 based on current targets.

Indeed, even for those countries that have already peaked, emissions would not decline quickly enough. For example, achieving an 80% reduction in emissions from a 2005 baseline to 2050 would require a constant rate of decline of 3.5% per year, when rates of decline from countries that have peaked range from 0.6% per year in Canada and 2.5% per year in Russia (UN Environment, 2018).

Bridging the Gap

The IPCC's Special Report on Global Warming of 1.5°C has demonstrated that limiting global warming to 1.5°C is still technically feasible. Nevertheless, stronger ambition to take action is required from national and sub-national governments, as well as nonstate actors (UN Environment, 2018).

All UNFCCC Parties have the opportunity to strengthen the ambitions of their NDC mitigation targets before 2020. Another opportunity to strengthen mitigation targets will take place after the global stock-taking in 2023. This opportunity might involve strengthening or adding a sectoral CO_2 or non- CO_2 emissions target, and/or developing the addition of new policies and actions within the NDC (UN Environment, 2018).

There is also a huge potential for expanded sub-national government and nonstate climate change action. Over 7,000 cities from 133 countries, and some 245 regions and 42 countries have pledged to take action to mitigate their emissions. Additionally, over 6,000 companies have pledged mitigation action, although this represents a small proportion of the more than 500,000 publicly traded companies on global stock exchanges.

Current pledged commitments of nonstate actors are consistent with emissions reductions of 0.45 Gt CO_2eq per year, but if these organizations were to achieve their fullest potential, they could reduce emissions by 19 Gt CO_2eq per year by 2030 compared to the status quo (UN Environment, 2018). In order to limit global warming to 1.5°C, all countries, sub-national governments, and non-state actors must increase their ambition for mitigation, as soon as possible.

Summary

Anthropogenic GHG emissions have already resulted in 1°C of global warming since pre-industrial times. This warming has prompted significant changes in our climate system, impacting every region of the world. Further changes will occur with global warming of 1.5°C by 2100, but risks will significantly worsen at 2°C, and at higher temperatures be greater still.

The international response to this issue has been slow. However, the Paris Agreement and the Nationally Determined Contributions (NDC) framework may provide the tools to achieve global action on climate change.

Limiting global warming to 1.5°C by 2100 is still technically feasible; Moreover it will be necessary to minimise the risks of climate change. Current commitments are far from getting us there. For the best possible chance of limiting global warming, we require rapid and ambitious action from all

levels of society; our path is not yet set.

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15 Climate Change Toolkit 2019 - Module 1

Climate Change Toolkit for Health Professionals Factsheet: Climate Change – Science, Drivers & Commitments

Climate science and the drivers of climate change

While greenhouse gases (GHG) are necessary to maintain the conditions for life on Earth, GHGs emitted by human activity are altering the planet's climate. Human activities have resulted in the release of an estimate 2,220 gigatons (Gt) of carbon dioxide (CO_2) from pre-industrial times to the present, increasing atmospheric concentrations from 315 to 410 parts per million (ppm) over a span of only 60 years.

Globally, the majority of GHG emissions from human activity are produced in only four sectors of the economy - electricity and heat production (25%), agriculture, forestry and other land use (24%), industry (21%) and transport (14%). In 2017, average temperature around the world had increased by 1°C since the the industrial revolution.

Future projections

With global temperatures increasing by about 0.2°C per decade, global warming is expected to reach 1.5°C by 2040 at the current rate of emissions.

Global warming of 1.5°C will amplify and extend the climate change impacts we have seen so far. It is expected to:

- increase the intensity and frequency of hot days and nights, and similarly decrease cold days and nights on a global scale;
- increase the frequency and intensity of heavy precipitation and strong tropical cyclones around the world, and increase flood hazards and the extent of droughts in some regions;
- decimate between 70 and 90% of warm water coral reefs;
- produce unprecedented habitat fragmentation that will halve the geographic range of 6% of insects, 8% of plants and 4% of vertebrates.

A global warming scenario of 2°C is projected to amplify these impacts even further. Compared with 1.5°C, 2°C warming will:

 expose over one third of the world's population to severe heatwaves at least once every five years, which is nearly three times the number of



people who would be exposed with 1.5°C of warming;

- increase the risk of heavy precipitation and droughts as well as strong tropical cyclones;
- increase global sea levels so that an additional 10.4 million people are impacted;
- increase climate-induced water stress by 50% and reduce agricultural yields of maize, rice, and wheat; and
- double the number of people exposed to more than one of these risks.

Where we are and where do we need to be?

In 2017, annual GHG emissions reached a record high of 53.5 Gt CO_2 eq on a global scale. To keep global warming from exceeding 1.5°C:

- annual CO₂ emissions must be reduced by 25 to 30 Gt CO₂eq per year by 2030, corresponding with a 45% reduction from 2010 levels, and attain net zero around 2050;
- renewable energy should supply between 52 to 67% of primary electricity generation by 2050, with coal providing only 1 to 7% of the total capacity;
- oil and gas usage should decline by 39 to 77% and 13 to 62%, respectively, from 2020 to 2050;
- changes are required in the agricultural sector, including improving efficiency of food production, closing the yield gaps, decreasing food loss and waste, and

shifting dietary changes to minimise the consumption of meat.

Mobilizing greater action in the global community

The Paris Agreement is the first climate change agreement that includes all nations. The Parties to this agreement have committed to keeping global warming well below 2°C, with the ambition of not surpassing 1.5°C global warming by 2100.

In compliance with the Paris Agreement, each country submits a Nationally Determined Contribution (NDC) strategy document, which includes their emissions reduction targets, and the plan for how they will achieve these from 2020 onwards, with reporting and review required every five years, starting in 2023.

Despite the progress represented by the Paris Agreement, meeting current NDC targets will not be sufficient to achieve the goal of 1.5°C or even 2°C global warming, and instead will likely result in 3°C warming by 2100. To align the NDCs with Paris Agreement targets, all Parties should strengthen their GHG emission reduction ambitions and targets before we enter their effect period in 2020. Additional revisions should be made at the first opportunity following global stock-taking of NDC achievements in 2023.

Note: References for this factsheet can be found in Module 1 of <u>CAPE's Climate</u> <u>Change Toolkit for Health Professionals.</u>



Climate Change Toolkit for Health Professionals Global Health Impacts of Climate Change

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Module 2 – Global Health Impacts of Climate Change

Introduction

In 2009, the University College London and The Lancet medical journal published the UCL-Lancet Commission on Managing the Health Effects of Climate Change, stating that, "climate change is the biggest global health threat of the 21st century" (Costello et al., 2009). In 2014, the World Health Organization (WHO) estimated climate change will result in an additional 250,000 deaths per year between 2030 and 2050 as the result of heat, undernutrition, diarrhoeal disease and malaria (Hales et al., 2014).

Direct and Indirect Health Impacts

Climate change impacts health directly via trauma, displacement and deaths associated with floods, storms, and wildfires,



Undernutrition. Photo by Parijatha Budidhi

and via heat-related illness. Exposures mediated through natural systems include insect-borne diseases such as malaria and air pollution resulting from increased production of pollen or smoke from wildfires. Exposures heavily mediated by human systems include food insecurity, migration, displacement, and conflict.

Direct Impacts of Climate Change Heat Impacts

Heat exposure can have a direct effect on population-level morbidity and mortality, due to increases in heat-related illnesses (heat exhaustion and heat stroke) and greater risk of cardiovascular, respiratory, and renal disease (Arbuthnott and Hajat, 2017). Heat exposure has further impacts on mental health (see Box 3).

Both increases in daily temperatures and periodic heat waves (i.e. extreme heat that lasts for 4 days or longer) can have complex health impacts. When they occur, heat waves have large impacts on entire populations; however, heat waves occur less commonly than days when temperatures exceed optimum levels for a location, and as such, contribute only a fraction of the overall morbidity and mortality associated with climate change heat exposure (Hales et al., 2014; Smith et al., 2014).

Studies have found that anthropogenic (human-induced) climate change has increased the likelihood and/or intensity of many recent heat waves, including heat waves experienced across Europe in 2003, Russia in 2010, and Australia, Europe, China, Japan, and Korea in 2013 (Watts et al., 2015). Indeed, 18 million more people over 65 were exposed to a heat wave in 2017 than were exposed in 2016, which is 157 million more than the 1986-2005 average (Watts et al., 2018).

In the absence of climate change adaptation, the WHO estimates that the excess burden of annual mortality due to extreme heat will exceed 92,000 deaths by 2030 and 255,000 deaths by 2050.

With 1.5°C of global warming by the end of the century, it is estimated that some 350 million more people will face exposure to deadly heat by 2050 than would be expected at current temperatures (Hasegawa and Slade, 2018). With 2°C of global warming, cities like Kolkata, India and Karachi, Pakistan could expect heat waves similar to those experienced in 2015 on an annual basis (Hasegawa and Slade, 2018). In the absence of climate change adaptation, the WHO estimates that the excess burden of annual mortality due to extreme heat will exceed 92,000 deaths by 2030 and 255,000 deaths by 2050; these numbers, they argue, could be improved by implementing adaptation measures (Hales et al., 2014).

Impact of Heat on Labour Capacity

Heat and heat waves also affect the labour capacity of sectors of the economy such as agriculture, industry, and services. In 2017, 153 billion labour hours were lost due to heat; 62 billion more than were lost in 2000, with 80% of the hours lost by the agricultural sector (Watts et al., 2018). Countries such as China and India are particularly vulnerable, with China alone experiencing 21 billion hours of labour lost in 2017, equivalent to the total working hours of 10.5 million employees in one year or 1.4% of the total Chinese working population (Cai, Cui and Gong, 2018). Even with the limited effects of a 1.5°C global warming scenario, labour capacity losses due to heat are expected to cost China 250 billion yuan (approximately US\$37 billion) per year by the 2030s (Hasegawa and Slade, 2018).

Cold exposure

Although cold-related health exposures are projected to decrease with global warming, increases in heat-related morbidity and mortality will far outweigh any benefits from these reductions at the global level (Smith et al., 2014; Hasegawa and Slade, 2018).

Floods and storms

Flooding and storms linked to climate change can adversely affect human health by damaging health services and other infrastructure; accelerating the spread of infectious diarrheal, leptospirosis, and vector-borne diseases; increasing the incidence of injuries, drowning, and hypothermia; and impacting mental health.

In many countries, flooding poses the biggest natural hazard risk for both mortality and the proportion of the population impacted and the frequency of river flooding events is increasing (Smith et al., 2014). Whether climate change influences the frequency of storms and other kinds of floods remains uncertain; however, there is some evidence that it contributed to flooding in the United Kingdom in 2011, and to seasonal precipitation in the United States and India in 2013 (Watts et al., 2015).



House destroyed by a Superstorm. Photo by Acrylik.

More frequent and intense flooding events means economic losses are increasing, but there has not been clear evidence of an increase in the number of deaths due to weather-related disasters (Watts et al., 2018). Whereas stable mortality rates are likely due to more effective adaptation responses in the wake of more frequent disasters, there could be tipping points where increasing population exposure occurs at a faster rate than the ability to mitigate the risk, causing the global number of deaths due to floods and storms to rise (Smith et al., 2014).

More frequent and intense rainfall is expected to affect most parts of the world, and particularly impact Asia, Africa, and Central and South America - regions that are often less equipped for preparations and responses to these events. One-inone hundred year storm-surge events are projected to impact an estimated additional 52 million people in 84 developing countries by 2100 (Smith et al., 2014).

Indirect Impacts Mediated by Natural Systems Air pollution

Air pollution is estimated to cause seven million premature deaths per year globally (Landrigan et al., 2017). The majority of air pollution produced by human activity is due to the combustion of fuels for

Box 1: Vulnerable populations

There are several populations that are expwected to be disproportionately affected by the health effects of climate change (Smith et al., 2014; Watts et al., 2015). Factors affecting climate change vulnerability include:

• **Geography:** Inhabitants of low-lying coastal settlements, socially and economically disadvantaged rural populations reliant on subsistence farming and with poorer access to services, and outdoor workers in countries with hot climates are more likely to experience health effects. Regions of Asia and Africa are projected to experience 85 to 95% of the global exposure to multi-sector risks (including risks to water, energy and land sectors, such as drought intensity and water stress, cooling demand change and heatwave exposure, habitat degradation, and crop yields) (Hasegawa and Slade, 2018).

• Indigenous Identity: Climate change poses greater risks of health effects to Indigenous peoples who depend heavily on local resources and live in parts of the world where the climate is changing quickly such as Inuit populations in the Canadian Arctic.

• **Current Health Status:** Populations with a high prevalence of conditions such as diabetes, ischaemic heart disease, and human immunodeficiency virus (HIV) will be at more sensitive to health effects. Populations exposed to baseline levels of pathogens and parasites such as dengue virus (dengue fever) and plasmodium (malaria) will be at greater risk of outbreaks following flooding events.

• **Age:** Children are physiologically more susceptible to undernutrition, diarrhea, malaria, and dengue fever. Households with children are likelier to have a lower than average income, rendering children more susceptible to food insecurity. Older people are often less physiologically able to respond to stressors like heat and air pollution, and tend to experience greater risks during extreme events, due to their poorer mobility and limited ability to extricate themselves from hazardous situations.

• **Gender:** Women and girls can be at greater risk for the health effects of climate change due to lower socioeconomic status and limitations imposed by gender roles. In many countries, women and girls have lower baselines of nutrition, and experience greater risk of poor nutrition during periods of food scarcity. In developed countries, males are at greater risk of fatality due to flooding. However, females face a greater risk in developing countries, where the overall risk of flooding fatality is higher. During heatwaves, working age men experience high risk of health effects due to higher numbers in manual work, although women of all ages maybe at greater risk during heatwaves overall.

• **Socioeconomic Status:** The poorest countries and regions within them are most susceptible to the health effects of climate change; the socioeconomically poorest individuals living in a population experience the greatest risks during heat waves, flooding, and tropical cyclones.

• Access to Health Care and Services: Populations with poorer access to health care and services have generally poorer climate resilience. Reduced health care and services capacity in the wake of natural hazard events can enable the resurgence of climate-sensitive infectious diseases.

Unfortunately, research has shown that populations are becoming more vulnerable to the health effects of climate change over time. For example, the authors of the 2018 Report of the Lancet Countdown on Health and Climate Change found that the proportion of people over the age of 65 with underlying health conditions, such as cardiovascular disease, is increasing, which means that there is an increase in the those who are becoming more vulnerable to heat exposure (Watts et al., 2018). electricity, cooking, heating, transportation, industrial and agricultural processes (Blanco et al., 2014). Since these activities additionally produce greenhouse gases (GHG) emissions, climate change and air pollution are inextricably linked.

Climate change affects the level of air pollution as higher temperatures increase the number of reactions giving rise to ground-level ozone in the atmosphere (Jacob and Winner, 2009). Ozone-related mortality is projected to be higher with 2°C of global warming compared to 1.5°C of global warming (Hasegawa and Slade, 2018).

Warmer conditions can increase the production and release of airborne allergens (such as fungal spores and plant pollen) and higher carbon dioxide (CO_2) levels can stimulate growth of these plants. Increases in airborne allergens could



Air pollution in Jodhpur India. Photo by PauFranch.

trigger asthma and other allergic respiratory diseases. (Smith et al., 2014).

Increasing temperatures, humidity, and air stagnation can increase the concentration of fine particulate matter (PM2.5) in the air, while increasing levels of precipitation can decrease PM2.5 concentrations (He et al., 2017). Fine particulate matter increases the risk of ischaemic heart disease (IHD), ischaemic stroke, chronic obstructive pulmonary disease (COPD) and lung cancer in adults and acute lower respiratory infections in children under five years of age (Forouzanfar et al., 2016; WHO, 2016). There is also emerging evidence of the association between PM2.5 and obesity, diabetes, attention deficit hyperactivity disorder, autism, neurodegenerative disease, premature birth and low birthweight (Landrigan et al., 2017)

Wildfires

Extreme wildfires are predicted to increase in many parts of the world as a result of climate change (Reid et al., 2016). Wildfires can lead to acute deaths due to burns and trauma (Cameron et al., 2009), the need for emergent evacuation of healthcare structures (Matear, 2017) and insomnia and post-traumatic-stress disorder symptoms in survivors of evacuations (Psarros et al., 2017). Smoke can produce extremely high levels of air pollution by releasing PM2.5 and other toxic substances that may affect populations for days to months, with these hazards more commonly occurring after heat waves and droughts. Estimates suggest that air pollution resulting from forest fires may lead to 339,000 premature deaths on a global basis per year (Smith et al., 2014). There is also emerging evidence of feelings of isolation, sadness, and anticipatory grief around wildfires as a sign of worsening climate change as a result of prolonged exposure to wildfire smoke itself (Dodd et al., 2018).

Estimates suggest that air pollution resulting from forest fires may lead to 339,000 premature deaths on a global basis per year.

Ultraviolet Radiation

The incidence and prevalence of non-melanoma skin cancers and cataract-related eye diseases are linked to levels of ultraviolet (UV) radiation and summertime maximum temperatures. It is uncertain how the rate skin cancers will be affected by climate change in the future. Levels of UV radiation are expected to return to pre-industrial conditions by the mid-century, owing to worldwide efforts to reduce emissions of ozone-depleting chlorofluorocarbons, but warmer temperatures in cooler climates may lead to people increasing their UV exposure by spending more time outdoors (Smith et al., 2014). Additionally, malignant skin melanoma mortality is rising, particularly in Europe, the Americas, and the Western Pacific (Watts et al., 2018).

Food- and water-borne infectious diseases

Diarrheal and enteric disease transmissions are affected by changes in temperature and rainfall, with studies indicating that higher temperatures and water scarcity increase diarrheal diseases of all causes (Hales et al., 2014; Smith et al., 2014).

Climate change influence the may growth, survival, persistence, transmission, and/or virulence of certain pathogens by affecting the local ecosystem capacity to act as a reservoir for species as vectors of animal-borne diseases. Risks of infection by Vibrio species of bacteria (which include cholera) are affected by temperature, precipitation, and changes in water composition. From the 1980s to the 2010s, the suitability of environments for Vibrio infections has increased by 27% and 24% in the northeastern United States, and coastal regions of the Baltic, respectively (Watts et al., 2018).

Every degree increase in average temperature increases the risk of diarrheal disease morbidity and mortality. In the absence of climate change, however, the WHO projects that global diarrheal mortality will decline over the course of the century in all socioeconomic development scenarios, so that overall risk of climate change attributable deaths due to diarrhea will be lower in 2050 than 2030, even as temperatures continue to rise (Hales et al., 2014). Despite a declining burden, excess diarrheal disease mortality will persist among children and youth up to the age of 15 years, with an estimated 48,000 additional deaths per year by 2030 and 33,000 additional deaths per year by 2050 (Hales et al., 2014).

Vector-borne Diseases

The spread of vector-borne diseases (including malaria, dengue fever, West Nile virus, and Lyme disease) is influenced by temperature, rainfall, flooding, economic development, and public health programs. For example, economic development and public health programs can decrease the risk of malaria and dengue fever, however, in most cases, climate change will increase the risk. Factoring in various developmental and climate scenarios makes quantifying future impacts for vector-borne diseases a challenging proposition.

Malaria

Even accounting for improvements in malaria control, the WHO projects that climate change will result in an estimated 60,000 additional deaths due to malaria by 2030 and 200 million more people are expected to be at risk of malaria by 2050 (Hales et al., 2014). Highland areas of Africa have increased in suitability for malaria infections by 20.9% from the 1950s to the 2010s, but similar trends Even accounting for improvements in malaria control, the WHO projects that climate change will result in an estimated 60,000 additional deaths due to malaria by 2030 and 200 million more people are expected to be at risk of malaria by 2050.

have not been observed in other malaria-endemic regions (Watts et al., 2018).

Later this century, climate change is projected to extend the geographic range of malaria, lengthen its seasonal period of infection, and place more people at risk, with worsening effects associated with 2°C of warming compared to 1.5°C of warming (Hasegawa and Slade, 2018). Higher temperatures and shifts in rainfall pattern associated with climate change are further expected to hamper malarial disease control efforts, placing an additional 200 million people at risk by 2050 (Smith et al., 2014).

Dengue Fever, Chikunguyna, Yellow Fever & Zika

Dengue fever is caused by a flavivirus and transmitted by the Aedes aegypti and Aedes albopictus species of mosquito. These mosquitoes are further responsible for the transmission of other viruses including chikungunya, yellow fever, and Zika. Warmer temperatures increase the capacity for these mosquitoes to act as a vector by affecting their rate of survival, frequency of biting, extrinsic incubation period to become infectious, and probability of transmission from vector to human and human to vector per bite (Hales et al., 2014; Watts et al., 2018). In 2016, global vectorial capacity for the transmission of dengue virus was the highest on record, rising 9.1% above the 1950s baseline for Aedes aegypti and 11.1% above the baseline for Aedes albopictus (Watts et al., 2018).

The geographic distribution of Aedes mosquitoes is projected to increase over a greater extent at 2°C versus 1.5°C of global warming by 2100, potentially affecting rates of transmission for both the dengue and chikungunya viruses (Hasegawa and Slade, 2018). Holding socio-economic development constant, an estimated 520 million additional people will be put at risk of dengue fever around



Mosquito. Photo by Tskstock.

the world by 2050; however, this number decreases if socioeconomic development improves (Hales et al., 2014).

Tick-Borne Diseases

Other vector-borne diseases are considered to be climate sensitive, although their global impact is anticipated to be less than is expected of malaria and dengue fever. In Europe since the 1970s, tick-borne encephalitis cases have risen, but climate change is just one of many factors driving this increase (Smith et al., 2014). West Nile virus, Lyme disease, and other tick-borne diseases will expand geographically with increasing suitability of the climate in North America, and European regions will see greater risk of Leishmaniosis and Chagas disease in endemic areas (Hasegawa and Slade, 2018).

Indirect Impacts Mediated by Human Systems Livelihoods and Poverty

As mentioned in the earlier section on heat exposure, heat can have large effects on labour capacity, particularly in agriculture. Other risks to occupational health associated with climate change include increased risk of malaria and dengue fever in field workers, and injuries and mortality risks from extreme weather events and flooding (Smith et al., 2014). Three to 16 million people could be forced into extreme poverty as the result of climate change. Climate change has the potential to reduce average global incomes and widen global income inequality, with more severe impacts projected in urban areas and some rural regions of sub-Saharan Africa and Southeast Asia (Hasegawa and Slade, 2018).

The authors of the 2018 Report of the Lancet Countdown tallied economic losses from all climate change-related events, including storms, floods, mudslides, heatwaves, droughts, and wildfires. In 2017, there were a total of 712 events, resulting in overall economic losses of US \$326 billion; 99% of these losses occurred in low-income countries,



Dead Cow. Photo by 1a_photography.

and were uninsured (Watts et al., 2018).

Migration and displacement

The social, economic, and environmental factors underlying migration decisions are complex and varied, making it difficult to observe or estimate the magnitude of climate change effects. Nevertheless, the authors of the 2017 Lancet Countdown Report found that climate change was the sole contributing factor for at least 4,400 people forced to migrate on account of sea level rise, changing ice conditions, coastal erosion, or damage to infrastructure (Watts et al., 2017).

In 2017, there were a total of 712 climate change-related events, resulting in overall economic losses of US \$326 billion; 99% of those losses occurred in low-income countries and were uninsured.

Populations living in the arctic, tropical regions, and on small-island developing states face the greatest threat of displacement. In the 2°C of global warming scenario, these populations may be required to move distances greater than 1000 km with evacuation from these areas to tropical margins and the subtropics increasing population density in these destinations by 300% (Hasegawa and Slade, 2018). According to the OECD International Migration Database, a 1oC increase in global warming was associated

Box 2: Climate Change and Mental Health

The impacts of climate change on mental health are difficult to track, owing to both a diverse range of mental health outcomes, and long and complex etiological pathways, which can include distal root causes such as famine, war, and poverty (Watts et al., 2017). A number of different climate-related risks can impact mental health, by placing increased stress on those with existing mental illnesses and triggering new onsets.

Both high temperatures and heatwaves are associated with more hospital admissions for mental illness, and increased risk of suicide. Flood, storm, and other natural hazard exposures increase the risk of psychological distress, including post-traumatic stress, anxiety, and depression and these mental impacts can remain for years after the event. Slow-developing events such as prolonged drought periods can result in chronic psychological distress, and increased risk of suicide. The consequences of extreme weather conditions in terms of productivity across agricultural, fishing, forestry and other economic sectors may affect personal livelihoods, placing added stress on individuals and communities.

The Medical Journal of Australia and The Lancet medical journal MJA-Lancet Countdown on Health and Climate Change examined the association between mean annual maximum temperatures and suicide rates for Australia. The authors found that higher temperatures predicted an elevated suicide rate in warmer states and territories; however, in cooler states elevated suicide rates were predicted by cooler maximum temperatures (Zhang et al., 2018).

In recent years, the term eco-anxiety has been used to describe people's experiences when faced with the ecological and existential threats posed by climate change, and other environmental issues (Castelloe, 2018). Solastalgia is another term that has been coined to describe the sense of loss people suffer when their natural environment has been destroyed; it conveys the feeling of being homesick while at home and experiencing the loss of land, amenities, and opportunity (Smith et al., 2014). with a 1.9% increase in migration from one country to another, and each additional millimetre of average annual precipitation is associated with an increase in this same kind of bilateral migration by 0.5% (Hasegawa and Slade, 2018).

Currently, millions of people are on the move worldwide, many for multi-factorial reasons, including climate change (Medecins Sans Frontieres, 2018). Mobility is known to take place on a spectrum from forced displacement to voluntary migration, with the majority of climate-related migration likely to be in-country and towards urban areas. Final numbers will depend on an interplay between climate impacts, vulnerability, and resilience (Medecins Sans Frontieres, 2018).

Conflict

Climate change could be one of the many drivers of conflict in various regions. For example, drought has been shown to significantly increase the likelihood of sustained conflict for nations or groups dependent on agricultural livelihoods (Hasegawa and Slade, 2018). The International Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C found that a number of studies link climate change and human conflicts across all major regions of the world. A 1°C increase in global warming, or more extreme rainfall, has been found to increase the frequency of conflict by 14%. If the world warms by 2°C
Box 3: Regional impacts

Regions in Asia and Africa are projected to experience the greatest risk of climate change impacts to multiple sectors (as described in Box 1). However, all regions of the world are facing numerous threats. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) outlined the most pressing current and future risks for each region (IPCC, 2014):

• Africa

o Compounded stress on water resources.

o Reduced crop productivity adversely affecting national, regional, and household livelihoods and food security.

o Changes in the geographic range and incidence of vector- and water-borne diseases.

• Asia

o Increased riverine, coastal, and urban flooding.

o Increased heat-related mortality risk.

o Increased risk of drought-related water and food shortages.

• Europe

o Flooding in river basins and along coasts driven by increased urbanisation, rising sea levels, coastal erosion, and peak river discharges.

o Increased water restrictions.

o Higher frequency of extreme heat events and associated risk of wildfires in Europe and the Russian boreal region.

• Australasia

o Degradation of coral reef systems in Australia.

o Increased frequency and intensity of flood damage to infrastructure and settlements.

o Increased risks to coastal infrastructure and low-lying ecosystems.

• Central and South America

o Decreased water availability in semi-arid and glacier-melt dependent regions.

o Decreased food production and food quality.

o Spread of vector-borne diseases in higher altitudes and latitudes spreading further from the equator.

• North America

o Wildfire-induced loss of property and ecosystem integrity, human morbidity and mortality.

o Increased heat-related mortality risk.

o Urban floods in riverine and coastal areas.

• Polar Regions

o Risks to freshwater, terrestrial, and marine ecosystems with changes in ice, snow cover, permafrost, freshwater, and ocean conditions.

o Increased food and water insecurity and damage to infrastructure.

o Unprecedented challenges for northern communities due to complex inter-linkages between climate-related hazards and subsistence land use if rates of change exceed societal adaptation.

• Small Islands

o Loss of livelihoods, coastal settlements, infrastructure, ecosystem services, and economic stability due to rising global mean sea level and high-water-level events.

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Box 4: The Lancet Countdown: Tracking Progress on Health and Climate Change

The Lancet Countdown: Tracking

Progress on Health and Climate Change is an international research collaboration building on the work of the 2015 Lancet Commission on Health and Climate Change. It was formed to provide a global overview of public health responses to climate change across national contexts. Aiming to help inform an accelerated response to climate change, this initiative tracks the levels of progress achieved on over 40 indicators across five key thematic areas:

- Climate Change Impacts, Exposures and Vulnerability;
- Adaptation, Planning, and Resilience for Health;
- Mitigation Actions and Health Co-benefits;
- Finance and Economics; and
- Public and Political Engagement.

The Lancet Countdown published its findings in The Lancet medical journal each year, immediately prior to the annual United Nation's Climate Change Conferences. As such, Lancet Countdown data provides a tool to drive national-level policy recommendations, furnishing information for tailored advocacy like the Lancet Countdown 2018 Report - Briefing for Canadian Policymakers (Howard, Rose and Rivers, 2018). The Lancet Countdown comes at a crucial time for international cooperation and national action on climate change, by helping to highlight and track the implementation of the Paris Agreement, and its resulting health benefits.

to 4°C by 2050, rates of human conflict would be expected to increase accordingly (Hasegawa and Slade, 2018).

As a result of concerns around undernutrition, vector-borne disease, migration, severe weather and conflict, humanitarian organizations are becoming increasingly concerned with climate change. In a recent policy brief produced as part of the Lancet Countdown project, Medecins Sans Frontieres/Doctors Without Borders emphasized that anticipated needs in an unmitigated scenario will far exceed the response capabilities of relief actors, and that medical mobilization must therefore address the systemic causes of climate change and emphasize the duty to accelerate mitigation (Medecins Sans Frontieres, 2018).

Conclusion

Climate change has been described as the biggest global health threat of the 21st century. These risks to health include changing exposures to heat, floods and storms, UV radiation, vector-borne diseases, diarrheal and enteric diseases, undernutrition, loss of livelihoods and poverty, migration and displacement, and conflict. Populations most vulnerable to the health impacts of climate change include those living in areas of most geographical risk, Indigenous populations, women, children, and the elderly, and people living in poverty, with pre-existing medical conditions, or with poorer access to health services. Climate change health effects will be felt in every region of the world; however, parts of Asia and Africa, small islands, and polar regions will face the greatest disparities. Unmitigated climate change will exceed the capabilities of medical humanitarian relief actors and put not only health, but global security and the continued functioning of health systems at risk.

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Module 2



Climate Change Toolkit for Health Professionals Factsheet: Global Health Impacts of Climate Change

Direct Health Impacts

Climate change can impact health directly or indirectly. Direct impacts can occur from trauma, displacement and deaths associated with floods, storms, and wildfires, and via heat-related illness.

Heat

The health impacts of heat will increase substantially with 1.5°C of global warming, but will be much greater with 2°C or 3°C of warming. Heat exposure can produce heat stress and heat stroke and aggravate adverse heart, lung and kidney conditions. In fact, 157 million more people were exposed to heat waves in 2017 than the average number between 1986 and 2005. The World Health Organization (WHO) estimates that, with no adaptation, climate change will produce over 92,000 additional deaths among people over 65 in 2030, and over 255,000 deaths in 2050.

Wildfires

Extreme wildfires are increasing and are associated with burns, trauma, deaths, emergent evacuation of healthcare structures, subsequent post-traumatic stress disorder, and cardiorespiratory and wellness impacts from smoke exposure.

Floods and storms

Floods and storms can result in both, direct health impacts such as drownings, injuries, hypothermia, and adverse mental health impacts, indirect health impact such as the spread of infectious diseases, and those resulting from damage to health services and other infrastructure.



House destroyed by a Superstorm. Photo by Acrylik.

Indirect Health Impacts

The indirect health impacts of climate change mediated through natural systems include insect-borne diseases such as malaria and air pollution resulting from the increased production of pollen or smoke from wildfires. Health impacts mediated heavily through human systems include food insecurity, migration, displacement, and conflict.

Infectious diseases

Climate change will affect the risk of vector-borne diseases, including malaria, dengue fever, tick-borne encephalitis, West Nile virus, Lyme disease, Leishmaniosis and Chagas disease. Temperature, rainfall and humidity affect the range and risk of malaria. The WHO estimates that climate change will result in an additional 60,000 deaths from malaria in 2030, and put more that 200 million more people at risk from malaria by 2050 despite malaria control efforts.

In 2017, there were a total of 712 climate change-related events, resulting in overall economic losses of US \$326 billion; 99% of those losses occurred in low-income countries and were uninsured. It is estimated that an additional 52 million people in 84 developing countries will be affected by a 1-in-100 year storm-surge by 2100.

Warmer temperatures increase the ability of dengue fever to be transmitted and the geographic distribution of the mosquito that carries the dengue virus. The same mosquito carries the viruses that cause chikungunya, yellow fever and Zika. It is estimated that an additional 520 million people around the world will at risk from dengue fever in 2050.

Diarrhoeal disease transmission is affected by changes in temperature and rainfall. The WHO estimates that rising temperatures due to climate change will cause an additional 48,000 deaths per year due to diarrhoeal diseases in children aged 0-15 years in 2030 and an additional 33,000 deaths per year in 2050.

Air pollution

Climate change can affect air quality by increasing concentrations of ground-level ozone, increasing air pollution from wildfires, and increasing the concentration of allergens such as fungal spores and pollens that are in the air. Many of the solutions to climate change can create significant health co-benefits by simultaneously reducing levels of air pollution and emissions of GHGs.



Air pollution in Jodhpur India. Photo by PauFranch.

Food Production, Food Security and Undernutrition

Undernutrition is currently the cause of almost half of the deaths of children worldwide. An increase in undernutrition is expected to be the most severe global health impact of climate change in the 21st century. Climate change affects the yields of many major food crops, with countries already seeing reduced yields of wheat, rice, maize, and soybean. As global warming increases, global production of wheat, rice, maize, and soybean will decrease. Additionally, increasing levels of carbon dioxide (CO_2) will decrease levels of zinc and iron in staple crops, exacerbating harmful nutrient deficiencies.

Climate change also poses many threats to fisheries and aquaculture through rising temperatures, ocean acidification, introduced species, disease, rising sea levels,



Undernutrition. Photo by Parijatha Budidhi.

storm intensification and ongoing rapid degradation of key ecosystems, even with smaller increases in global warming.

Poverty

Three to 16 million people could be forced into extreme poverty due to climate change. Unmitigated climate change could reduce global average incomes and widen global income inequality, with the most severe impacts projected for urban areas and some rural regions in sub-Saharan Africa and Southeast Asia.

Mental Health

Climate change impacts are expected to increase: mental health hospital admissions during heatwaves; post-traumatic stress, anxiety and depression following extreme weather events; and chronic psychological distress; and the risk of suicide due to slow-developing events such as droughts.

Migration and Displacement

Climate change has been the sole reason for forced migration for at least 4,400 people due to rising sea levels, changing ice conditions, coastal erosion and damage to infrastructure. Millions of people are currently on the move worldwide, with varying estimates for climate-related migration. Mobility is known to take place on a spectrum from forced displacement to voluntary migration, with the majority of climate-related migration likely to be in-country. Tropical populations may have to move distances greater than 1000 km to escape the impacts of climate change which could increase population densities in the subtropics by up to 300% if global warming rises to 2°C above pre-industrial levels.

Conflict

A number of studies have demonstrated links between climate change and conflict in regions across the globe. A further 1°C increase in global warming, or more extreme rainfall, is expected to increase the frequency of conflict by 14%. Unmitigated climate change will exceed the capabilities of medical humanitarian relief actors and put not only health, but global security and the healthcare systems at risk.



Dead cow. Photo by 1a_photography.

Vulnerable populations

On a global scale, people who are more vulnerable to the health effects of climate change include:

- people living in the arctic, on islands, in coastal regions, in rural areas, and tropical regions;
- indigenous populations that rely on local resources for food;
- women, children, and the elderly who are more vulnerable to undernutrition and extreme heat;
- developing countries that are already struggling to feed their people;
- low income populations in all societies; and
- people with existing medical conditions who are more sensitive to environmental stressors such as heat and air pollution.

Note: References for this factsheet can be found in Module 2 of <u>CAPE's</u> <u>Climate Change Toolkit for Health</u> <u>Professionals.</u>

Model

Climate Change Toolkit for Health Professionals Climate Change Health Impacts Across Canada

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ACME Association Canadienne des Médecins pour l'Environnement for the Environment

Module 3 – Climate Change Health Impacts across Canada

Introduction

Climate variability and change is already impacting the health of Canadians across the country. Cardiovascular and respiratory diseases, cancer, infectious diseases, mental health, injuries and deaths can all be linked to our changing climate. While the burden of disease remains uncertain, there is strong evidence that the climatic conditions that contribute to these health outcomes are very likely to occur across Canada and are already occurring in many communities (Berry et al., 2014).

Overview of Health Impacts

Extreme heat contributes to heat-related illnesses and deaths. Air pollution, which has been attributed to approximately 14,400 annual deaths in Canada, is likely to increase with climate change (Health Canada, 2017). Forest fire smoke, smog, dust from droughts, and pollen, contributes to respiratory ailments and cardiovascular incidents. Damaging sunburns and skin cancer are on the rise. The incidence of vector-borne diseases is increasing. (PHAC 2018a). Food and water-borne illnesses have been linked to both extreme precipitation and droughts. Extreme weather events such as heavy rainfall, tornadoes, and ice storms put Canadians at risk from illness, injury, death and poor mental health as communities try to cope with power outages, food and water quality concerns, environmental exposures, evacuations and financial hardship in the aftermath of the event (Berry et al., 2014).

Flooded homes and buildings that are not properly remediated can lead to mould growth, aggravating allergy and asthma symptoms. Stress and mental health impacts are increased following extreme weather events that often leave people displaced for extended periods (Hayes et al, 2018). Disaster recovery costs may be unmanageable for some, increasing financial insecurity. Many of



Flooding. Photo by Chris Gallagher on Unsplash.

Table 1: Examples of climate-related health impacts and causal pathways of relevance in Canada.

HEALTH OUTCOME	HAZARD/ EXPOSURE	ENVIRONMENTAL EFFECT	CLIMATE CHANGE DRIVER
Cardiovascular	Air pollutants	↑ formation of air pollutants	Rising temperatures
Disease		↑ forest fires	Extreme weather events
		↑ droughts and dust storms	Changes in precipitation
	Extreme heat	↑ frequency and duration of heat	Rising temperatures
		waves	Extreme weather events
Respiratory Conditions	Air pollutants	↑ formation of air pollutants	Rising temperatures
	-	↑ forest fires	Extreme weather events
		↑ droughts and dust storms	Changes in precipitation
	Extreme heat	Heat waves – hot days & warm	Rising temperatures
		nights	Extreme weather events
Allergic Reactions	Pollen & spores	Longer growing season	Rising temperatures
	Mould	Heavy rainfall & flooding	Extreme weather events
Heat stroke/ exhaustion	Extreme heat	\uparrow frequency and duration of heat	Rising temperatures
		waves	Extreme weather events
Cancer	Air pollutants	\uparrow formation of air pollutants	Rising temperatures
	UV radiation	Ozone layer depletion	Temprelated changes
		Longer summer season	Rising temperatures
Traumatic	Physical trauma,	Floods, forest fires, tornadoes,	Extreme weather events
Injuries	dangerous travel,	hurricanes, storm surges, winter	Rising temperatures
	drowning, violence	storms, melting permafrost	Sea level rise
Vector-borne	Infected	Expanding habitat conducive to	Rising temperatures
Diseases	mosquitoes, ticks	disease vectors	Extreme weather events
	and rodents	T conditions for vector propagation	Changes in precipitation
Food-borne	Food-borne	Contaminated food/flood waters	Extreme weather events
Illness	pathogens/toxins	T conditions for bacterial growth	Rising temperatures
Water-borne	Water-borne	Contaminated water sources	Extreme weather events
Illness	pathogens/toxins	↑ conditions for bacterial growth	Changes in precipitation
Malnutrition	Food insecurity	Drought, crop loss, biodiversity loss	Rising temperatures
	Water shortages	Floods	Extreme weather events
Mental Health	Population	Floods, forest fires, tornadoes,	Rising temperatures
Stress &	displacement	droughts, heat waves	Extreme weather events
Anxiety	Multiple stressors	Prolonged and repeated climate-	Sea level rise
	Climate-induced	related events	Changes in precipitation
	stress	Latastrophic events	
Socio-	Social disruptions	Floods, forest fires, tornadoes,	Rising temperatures
economic	Loss of incomes	droughts, heat waves	Extreme weather events
impacts	and culture	Prolonged climate-related events	
	↓ quality of life	Catastrophic events	

these health impacts and health inequities are predicted to increase with climate change (Rudolph et al., 2018).

Climate Adaptation

Adaptation by health authorities, communities and individual Canadians can be effective in reducing climate change risks to health (Martinez and Berry, 2018). Thus, the degree to which climate change contributes to adverse health outcomes in Canada is also highly dependent and reliant upon the public health interventions that are put in place, and the supporting adaptation efforts in other sectors. This will be discussed in more detail in Modules 6 and 7.

Health impacts may be partially offset by the benefits of a warming climate such as a longer growing season or fewer injuries and death associated with cold weather (Canada, 2018a; NRCan, 2017a). However, as the climate continues to warm, the threat of more severe and even catastrophic impacts on health to Canadians increases through cascading events and other climate surprises that may occur (Campbell et al., 2014).

Table 1 summarizes the adverse health outcomes that are associated with climate change and provides examples of the causal pathways from climate change driver to environmental effect to exposure to adverse health outcome. A heat wave in Quebec in July 2018 resulted 93 heat-related deaths (ECCC, 2018b), while a 2010 heat wave in the same province saw a 33% increase in deaths (~ 280 deaths) and a 4% increase in hospital admissions (~ 3400 admissions) (Bustinza et al. 2013).

A 2009 heat wave in British Columbia saw a 40% increase in mortality within days of onset of the event and was associated with an increase in all-cause mortality compared to the previous 5-year average (Kostatsky et al., 2012; Kostatsky, 2010).

Extreme Heat

It is not just annual average temperature increases (general warming) that are of concern with a changing climate. Temperature extremes are of great concern for human health. Environment & Climate Change Canada (ECCC)'s climate scenarios indicate that the rate of warming in Canada has been more than double the global mean, with warming in the northern part of Canada approximately three times the global mean (ECCC, 2018a). While increasing average temperatures have multiple implications for human health, including drought, loss of biodiversity, food insecurity and changing habitat for vector-borne diseases, extremes of temperature have serious direct health consequences (Berry et al., 2014).

Canadians across the country are already experiencing heat-related health impacts and can expect to see more frequent, intense and prolonged heat waves because of climate change. The number of extremely hot days is expected to double or triple in some parts of Canada in the next 30 years. While all provinces and territories will see a significant increase the most populated urban centres in Saskatchewan, Manitoba, Ontario and Quebec are predicted to experience approximately 50 extremely hot days and over 30 warm nights (Climate Atlas, 2018). This has severe consequences for heat-related illness when people don't have the opportunity to cool down over extended periods of time.

Health Impacts

Prolonged, extreme heat events are associated with increased mortality, especially among older adults, persons with chronic illness, or people on certain medications, and those that are socially isolated. (Berry et al., 2014). Exposure to extreme heat can cause heat stroke, dehydration, cramps, skin rash and heat exhaustion. It can also exacerbate pre-existing conditions such as cardiovascular and respiratory diseases and neurological disorders. Extreme heat is also dangerous for young children and infants, outdoor workers, people who are active outdoors, and those who may not have the financial or social supports to protect themselves and their families from the heat (Health Canada, 2012).

While heat waves extending over multiple days highlight the most visible signs of health impacts, as seen in spikes in mortality, seasonal heat is also a risk. Canadian research has shown mortality rates increasing after daily average temperatures as low as 20°C (Doyon et al., 2008). In temperate climates like Canada, heat-related health impacts may occur earlier in the season,



Figure 1: Historical and projected annual mean number of hot days (>=30C) in Canadian cities under high greenhouse gas (GHG) scenarios. Datasource: Climateatlas.ca (accessed March 6, 2019) at less extreme temperatures, when the population is not yet acclimatized to the warmer weather (Ontario, 2016a).

Ultra-Violet Radiation Health Impacts

Non-melanoma skin cancer is caused by ultra-violet (UV)-B radiation and scientists suspect that melanoma is also caused by exposure to UV light (Canada 2013a). The incidence of non-melanoma basal cell and squamous cell skin cancer is directly related to the amount of UV radiation exposure (Portier et al., 2010). Climate change is related to harmful UV radiation through two mechanisms. The first has to do with the depletion of the ozone layer or stratospheric ozone. While ground-level ozone is harmful to human health, stratospheric ozone provides protection from UV radiation that can cause skin cancer, sunburns, cataracts and eye damage. Some of the same greenhouse gases (GHG) that contribute to climate change e.g. chlorofluorocarbons (CFCs) are also responsible for depletion of the ozone layer. As stratospheric ozone levels decrease, UV radiation increases. While scientists are beginning to observe some stratospheric ozone layer recovery, there remains uncertainty which limits the ability to predict future changes (WMO 2018; Ball et. al., 2018).

The second way that climate change is related to UV radiation relates to the gen-

erally warmer climate that Canadians will experience. Warmer temperatures may lead to behaviour changes with people spending more time outdoors with greater exposure to UV radiation (Berry et. al., 2014). One study demonstrated this compounding impact by correlating non-melanoma skin cancer with both UV dose and average daily maximum summer temperature (van der Leun et al., 2008).

While the incidence of skin cancer associated with ozone layer depletion is expected to continue to rise over the coming decades, current observed reductions of ozone-depleting substances in the atmosphere and efforts to restrict their use could see significant improvement to the ozone layer by mid-century (WMO 2018; WHO, 2019a). At that point,



Smoke in a forest. Photo by Joanne Francis on Unsplash.

exposure to UV radiation and incidence of skin cancer may be more a consequence of behaviour change as a result of warmer weather (Bharath et al., 2009).

Air Pollution **Health Impacts**

Air pollution is one of the most important risk factors for premature mortality in Canada and around the world. Climate change may increase this risk. Health Canada has estimated that 14,400 premature deaths annually in Canada result from air pollution emitted from human activities. This number represents air pollution deaths from all causes including heart disease, stroke, lung cancer and chronic obstructive pulmonary disease, from both chronic and acute exposure to three pollutants – fine particulate matter (PM2.5), nitrogen dioxide and ground-lev-(Health Canada, el ozone 2017).

During the British Columbia forest fires in 2018, millions of people in Vancouver, Calgary and Edmonton were exposed to very poor air quality for days or weeks at a time because of smoke from regional wildfires.

In the month of August 2018 alone, the Air Quality Health Index (AQHI) was recorded as "high risk to health" (AQHI reading of 7-10) or "very high risk to health" (AQHI reading of 10+) for 128 hours in Vancouver, 138 hours in Edmonton, 92 hours in Calgary and 42 hours in Saskatoon (ECCC, 2019; Canada 2017a). Air pollution also increases the risk of cardiovascular disease and exacerbates respiratory conditions, asthma and allergies (Berry et. al., 2014). Populations most vulnerable to the impacts of air pollution include: seniors, young children, people with pre-existing respiratory and cardiac conditions, people with diabetes, people who are on certain medications, people on low incomes, people living in close proximity to high volume traffic corridors, and people who are active outdoors (Canada, 2019a).

Climate Impacts on Air Quality

Climate change is expected to increase the weather conditions that can increase air pollution. Poor air quality is a factor of both emissions and weather conditions (Pfister et al., 2014). Warmer temperatures increase the formation of ground-level ozone which is linked to premature mortality, decreased lung function, shortness of breath, chest discomfort, and eye, nose and throat irritation (Canada, 2015a). Even healthy individuals can experience respiratory impairments when exposed to low levels of ozone (Canada, 2019a).

Warming weather and milder winters are already resulting in an increase in pollen and spore production in plants, causing health concerns for people with allergies and asthma. Climate change may also increase the allergenicity of pollen (Sierra-Heredia et. al., 2018). Ragweed is highly allergenic and the leading cause of seasonal allergic rhinitis in north-eastern North America (Sierra-Heredia et. al., 2018; Berry et. al., 2014). The plant is highly prevalent in parts of Canada with the ragweed season having lengthened considerably in parts of the country (Sierra-Heredia et al., 2018; Ziska et al., 2011; Berry et.al., 2014). Climate change is expected to continue extending the allergy season in Canada as the growing season extends and frost-free days increase (Climate Atlas, 2018).

The combination of higher temperatures, droughts, wind and dust storms will increase exposure to PM2.5 and other air pollutants as will forest fire smoke. The small size of these particles poses serious health problems because they can get deep into the lungs, contributing to heart and lung conditions (PHAC, 2018a; INSPQ, 2014).

Vector-borne and Zoonotic Diseases

Climate change will alter conditions in the environment that may be more conducive to the emergence and spread of zoonotic and vector-borne diseases. Of particular concern in Canada is the spread of the Lyme disease tick vector, conditions that may increase exposure to the mosquito vectors of West Nile virus and other diseases, and zoonotic diseases such as hantavirus (Health Canada 2008). While



Mosquito. Photo by Егор Камелев on Unsplash.

research suggests that Canada's current climate does not support local mosquito transmission of more tropical diseases such as malaria, Zika, chikungunya or dengue, some studies suggest that climate change may increase conditions conducive to the emergence and transmission of these diseases in parts of Canada (Ogden, 2016; Lindsay, 2016; Kulkarni et al., 2015; Berrang-Ford et al., 2009).

Lyme Disease

Human cases of Lyme disease have increased significantly in Canada over the last decade, with the number of reported cases going from 144 in 2009 to 2025 in 2017. The total number of cases reported in this time period was 6029 (Canada, 2018b). Lyme disease can be very serious if left untreated, including symptoms such as severe headaches, facial paralysis, arthritis, heart disorders and neurological disorders. In rare cases, Lyme disease can lead to death (Canada, 2017b). Evidence indicates that the spread into eastern and central Canada of the blacklegged tick (Lyme disease vector) is likely associated with climate change and the rapidly expanding geographical range of this tick (Gasmi, et al., 2017; Leighton et al, 2012). Lyme disease-endemic areas in Canada include southern Manitoba, southern and eastern Ontario, southern Quebec, southern New Brunswick and Nova Scotia (Ogden et al., 2014).

West Nile Virus

The number of human cases of West Nile virus (WNv) has peaked and waned over the last several years, but the disease remains a concern for Canadians. The first human case in Canada was reported in 2002. Since that time, over 6000 human cases of WNv have been reported in Canada (Canada, 2018c). Symptoms can range from mild to severe (Canada, 2015b). Older adults and persons with underlying chronic conditions are more at risk of severe symptoms which may include infections of the central nervous system, muscle weakness, paralysis, and loss of consciousness. Some severe cases of WNv can be fatal (Canada, 2015). The geographical range for WNv is predicted to expand in some regions of Canada such as the Prairie provinces (Zheng et al. 2014). In 2017, 193 human cases of WNv, including 8 deaths were reported to the Public Health Agency of Canada (PHAC), from the provinces of Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia; while in 2018 (up to Dec 15th), a total of 367 cases were reported from the provinces of Ontario, Quebec, Manitoba and Alberta (Canada, 2018c).

Rodent-borne Diseases

With climate change, there is also the potential for increases in rodent-borne diseases such as hantavirus, as warmer winters improve conditions for rodent survival, and heavy rainfall and flooding translate into higher likelihood of human contact with infected rodent urine or faeces (Health Canada, 2008). Hantavirus pulmonary syndrome is a severe respiratory infection spread through the inhalation of excreta of deer mice that have been infected with the hantavirus. Between 2000 and 2016 there were a total of 88 reported cases of hantavirus in Canada (PHAC, 2018b). The majority of cases were reported from the western provinces - British Columbia, Alberta, Saskatchewan and Manitoba. While cases of hantavirus are rare in Canada, they can cause serious health impacts. Hantavirus pulmonary syndrome has a 30% fatality rate in Canada (Drebot, et.al., 2015).



A field of lettuce. Photo provided by Pexels.

Food Safety Health Impacts

Every year, approximately 4 million Canadians are affected by food-borne illness resulting in approximately 238 deaths and over 11,000 hospitalizations (PHAC, 2016). A warming climate and extreme weather events may increase food-borne illness rates in Canada. The food-borne pathogens responsible for the majority of these illnesses are norovirus, C. perfringens, Campylobacter, and Salmonella (PHAC, 2016). While anyone can contract a food-borne illness, seniors, pregnant women, and people with weakened immune systems are at greater risk of harm from them (Health Canada, 2015).

Fruits and Vegetables

The safety of food products may be compromised at any point in the food system. Climate change may create favourable conditions that support the growth and survival of foodborne diseases and create pathways that could increase the risk of contamination of food products through environmental media (i.e. contaminated flood waters inundating agricultural fields). Higher temperatures may stress livestock, increasing the likelihood of infection and the shedding of pathogenic micro-organisms in faeces (Health Canada, 2008).

Heavy rainfall events, followed by flooding, can contaminate water supplies that are used to irrigate produce. This is of particular concern for produce such as salad greens and fruit that are eaten raw. Increasing extremes of weather may result in the emergence or re-emergence of food-borne pathogens (Lake & Barker, 2018; Lake, 2017). Climate change has the potential to alter the spatial pattern and extent of food-borne pathogens allowing them to survive and thrive in geographical locations that were previously unsuitable (Short et al., 2017; Lake & Barker, 2018).

Every year, approximately 4 million Canadians are affected by food-borne illness resulting in approximately 238 deaths and over 11,000 hospitalizations.

Fish and Shellfish

Climate change may increase the severity and frequency of the occurrence of harmful algal blooms in marine waters increasing the risk of shellfish poisoning (NCCEH, 2017). In November 2018, Fisheries and Oceans Canada closed bivalve shellfish harvesting along much of the Sunshine Coast in British Columbia because of very high levels of paralytic shellfish poisoning toxin (Global News, 2018). In 2011, the first reported outbreak of shellfish poisoning in Canada was associated with consumption of cooked mussels causing 62 reported illnesses (Taylor et al., 2013). Warmer waters are conducive for growth of harmful algal blooms, thus increasing potential for shellfish poisoning to increase (Bouchouar et al., 2014)

Food Spoilage

The safety of food supplies, including traditional foods, in northern and Indigenous communities is a serious concern given the changing climate and warming temperatures already observed in some regions. Communities in northern Canada are reporting increases in food spoilage and inability to store food safety while hunting, because of warmer temperatures. This will become more difficult with climate change (Berry et al., 2014; Furgal and Sequin 2006).

Some studies have shown a higher risk of food-borne illness in warmer seasons,

For the 5 days prior to the Walkerton outbreak in 2000, the community experienced very heavy rainfall which facilitated the transport of WBD pathogens into the community water supply (O'Connor, 2002).

in part due to social behaviour and the potential for improper food handling and storage resulting in food spoilage and contamination (e.g. more BBQs, people preparing food outside). Other studies have shown a link between the occurrence of certain food-borne illness and warmer temperatures (Health Canada, 2008).

Water Quality Health Impacts

The most common water-borne disease (WBD) pathogens in Canada are Giar-Cryptosporidium, Campylobacter, dia, Shigella and verotoxigenic E. coli. These pathogens cause gastrointestinal illnesses, and some have led to chronic health conditions and death (Health Canada, 2008). While WBD outbreaks are rare in Canada, several outbreaks reveal the serious health impacts associated with these pathogens (Canada, 2013b). In 2000, contamination of the municipal drinking water supply in Walkerton, Ontario by pathogenic E. coli and Campylobacter killed seven people and was estimated to cause 2300 illnesses (O'Connor, 2002). In 2005, water supplies contaminated with E. coli caused the evacuation



Flooded Neighbourhood in Calgary. Photo provided by Thinkstock.

of residents of the Kashechewan reserve in northern Ontario (Canada, 2013b).

While there are multiple risk factors (including inadequate source-water protection and water treatment) for WBD outbreaks, several have been linked to extreme weather events, in particular intense, heavy rainfall and overland flooding (Wang et al., 2018; Auld et al., 2004; Moffat and Struck 2011). Private and small drinking water systems are more vulnerable to WBD outbreaks (Canada 2013).

Heavy Rain and Floods

With climate change, the intensity and frequency of heavy rainfall events is expected to increase across Canada. The combination of possible drought conditions, warmer temperatures, and intense heavy rainfall events can increase the risk of WBD outbreaks and illness from contaminated drinking water supplies. There is also the concern for chemical contamination of water supplies following heavy rainfall events as a result of fertilizers, pesticides, nitrates and other substances carried by run-off and floodwaters, including through large scale events like tornadoes or hurricanes that damage large industrial facilities or disturb contaminated sites (Berry et al., 2014).

Climatic conditions, warmer weather, and heavy precipitation may impact water quality at recreational beaches increasing the potential for beach postings or closures due to high bacterial counts or the presence of toxic cyanobacteria blooms. Some cyanotoxins can impact health if the water is ingested or inhaled if aerosolized. Cyanobacteria blooms have been reported across Canada (Health Canada, 2008).

Melting Permafrost

While climate change has the potential to increase the likelihood of contamination of drinking water supplies, several indigenous communities continue to experience water quality problems. As of February 4th, 2019, sixty-two (62) long-term drinking water advisories remained in place on public drinking water systems on reserves in Canada (Canada, 2019b). Drinking water quality in northern communities may also be compromised due to melting permafrost and the transport of contaminants to drinking water supplies. These communities may also be at higher risk as they are more dependent on untreated water and snow melt for their drinking water source (Auditor General of Canada, 2005).

Droughts and Rising Sea Levels

Increasing drought brought on by climate change can also impact water quality in parts of Canada. Chemicals and pathogens may be concentrated in a diminishing water source. In addition, drought conditions followed by heavy rainfall increases the potential for overland flow of rainwater, and with it, both chemical and microbiological contaminants (Yusa et al. 2015; Semenza et al. 2011). Sea level rise could impact drinking water supplies in coastal regions due to saltwater intrusion (Health Canada, 2008).

Food and Water Insecurity Food and Water Insecurity

Numerous factors come in to play when considering the impact of climate change on both food and water security. Many families and communities across Canada currently live with food insecurity. According to a 2009 - 2012 survey, 7.2% of Canadians aged 18 and over reported living in households with food insecurity (PHAC, 2018c). These percentages were much higher for people identifying as Inuit (24.8%), First Nations living off reserve



Cooking goose-Severn River Watershed. Photo by Dan Tobias.

(18.3%), and Metis (14.8%). Information on food insecurity for First Nations people living on reserve and in northern communities is collected through the First Nations Regional Health Survey. The 2008-2010 survey revealed that 38.3% of First Nations adults living on reserve and in northern communities lived in a food insecure household (PHAC, 2018c).

Climate change could affect the availability and cost of some foods, which is of particular concern for persons on low incomes or those in isolated communities (Berry et. al., 2014). Droughts and heavy rainfall may lead to crop loss or diminished crop yields which could result in disruptions to the food supply. Bacterial or chemical contamination of water supplies because of heavy rainfall, warmer weather, droughts or a combination of these factors, may render a water source no longer useable. Droughts may diminish or deplete a community's drinking water supply (Yusa et al., 2015).

Northern communities that rely on traditional food sources are more vulnerable to food insecurity as climate conditions, melting permafrost, unstable hunting and harvesting routes, and changes in the geographical distribution and diminished quality decrease availability and nutritional value of these food sources (Berry et al., 2014).

Extreme Weather Events More Frequent and Severe

Extreme weather events are increasing in frequency and severity across Canada. The Canadian Disaster Database reported over 195 disaster-level extreme weather events between 2008 and 2018. These included wildfires, floods, winter storms, droughts, extreme heat, and tornadoes. These pose serious health and safety risks to Canadians. Between 2003 and 2019, there were 203 deaths due to extreme weather recorded in Ontario (PHO, 2015). In 2016 alone, wild-

According to a report of the Canadian Forest Services between 1980 and 2017 almost half a million people across Canada were evacuated because of wild fires (NRCan, 2017b).



Toronto Ice Storm 2013 - Forest Hill Road. Photo by Andrea Williams.

fires, floods, tornadoes and severe winter storms resulted in the evacuation of approximately 94,485 residents in communities across the country (PSC, 2019a).

Climate change is expected to make weather more variable, increasing the likelihood of more intense and frequent extreme weather events and natural hazards such as heavy rainfall, flooding, winter storms, freezing rain, droughts, wildfires, extreme temperatures, sea level rise, storm surges, hurricanes, landslides and avalanches (Warren et al., 2014). Some of these events will build slowly and others will have a rapid onset, but all of them can have direct and/ or indirect impacts on human health.

Examples of direct impacts include injury or death from physical trauma suffered during severe storms, flooding, temperature extremes or wildfires. Indirect health impacts include illness or death resulting from prolonged events or the aftermath of events. These can include food-, water- or vector-borne diseases, food or water shortages, exposure to mould and other contaminants, exacerbation of cardiovascular and respiratory conditions, disruptions of health and emergency services, stress from community evacuations and population displacement, mental illness, and compounding of existing health inequities (Moudrak et al., 2018; Berry et al, 2014).

Floods

Floods are the most commonly occurring and costliest natural disaster in Canada. Floods can occur in coastal areas and along rivers and lakes. They can result from extreme rainfall events and rapid snow melt (NRCan 2018a). Flood risk is exacerbated by urbanization and development on floodplains (Peter et al., 2014). Heavy rainfall and flooding can impact health in the short term and longer term by damaging crops, increasing risk of water-borne disease outbreaks, increasing risk of respiratory ailments from mould and poor indoor air quality in flooded homes that have not been adequately remediated,

A winter storm in February 2016 resulted in over 750,000 people in Quebec being without power for an extended period (PSC, 2019). and causing anxiety and mental health issues if people have to be evacuated, lose their home and suffer financial losses (Berry et al., 2014; Hayes et al., 2018).

Droughts

Climate change projections for Canada suggest that the south and interior parts of the country will experience more drought (Yusa et al., 2015). Drought can impact health by aggravating existing respiratory conditions (e.g. inhalation of particulate matter from dust storms and smoke from wildfires), increasing risk of water-borne diseases, increasing risk of vector-borne diseases and increase stress and mental illness for people whose livelihood is tied to the agricultural sector (Yusa et al., 2015).

Droughts and heavy rainfall events can have devasting impacts on farm families and communities that rely primarily on agriculture for their economic and social sustainability. Climate models project drier summers and increased precipitation in both winter and spring, making it more difficult for farmers to plant and harvest crops (Climate Atlas, 2018). A study of heat stress on dairy cow herds during heat waves between 2010-2012 in Ontario showed an increase in animal deaths from heat stress, a loss in milk production, and a projected economic loss with the increasing number of extreme heat events expected from climate change (Bishop-William, 2015).

Case Study: Interior Health Authority, B.C.

Interior Health Authority reported that a wildfire resulted in:

• 48,000 registered wildfire evacuees;

- 15 First Nations communities under alert or order;
- 800 patients/clients evacuated;
- 700 staff displaced;
- 19 Interior Health sites/facilities closed;
- 2000+ air filters replaced every two to three weeks at Interior Health facilities due to smoky conditions.

Estimated cost to the Interior Health Authority for wildfire response was \$2.7 million (Toews, 2018).

Power Outages

Extreme weather events often disrupt power supplies which can increase various health and safety risks e.g. food or water-borne illness from spoiled food or untreated water supplies, carbon monoxide poisoning from indoor use of gas-powered generators, medical emergencies for persons needing electric-assistive devices, and exposure to extreme heat or extreme cold. While winters are expected to be warmer across Canada, extreme cold events will continue to happen, but less frequently, thus continuing to contribute to cold-related morbidity and mortality in the coming decades (Romero-Lankao et al., 2014; Martinez-Solanas et al., 2018).

Wildfires

As noted earlier, wildfires have a very significant impact on communities across Canada. A critical review of the health impacts of wildfire smoke exposure found consistent evidence for the association between wildfire smoke exposure and respiratory morbidity with growing evidence supporting an association with allcause mortality (Reid et al., 2016). With climate change expected to increase the number of warmer, drier and longer wildfire seasons, the health risks associated with exposure to wildfire smoke is likely to increase.

Impact on Healthcare Services

Extreme weather events can also disrupt health and community services, impacting the health of Canadians. Damage to critical infrastructure such as hospitals and healthcare facilities may disrupt the ability of health services to respond to the health care needs of the community, further compromising the health of disaster victims (Curtis et al., 2017; Balbus et al., 2016; HCWH, 2018). More information on how health care facilities is provided in Module 6.

Mental Health

Climate change can have both direct and indirect impacts on mental health. Extreme weather events, such as wildfires, heat waves and floods can lead to post-traumatic stress disorder (PTSD), anxiety, depression, and substance abuse.

Extreme Events

Studies out of Australia following communities directly impacted by bush fires report that a significant minority of the population reported persistent PTSD, depression and psychological distress, and that mental health consequences can persist for many years (Bryant et al., 2014). Researchers studying Fort McMurray residents six months after the fire found that certain risk factors increased the risk of anxiety symptoms, including pre-existing



A Heiltsuk girl holding one of the paddles of the "Glwa", the Heiltsuk canoe, during the official opening of the Qatuwas Festival, an international gathering of maritime indigenous nations of the Pacific Rim. 27/ Jun/1993. UN Photo/John Isaac.

anxiety disorder, witnessing homes burning, exposure to media coverage on the fire, being relocated, and perceived lack of support from family, friends and/or government agencies (Agyapong et al., 2018).

Some studies suggest that healthcare providers may be higher risk of mental health and psychosocial effects following disasters as they could be working in heightened stressful situations or high-risk conditions (e.g. physical damage to facilities), working longer shifts or experiencing personal anxiety concerning the disaster (Nukui et al., 2018; Nickell et al., 2004). Emergency responders may be at increased risk of climate-related mental health outcomes as they are often the first to be exposed to the effects of extreme weather events, affected for longer durations and dealing with personal stressors such as separation from families (Tak et al., 2007).

Changing Climate

Climate variability and incremental changes such as sea level rise, rising temperatures and drought can also lead to poor mental health outcomes including anxiety, depression and suicidal thoughts. The threat of future climate-related disasters, current climate change risks and Table 2: Examples of how climate change may amplify existing health inequities and increase cli-
mate-related health risks for vulnerable populations.

Health	Examples of Climate-Related Inequity Multipliers		
Inequity			
Income and	\uparrow risk from extreme heat, air pollution, UV exposure and extreme weather events		
social status	Limited financial resources/ability to take adequate protective action e.g. seek shade,		
	access cool spaces, afford air conditioning, make needed repairs to housing, and avoid		
	sources of air pollution such as high traffic corridors		
Food security	\uparrow risk of food insecurity due to extreme weather events such as droughts, heavy rainfall		
	and flooding that damage or destroy food crops, leading to $ au$ cost of healthy foods		
Employment	exposure to extreme heat, air pollution, UV radiation and extreme weather events for		
and working	outdoor workers (agriculture, construction)		
conditions			
Housing and	I risk from extreme heat and extreme cold for people who are homeless or living in		
nomelessness	housing with inadequate heating or cooling		
	I risk of damage from flooding and storms if living in home in need of major repair or		
	living in flood-prone areas		
Children and	risk of poor indoor and outdoor air quality if living close to sources of air pollution		
older persons	sensitivity to extreme neat, air pollution \uparrow side from the formula \uparrow and \downarrow and here i and here i and he		
older persons	\uparrow risk from extreme weather events due to \checkmark mobility and \uparrow reliance on care-givers		
La d'anna anna	risk from mental health following disasters and extreme weather events		
Indigenous	existing inequities (e.g. access to traditional cultural practices, access to safe water,		
people	access to nearth care) \uparrow		
	First food insecurity due to general warming and ↓ availability/access to traditional		
Hoalth status	Tood sources		
nearth status	for persons who are immunocompromised or living with chronic diseases or disabilities		
Access to	\uparrow risk for porthern, remote and low-income communities that currently experienced		
health	inequities in terms of access to health care		
services	\uparrow risk from extreme weather events as health, community and social supports may be		
Jervices	disrupted by evacuations, population displacement and damage to critical infrastructure		
	(e.g. hospitals, water, wastewater and transportation systems)		
Social support	Persons who are marginalized or socially isolated are more vulnerable to extreme heat		
networks	and extreme weather events		
Personal	↑ risk from extreme weather events, extreme heat and climate variability and change		
behaviours &	While the general population is vulnerable to climate-related stress and distress, risks		
coping skills	are amplified for persons with existing mental health conditions		

perceived threats can cause emotional distress, heightened anxiety and feelings of hopelessness (Hayes et al., 2018). People may experience "solastalgia" – a term coined by researchers to refer to feelings of distress or mental health effects as a result of loss of home or identity, often as a result of environmental damage (Sandifer et al., 2017).

High Risk Populations

Marginalized populations including those already experiencing poor mental health, are at greater risk of increased mental health impacts. While it is difficult to link mental health outcomes to specific risks, a growing body of evidence suggests that climate-related mental health outcomes will increase with climate change, and that certain populations will be disproportionately impacted (Hayes et al., 2018).

An exploratory study in Nunatsiavut, Labrador ranked mental health and well-being as climate-sensitive health priorities for the region (Harper et al., 2015). Researchers noted that mental health of northern Indigenous people may be affected by a variety of climate-related impacts including food insecurity, damage to infrastructure, changes in land, ice and snow, changes in weather, and a loss of a sense of place, and that these impacts may be compounding existing stress and distress (Cunsolo et al., 2015).

Other populations at increased risk of climate-related mental health outcomes include children, seniors, women, resource-based workers, people with low incomes and people with pre-existing medical conditions (Hayes and Poland, 2018).

Health Equity & Vulnerable Populations Vulnerable Populations

Climate change will affect everyone, but certain Canadian populations, especially those already experiencing health inequities, will be disproportionately impacted. Canada ranks as one of the top countries to live in terms of quality of life, yet health inequities do exist. Unequal distribution of income, education, and social and environmental conditions contribute to these inequities (Mikkonen and Raphael, 2010).

In Canada, Indigenous people, sexual and racial minorities, immigrants, people living with disabilities, and populations living on low incomes are at greater risk of adverse health impacts (PHAC, 2018c). In 2011, onethird of Canadians lived in households with core housing needs due to cost, over-crowding, or housing in need of repair; and 8.3% of Canadian households experienced moderate to severe food insecurity (PHAC, 2018c).

Poverty Multiplier

Climate change has been described as a "poverty multiplier" (Ebi et al., 2018). The World Health Organization describes determinants of health as the physical environment, socio-economic environment and individual characteristics and behaviours which all play a part in determining the health of individuals or populations (WHO, 2019b). Table 2 provides examples of how climate change may amplify health inequities by acting on the determinants of health.

Persons on low incomes are at increasing risk of food insecurity if the cost of healthy foods increases or availability decreases because of droughts or other extreme weather events. Persons on low income are less likely to be able to afford home insurance or necessary upgrades to increase climate resiliency e.g. flood-proofing, roof repairs, and air conditioning (Moudrak et al., 2018,



Girl with ashtma inhaler. Photo provided by Thinkstock.

Berry et al, 2014). Low income neighbourhoods are more likely to be situated in areas with greater exposure to natural and human-made hazards that may be amplified by climate change (e.g. high traffic corridors, flood-prone areas, lack of greenspace). Lower socioeconomic status populations are more likely to have reduced access to health care and social supports than the general population, putting them at increased risk of extreme heat, or from injury and disease following extreme weather events (Rudolph et al., 2018).

Indigenous Populations

Indigenous people are already seeing impacts on their way of life because of a changing climate (Climate Telling 2017; ERG 2017). Those in northern and remote communities that rely on traditional food sources will experience greater challenges. Melting permafrost, unstable transportation routes and the changing migration patterns and availability of food sources such as the caribou are all consequences of climate change. Indigenous people may be at greater risk because of existing health inequities and compounding socio-economic factors (e.g. history of colonization, social exclusion, income, housing and water quality, food insecurity and chronic diseases) (Mikkonen and Raphael, 2010).

Medical Conditions

Persons with pre-existing medical conditions face additional health risks from climate change. Exposure to extreme heat increases risk for those with cardiovascular disease. People with respiratory or cardiovascular disease are more vulnerable to air pollution. Asthmatics and persons with allergies face increased exposure to pollen. Immuno-compromised persons have a greater likelihood of illness and serious complications from food-, water- and vector-borne diseases. Extreme weather events may knock out power, disrupt transportation systems and require evacuation of homes, creating additional risks for persons on medications, using electrically-powered medical equipment, or with limited mobility (Rudolph et al., 2018; Molinari et al., 2017; Berry et al., 2014).

Age, Gender and Occupation

Both elderly persons and children are more vulnerable than the general population to climate-related risks. They are more susceptible to heat stress as they are less able to regulate their body temperature, more sensitive to the adverse impacts of air pollution, and more vulnerable to extreme weather events because of mobility issues. Young children and infants are more vulnerable to food-borne and water-borne diseas-



Children running. Photo by Jordan Whitt.



Figure 2 presents the projected change in mean annual temperature for provinces and territories across Canada from the historical period (1976-2005) to the future period (2051-2080) (Climate Atlas, 2018). All regions are projected to experience significant increases in mean annual temperature with the greatest increase in Canada's northern regions.

es because their immune systems are not fully developed (Health Canada, 2008).

Urban and Rural Vulnerabilities

Climate change health risks vary for urban populations and rural populations. Canadians living in urban communities may be at greater risk from heat-related morbidity and mortality because of the urban heat island effect – as limited green space, greater asphalt and dark surfacing on buildings, roads and pavement trap heat and result in hotter microclimates. Urban communities may also be more prone to flooding and sewer system overflows during heavy rainfall events as water flows more rapidly over impervious surfaces, and sewer and storm-water systems may not be designed to handle heavy and prolonged rainfall (Berry et al., 2014).

Many rural areas rely on private wells or communal systems that may be at greater risk from flooding and contamination from heavy rainfall events, snowmelt or permafrost melt. Rural communities that are more heavily reliant on the land for their food and their livelihood face greater risk from extreme weather events like droughts and heavy rainfall that can damage crops, and from a changing climate that diminishes their traditional food sources. Many rural communities are already facing economic difficulties because of dependence on natural resources. Rural residents can also be at greater risk for injury, illness or death from natural hazards such as rising sea levels, storm surges, forest fires and avalanches. Rural and remote communities may also have limited access to healthcare and other vital services in the aftermath of an extreme weather event (Berry et al., 2014).

Key Regional Climate Risks to Canadians

Climate variability and change is being felt in communities throughout Canada, but the picture looks different across and within regions (Canada, 2018e). Regional impacts and climate change risks are influenced by geography, demographics, and existing economic and societal conditions.

This section highlights some climatic trends and future predictions in the six regions across Canada. It also includes regional information on some health impacts and potential climate change health risks, but is not inclusive, noting that the same degree of information is not consistently available across the country. For more information on local climate change health risks and impacts, consult the provincial/ territorial and local public health, environment and climate change agencies for the region.

Northern Canada

Northern Canada is experiencing the most rapid changes in climate which is presenting multiple health challenges for communities and populations. The north is warming faster than the global average (ECCC, 2018a) and some of the strongest seasonal warming trends (both summer and winter) that Canada is seeing are in the north. While nationally, winter temperature averages have warmed by 3.4°C over the past 71

Extreme Weather Event – 2008 Flooding in Pangnirtung, Nunavut

Flash flooding in the community of Pangnirtung, Nunavut in June of 2018 caused 2 bridges to collapse and cut off access to the water reservoir, sewage treatment facility and garbage dump for some residents in the community. Water taxis were used to connect residents to food and community services. Poor weather conditions prevented the Nunavut government from flying in emergency crews to the community which is not accessible by road. Community officials declared a state of emergency for the hamlet of Pangnirtung. Officials said that this type of extreme weather event was new to their community, but they had heard of similar anecdotes from other Nunavut communities (CBC News, 2008). The community didn't have the economic capacity to repair the damage and requested financial support from the Federal government for the \$5 million cost to repair the damages (Spinney and Pennesi, 2012).

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years, areas of the Yukon and North B.C. Mountains region have seen a 5.7°C increase (ECCC, 2018a). The strongest summertime trend has been observed in the Mackenzie District region which has seen a 1.9°C increase compared to the national average of 1.5°C (ECCC, 2018a).

The warming trend in the north across all seasons is having significant impacts on the environment. Examples of changes include melting permafrost, shorter ice season, thinning of sea ice, reduced snow cover, coastal shoreline erosion and change in plant species and wildlife (Lemmen et al., 2014; Bush et al., 2014, Fungal and Sequin, 2006). These climatic changes in turn are impacting communities. Melting permafrost is threatening the stability of homes, buildings and critical public health infrastructure (water and power supplies). Shoreline erosion and storm surges



Hurricane Igor's devestation, Newfoundland. Photo by Zippo S.

have the potential to damage infrastructure and supply routes. Warmer temperatures are shortening the ice season and the ability to safely use ice roads. Forests are becoming more vulnerable to pests and forest fires (Warren et al., 2014).

Indigenous communities have a strong relationship to the land. The climatic changes that are happening in the north are impacting their way of life and increasing health and safety risks. Many indigenous people harvest natural resources for their sustenance and livelihood (Ford, 2012; Fungal and Sequin, 2006). Hunting and fishing are becoming more difficult as travel becomes more dangerous. Warmer temperatures increase the potential for food spoilage. Traditional food sources are harder to find as wildlife migration patterns change and availability of sensitive plant species diminishes. Extreme weather events such as storm surges, coastal erosion, flooding and forest fires may result in population displacement (Warren et al., 2014). These changes threaten food safety and security, water quality, physical and mental health, and traditional cultural practices in northern communities in Canada.

Atlantic Canada

Climate change will bring more frequent and intense storms, rising sea levels, storm surges, coastal erosion and flooding to parts of Atlantic Canada. Hurricanes and floods in Atlantic Canada in the past have resulted in injury and death, property and infrastructure damage, power outages and loss of access to emergency services (Kovacs and Thistlewaite, 2014; Lemmen et al., 2008). While average temperatures are not expected to increase by as much in the Atlantic provinces as in other parts of Canada, 2018 saw the highest ever average temperature records set in cities in all four Atlantic provinces in the month of July (ECCC, 2018b).

Coastal communities may be faced with infrastructure damage, loss of livelihood, displacement or loss of their community. Heavier rainfall could increase risk of contamination of water supplies and overwhelm water treatment facilities. Newfoundland is seeing an increasing number of tropical storms and hurricanes now than in the past (Newfoundland and Labrador 2013).

Certain populations within Atlantic Canada are more vulnerable to climate changes. Many communities have an aging population and lower income compared to the national average. Indigenous communities in the Atlantic region have lower per capita income and higher proportion of younger citizens compared to the rest of Canada. They also rely more on traditional foods, have close ties to the land and have food security concerns (Harper et al., 2015). Climatic changes may result in communities being displaced because of storm events or rising sea levels. Loss of livelihood and income because of climate disruptions to sectors such as fisheries, agriculture and tourism could have health and social impacts, leading to stress-related illness and mental health issues (Lemmen et al., 2008).

Extreme Weather Event – Hurricane Igor, Newfoundland, 2010

One of the strongest hurricanes in Atlantic Canada's history struck the eastern coast of Newfoundland in September 2010 with winds reaching 140 km/hour and a storm surge a meter high. Over 200 mm of rain was reported, flooding and washing out roads and bridges. One person died when his driveway was washed away. Thirty communities declared a state of emergency and some residents were forced to evacuate their homes because of flooding. Power outages and road washouts cut off tens of thousands of residents. Health officials closed down community-based facilities, issued advisories for persons on home oxygen and ventilators, and made provisions to ensure residents had access to emergency and acute care services (ECCC, 2013; Weather Network, 2014; CBC, 2015).

Chronic health conditions may be exacerbated or increase vulnerability to climate related risks such as extreme heat and poor air quality. Air pollution is estimated to cause 286 premature deaths annually across the Atlantic provinces (Health Canada, 2017). The prevalence of diabetes and obesity is higher in the Atlantic provinces than the national average (PHAC, 2010) which can put people at greater risk from air pollution. Warmer temperatures and wetter weather may increase burden of water-, food-, and vector-borne diseases. The health care system may need to respond to an increasing number of illnesses and injuries due to extreme weather events, respiratory ailments or disease (Nova Scotia, 2014).

Quebec

Climate change has already had significant health impacts for the Quebec population and will continue to do so as the climate warms and extreme weather events become more frequent (Ouranos 2015). Climate predictions indicate increased health risks for Quebec from: heat-related morbidity and mortality; cardiovascular and respiratory risks resulting from air pollution (forest fires, ozone and particulate matter); allergic reactions from pollen; skin cancer from UV radiation; and water-borne, vector-borne (Lyme disease) and zoonotic diseases (Gosselin et al. 2011).

Mean average temperatures in Quebec have increased from 1 to 3°C between 1950 and 2011. Annual average temperatures are expected to rise by 2 to 4°C for the 2014-2070 period and 4 to 7°C for the period 2071-2100. Maximum temperatures are expected to increase in Quebec resulting in a greater number of hot summer days and warmer nights (Ouranos, 2015). The southern part of Quebec has been increasingly experiencing very hot summers. Heat risk maps show high risk areas in the most populated areas of Quebec, with a higher proportion of socially vulnerable populations (INSPQ, 2012).

The number of very hot days (>30°C)

Extreme Weather Event -Quebec Heat Wave, 2018

A prolonged heat wave in July 2018 in Quebec resulted in 93 deaths from heat-related complications (ECCC, 2018b). The majority of the deceased were males living alone. Montreal's public health officials said that many of the people who died did not have air conditioning in their homes and many suffered from chronic illnesses. Most of the deaths occurred in Montreal. The heat wave lasted over 5 days with temperatures exceeding 40°C with the humidex. Emergency health services in Montreal experienced a 30% increase in calls during the heat wave (ECCC, 2018b; Toronto Star, 2018). in Montreal is expected to increase from historical levels (1976-2005) of 8 per year, to over 20 for the 2021-2050 period and over 50 per year for the 2051-2080 period. The number of warm nights (>20°C) is expected to increase from 5, to 12 to over 30 for the same time periods (Malik et al., 2018). Significant increases in the length of heat waves is expected (Ouranos, 2015).

Flooding is the main natural climate-related risk in Quebec. Quebec has seen an upward trend in spring and summer rainfall in the period 1950-2010 as well as an increase in the quantity of rainfall within a short time frame and subsequent flooding. More intense rainfall events are predicted which is a particular risk for urban areas where intense rainfall increases the likelihood of localized flooding (Ouranos 2015).

Coastal erosion will create risks for homes, infrastructure and roads. Acidification of the oceans because of increasing CO_2 levels will impact fisheries. While it is harder to predict the frequency and intensity of post-tropical cyclones, it is expected that the quantities of precipitation from these events will increase. Similar to challenges in northern Canada, melting permafrost will further impact communities in northern Quebec, damaging homes and infrastructure, and limiting ability to secure traditional foods and access to the land (Ouranos, 2015).

Ontario

Ontario's annual mean temperature has increased by 1.5°C between 1948 and 2008 and is expected to increase by 3 to 8°C over the next century. Winter average temperatures are projected to increase by 4.6°C by mid-century with summer averages projected to increase by 3°C (Ontario, 2016b). Ontario has already seen an increase in prolonged heat waves and this trend is expected to continue, with the southern and most populated urban areas of the province expected to see an average of three heat waves per year by the 2050s and six per year by the 2080s (Ontario, 2016b).



Bayview Ave under water after record breaking rainfall in Toronto, ON in 2013. Photo by Roozbeh Rokni.
Climate-Related Event – Forest fires in northern Ontario in 2011

Forest fires in July 2011 resulted in the evacuation of over 3000 people in northwestern Ontario. Sandy Lake First Nation residents were evacuated to Sioux-Lookout, Thunder Bay and 11 other communities throughout Ontario and into Manitoba (Sandy Lake First Nation, 2011). In 2014-2015, the First Nations Wildfire Evacuation Partnership met with Sandy Lake First Nations residents to investigate how they were affected by the 2011 wildfires and evacuations.

Residents reported that it was very stressful because they were separated from family members, received little information on the location of family members and experienced financial problems. Elders missed traditional food and culture; some forgot medicines and other essentials; and some medically vulnerable people were sent to evacuation locations without care givers. Statements from com*munity members tell a very impactful story:* "I was concerned about my granddaughters; two of them had asthma, along with my wife"; "When people were put on the plane, they didn't know where they were going. For you, if you want to go somewhere, and you're going on the plane, you know where you're going, right? You know your destination. But these people, they were just put on the plane without knowing where they were going" (Asfaw 2017; FNWEP, 2019).

Climate change is expected to increase air pollution in Ontario by increasing levels of ground-level ozone, pollen concentrations and forest fire smoke. Currently, approximately 7,020 premature deaths per year in Ontario have been attributed to air pollution. (Health Canada, 2017). Due to increasing temperatures and higher UV exposure, levels of basal cell carcinoma across Ontario are predicted to increase by 7.8 to 8.7% by the 2050s and 12.8 to 14.8% by the 2080s (Ontario, 2016b).

Ontario is already seeing a change in the geographic range of disease vectors such as the black-legged tick that is responsible for the increase in Lyme disease cases. Lyme disease is established in southern Ontario and could expand into northern Ontario. West Nile virus is in southern, western and central Ontario and is expected to cover all of Ontario by 2050-2080 (Ontario, 2016b).

The frequency and intensity of extreme precipitation events across Ontario is increasing. Ontario communities are already seeing damage to critical infrastructure such as water, wastewater and transportation systems, overflowing sewers and road washouts because of intense rainfall and flooding. Extreme precipitation in the summer months may result in in-

creased beach closures (Ontario, 2016b).

The Prairies

Climate change across the Prairies can be expected to produce more warmer and drier weather, droughts, changing vector-borne disease habitats, more weather variability and more frequent and intense extreme weather events.

Extreme Weather Event – 2013 Alberta Flood and Public Health Surveillance Post-Flood

In June of 2013, heavy rainfall and a massive flood impacted 30 communities and over 100,000 residents in southern Alberta. Water and wastewater infrastructure and transportation infrastructure were damaged as well as several schools and health care facilities. A provincial state of emergency was declared and some areas were evacuated, with 12,000 residents of High River north of Calgary having to leave their homes.

Alberta Public health officials implemented enhanced surveillance following the flood. Various data sources were used including Emergency Department data, pharmaceutical information data, communicable disease reporting and laboratory reporting. Surveillance revealed increases in injuries, tetanus administration, carbon monoxide poisoning, use of anti-anxiety medication and sleep aid, and an increase in sexual assaults. No increases in gastrointestinal illnesses were identified but small clusters of norovirus at evacuation centres were noted and mitigated. The enhanced surveillance allowed public health officials to send media alerts (e.g. warning about carbon monoxide poisoning when using generators indoors) and to implement rapid response to communicable disease reports if needed (Sahni et al., 2015).

The Canadian Prairies are particularly susceptible to drought (Warren et al., 2014). With climate change, reduced summer rainfall will affect both the quality and quantity of water and increase droughts. Increased spring floods could increase run-off, soil nutrient loss and the production of algal blooms in surface water (Warren et al., 2014).

Summers will be especially drier on the Prairies, with more severe storms, climate extremes, and flood events expected (PARC 2007; Teufal et al., 2017). It is difficult to attribute any one extreme weather event, such as the 2013 flood or the 2016 wildfire in northern Alberta, to climate change; however, scientists assessing these disasters are noting the contributing climate-related factors. The 2016 Wood Buffalo Wildfire Post-Incident Assessment Report noted that the largest contributing factor was the hazard conditions in northern Alberta – extremely dry the previous summer, low moisture over winter and a dry warm spring (KPMG, 2016).

Changing ecosystems on the Prairies could increase vector-borne and zoonotic diseases that are sensitive to climate. Higher rodent populations are linked to warmer mild and wet winters. Mild winters allow certain mosquito vectors to over-winter. In 2007, 98% of the 2,215 reported cases of WNv in Canada were in the Prairies. Climate models suggest an expanding range of WNv in the Prairies (Zheng et al., 2014; Chen et al., 2013). While some studies suggest that the Prairies are too dry for the spread of Lyme disease other vectors could become a health threat either because they have an animal reservoir population, there have been human cases, or they have a history in the Prairies (Charron et al., 2003).

British Columbia

Average annual temperature in British Columbia has increased by 1.4°C since the turn of the century. Lakes and rivers are becoming ice free earlier in the spring, annual precipitation has increased, sea level has risen along most of the coast and sea surface temperature has increased (BC, 2016). It is predicted that the average annual temperature in B.C. may increase by 1.7 to 4.5°C from 1961-1990 averages, and average annual precipitation may increase by 4 to 17% from the 1961-1990 averages (BC, 2016).

Heat-related illnesses are expected to increase in British Columbia. While Victoria experienced, on average, 3 hot days per year between 1951 and 1980, this number is estimated to increase to 13 days in the 21st century. The Lower Mainland and interior will likely see more frequent hot days (BC, 2016).

Air pollution is a concern for B.C. residents (BC, 2016). Approximately 1310 premature deaths per year in B.C. have been attributed to air pollution (Health

Extreme Weather Event – British Columbia Forest Fires 2017/2018

The number of forest fires in British Columbia during the 2018 season far surpassed the 2017 records and resulted in air quality advisories in B.C. and across Alberta. As noted in these on-line media headlines from August 2018, smoke from the B.C. forest fires created poor air quality and visibility concerns in several cities in Alberta:

• CBC News. August 8, 2018: "Smoke from B.C. wildfires prompts air quality advisories across Alberta"

• Global News. August 18, 2018: "Safe bet Alberta will be impacted by B.C. wildfire smoke in future" – 10+ Air Quality Health Index reading in Edmonton and other Alberta communities forecast air quality to be very high risk to health

• Global News. August 19, 2018 "Air quality in nearly a dozen B.C. communities 'very high risk' on Sunday" – BC's Air AQHI forecast 10+, or very high risk to health

• Global News. August 20, 2018: "Smokiest summer on record in Calgary: Environment – Canadian records set in Calgary, Edmonton, Red Deer and Grande Prairie

• Global News. August 23, 2018: "Smoke from B.C. wildfires impacted parts of Saskatchewan"

– Environment Canada models show smoke from B.C. fires have spread to west central parts of Saskatchewan causing poor air quality

Resources for Health Professionals

• Acute Care during Extreme Heat: Recommendations and Information for Health Care Workers. Government of Canada

• <u>Air Quality Health Index Publications. Government of Canada</u> <u>Climate Atlas of Canada</u>

• Climate Change and Public Health Fact Sheets. Government of Canada

- Climate Change, Health, and Equity: A Guide for Local Health Departments
- Factsheets and Infographics on Climate Change. American Public Health Association
- For Health Professionals. Lyme disease. Government of Canada
- Health of Canadians in a Changing Climate. Government of Canada
- Notifiable Diseases Online. Government of Canada

Canada, 2017). Forest fires continue to devastate local communities and increase health risks as smoke from fires can travel large distances and impact air quality. In 2017 forest fires in B.C. caused the evacuation of over 65,000 residents (NRCan, 2018b).

A warming climate, heavy rainfall and expanding disease vector habitats could result in increases of food-, water-, and vector-borne diseases. In 1995, in Victoria, an outbreak of toxoplasmosis was linked to extreme precipitation that contaminated a drinking water supply (BC, 2016). Shellfish poisoning has been associated with ingestion of mussels contaminated with the toxin from algal blooms. Climate change may increase the occurrence of toxic algal blooms (BC, 2016). Warmer weather increases risk of exposure zoonotic diseases. Six cases of hantavirus, spread by the deer mouse have been reported in BC in the past, with 2 cases resulting in death. The vector of Lyme disease has been found in black-legged ticks in the Fraser Valley. The black-legged tick is very common in B.C. (BC, 2016).

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Climate Change Toolkit for Health Professionals Factsheet: Climate Change Health Impacts across Canada

Introduction:

Climate change is impacting the health of Canadians. Heat-related illness, cardiovascular and respiratory diseases, cancer, infectious diseases, mental health, injuries and death can be linked to our changing climate and there is strong evidence that we will see an increase in these health conditions across Canada as a result of climate change. Climate change may also increase existing health inequities.

Extreme Heat:

The number of extremely hot days is expected to double or triple in some parts of Canada in the next 30 years. Heat waves extending over multiple days are associated with increased mortality, especially among older adults, people with chronic illness, and those who are socially isolated. Exposure to extreme heat can cause heat stroke, dehydration and heat exhaustion and it can also exacerbate pre-existing conditions such as cardiovascular disease and respiratory diseases.

Air Pollution:

Air pollution produces approximately 14,400 premature deaths per year in Canada. It increases the risk of heart disease, strokes, lung cancer and respiratory disease, as well as aggravating existing heart and lung conditions. Transportation and industrial emissions, forest fire smoke and pollen all contribute to the burden of illness from air pollution. Climate change is creating the conditions that exacerbate this impact. Warmer temperatures increase the formation of ground level ozone. Drier, longer warmer summers increase the risk of exposure to forest fire smoke, dust from droughts, and pollen.

UV Radiation:

Damaging sunburns and skin cancer are on the rise because of depletion of the ozone layer that protects us from the sun's ultra-violet (UV) radiation. While there are some signs of ozone layer recovery, the incidence of skin cancer associated with UV exposure is expected to continue to rise over the coming decades. This may also be attributed to recreational behaviour as people spend more time outdoors with the warmer longer summer seasons expected with climate change.

Vector-Borne Diseases:

Vector-borne diseases are spread by mosquitos, ticks and other species that act as agents of transmission for these diseases. Climate change is altering conditions in the environment that may be more conducive to the emergence and spread of vector-borne diseases. Human cases of Lyme disease have increased significantly in Canada over the last decade. West Nile virus remains a concern for Canadians. Both West Nile virus and Lyme disease have been found in urban and rural settings.

Extreme Weather Events:

Extreme weather events are increasing in frequency and severity across Canada because of climate change. Over 195 disaster-level extreme weather events were reported between 2008 and 2018. Wildfires, floods, winter storms, droughts, extreme heat, and tornadoes have proven dangerous and devastating. From forest fires requiring rapid evacuation, to deadly heat waves, to flash floods and hurricanes that destroy homes and damage infrastructure, their impact is alarming. Some are measurable, such as number of deaths, number of evacuees or cost of recovery. Some are more difficult to identify such as water-borne illnesses linked to a heavy rainfall event.

Mental Health Impacts:

The health impacts of climate change that often go unrecognized are those related to mental health. Extreme weather events can lead to anxiety, depression and post-traumatic stress disorder. People may experience solastalgia or eco-anxiety – terms used to describe feelings of distress or poor mental health as a result of loss of home or identity due to environmental damage. People who currently experience increased health risks because of income or other factors, are more likely to experience increased mental health risks due to past and future climate-related disasters.

Northern Experience: Northern Canada is experiencing the most rapid changes in climate and facing multiple health-related concerns. Melting permafrost, shoreline erosion and storm surges threaten the stability of homes, infrastructure and water supplies. Warmer temperatures are shortening the ice season, impacting the way of life for indigenous communities. Hunting and fishing is more difficult as travel becomes more dangerous and traditional foods are harder to obtain. Extreme weather events such as coastal erosion and forest fires may result in population displacement. These changes threaten food safety and security, water quality, physical and mental health, and traditional cultural practices of northern communities.

Regional Risks to Canadians:

Atlantic Canada: Climate change will bring more frequent and intense storms to Atlantic Canada. Past hurricanes and floods in Atlantic Canada have resulted in injury and death, infrastructure damage, power outages and loss of access to emergency services. Coastal communities may be faced with infrastructure damage, loss of their livelihood, displacement or loss of their community because of sea

Canadian Region	Historical Warming Trend	Future Warming Expected	Environmental Changes and Health Risks Already Observed	Examples of Environmental Changes and Health Risks Expected	Mental Health & Health Inequity Risks
Northern Canada	1	~	Melting permafrost; thinning sea ice; reduced snow cover; shoreline erosion; changing plant, wildlife and disease-vector habitats; Food insecurity; dangerous travel.	 ↑ food insecurity ↓ availability of traditional food sources ↑ risk of injuries and death from changing environment – thinning sea ice, dangerous ice roads ↑ population displacement 	Ţ
Atlantic Canada	1	\checkmark	Tropical storms; heavy precipitation events; flooding; shoreline erosion; changing sea ice; rising sea-levels; warming ocean.	 ↑ injury from extreme weather ↑ displacement & loss of livelihood from changing shoreline and ocean conditions and extreme weather events 	¢
Quebec	1	1	Heavy rainfall events; flooding; more frequent and prolonged extreme heat events; changing vector-borne disease habitats.	 # hot days & warm nights heat-related illness & death air-pollution illness & death heavy rainfall and flooding incidence of vector-borne diseases 	Ţ
Ontario	1	1	Heavy rainfall events; flooding; more frequent and prolonged extreme heat event; changing vector-borne disease habitats.	 # hot days & warm nights heat-related illness & death air-pollution illness & death heavy rainfall and flooding incidence of vector-borne diseases 	Ţ
Prairie Provinces	1	\checkmark	Extreme weather events; wildfires; extreme rainfall and flooding events.	 drought conditions wildfires air-pollution related illness death from dust, wild-fire smoke 	1
British Columbia	1	\checkmark	Risking sea level; rising sea surface temperature; earlier ice- free lakes and rivers; Increase in the number and severity of wildfires	 ↑ heat-related illness & death ↑ air-pollution illness & death ↑ heavy rainfall and flooding ↑ incidence of vector-borne diseases 	ſ

Table 1: Regional risks to Canadians. Provided by Helen Marie Doyle.

level rise, storms, coastal erosion and flooding. Variability in precipitation and limited water resources could impact the fisheries and agricultural sectors, which could mean a loss of income – an important determinant of health.

Quebec: Quebec has seen significant climate-related health impacts and expect this to continue as the climate warms and extreme weather events become more frequent. Climate change health risks in Quebec include heat related illness, cardiovascular and respiratory risks from exposure to air pollution from forest fires, ozone and particulate matter, allergic reactions from pollen, skin cancer from UV radiation, and water and vector-borne diseases. Significant increases in the length of heat waves and

warmer nights are expected. Flood hazard is the main natural risk in Quebec. More intense rainfall events are predicted which means increased flood risk because of climate change.

Ontario: Climate change is putting Ontarians at increasing risk from heat-related illness, cardiovascular and respiratory disease, water-borne disease, injury and other illnesses including stress-related disorders and poor mental health. Health impacts from air pollution is a current concern in Ontario and will be exacerbated by warmer temperatures, forest fires and increasing pollen production. The geographic range of Lyme disease and other vector-borne diseases is expanding. Higher UV exposure is increasing skin cancer risk. The frequency and intensity of heavy precipitation, flooding and other extreme weather events is increasing across Ontario.

Canadian Prairies: The Prairies are particularly susceptible to drought. Climate change across the Prairies is expected to produce more warmer and drier weather, droughts, changing vector-borne disease habitats, more weather variability and more frequent and intense extreme weather events. People in the Prairie provinces experience increasing climate change health impacts related to heat-related illness, air pollution, vector-borne diseases, food and water-borne diseases, and poor mental health.

British Columbia: Forests fires in British Columbia continue to devastate local communities. Climate change will increase the likelihood of warmer, dryer and longer wildfire seasons. As a result, the health risks associated with exposure to wildfire smoke is likely to increase. Heat-related illness is expected to increase in British Columbia. Climate change may also increase the occurrence of toxic algal blooms and shell fish poisoning as warmer coastal waters provide conditions conducive to algal growth. Some communities currently have water quality issues - for both drinking water and recreational water use. The incidence of water-borne disease may increase with climate change.

References for the Factsheet can be found in Module 3 of <u>CAPE's Climate</u> <u>Change Toolkit for Health professionals</u>.

Module 4

Climate Change Toolkit for Health Professionals Greenhouse Gas Emissions in Canada by Sector and Region April 2019



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Module 4 – Greenhouse Gas Emissions in Canada by Sector and Region

Canada Canada's Commitment

Canada was one of the first countries to sign and ratify the Paris Agreement, an international treaty negotiated by 194 countries in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC). As set out in Article 2, the Paris Agreement "aims to strengthen the global response to the threat of climate change... including by holding the increase in global average temperature to well below 2°C above pre-industrial levels and [by] pursuing efforts to limit the temperature increase to 1.5°C, recognizing that this would significantly reduce the risks and impacts of climate change."

Under the Agreement, which allows countries to establish their own climate plans and goals, Canada committed to an economy-wide target for greenhouse gas (GHG) emissions reductions of 30% relative to 2005 levels by 2030 (Canada, 2017). According to Canada's official emissions data, this is equivalent to an absolute level of 513 megatonnes of carbon dioxide equivalent (Mt CO_2eq), or 191 Mt below current levels (704 Mt in 2016).1¹

While some question whether that tar-

get represents an appropriate level of ambition (CAT, 2018)—given, for example, Canada's outsized historical contributions to the stock of human-caused GHGs in the global carbon cycle; the need for developed countries, particularly top emitters, to lead emissions-reduction efforts; and the urgency of the latest scientific warnings about the likely effects of even 1.5°C of global warming (IPCC, 2018)—there is little doubt that achieving reductions of this scope will involve serious policy shifts and socio-technical challenges across every economic sector.

Pan-Canadian Framework

Canada's official plan for achieving its current national target is called the Pan-Canadian Framework on Clean Growth and Climate Change (PCF). Negotiated over the course of 2016 through public consultations and several inter-governmental working groups, the PCF has been endorsed by nearly all of the country's constitutional jurisdictions. It is thus regarded by many observers as Canada's first truly national climate plan. Currently, every province and territory except Saskatchewan has signed on to the Framework (ECCC, 2018a).²





The PCF encompasses four policy "pillars" including economy-wide carbon pricing, complementary mitigation actions (e.g., sector-specific regulations), measures to support climate adaptation and resilience, and new investments in clean technology and innovation (Canada, 2016b). Due to its broad scope and its collaborative origins in federal-provincial-territorial negotiation, the PCF is also undoubtedly Canada's most comprehensive climate plan to date.

At present, after accounting for anticipated reductions from both current policies and those still under development, the federal government projects a significant shortfall to Canada's emissions target (Figure 1) (ECCC, 2018b). Nationally, Canada has yet to meet any of the climate targets set under UNFCCC processes, such as the 1997 Kyoto Protocol (from which Canada withdrew in 2011) or the 2009 Copenhagen Accord (under which Canada proposed to reduce GHGs 17% below 2005 levels by 2020). However, the Canadian government continues to reiterate its commitment to meeting its 2030 target.

Emissions Trends

Figure 2 combines historical data describing sectoral trends in Canadian GHG emissions along with government projections (dotted lines) for each sector in 2030. **Figure 4** provides a current break-



Figure 2: Canadian greenhouse gas emissions by economic sector, 1990-2016 (historical), with federal projections to 2030^{*Figure 2:7} Graphic provided by Pembina.

down of the total GHGs emitted by different sources of economic activity in 2016, the last year for which data are available. From 1990 to 2016, overall Canadian GHGs grew nearly 17%, driven mainly by steady emissions increases from both the oil and gas (+16%) and the transportation (+7%) sectors (ECCC, 2018d). The upstream and downstream oil and gas sector (i.e., extraction and production through refining and distribution) is the largest contributor to Canadian emissions. Although conventional oil production has remained essentially constant since the turn of the century, unconventional oil production-especially from bitumen in Alberta's oil sands-has surged over the same period (Robins, 2016).

Meanwhile, the transportation of people and goods is responsible for fully one-quarter of Canadian GHG emissions and is the second-largest contributor to the national inventory. Emissions from transportation rose steadily from 1990 to 2010, driven mainly by growth in emissions from onroad vehicles (including light-duty personal vehicles and heavy-duty trucks), which constitute more than two-thirds of that sector's GHGs (ECCC, 2018d). While passenger transport (cars, light trucks, and motorcycles, plus buses, rail, and domestic aviation) has fallen slightly as a share of total transport GHGs—from 57% in 1990 to 54% in 2016-emissions from freight transport (heavy duty trucks, rail, domestic aviation, and marine) have



Figure 3: Average carbon dioxide (CO2) emissions per capita, 2016 (tonnes per year) Data Source: (Ritchie and Roser, 2019)

surged 15 percentage points over the same period, from 26% to 41%. The latest GHG projections from Environment and Climate Change Canada (ECCC) suggest freight will reach parity with personal transport by 2030 and surpass it sometime shortly thereafter (ECCC, 2018b).

Over the full record (1990-2016), emission increases from oil and gas and transportation have mostly offset emission decreases in the electricity (34%), heavy industry (13%) and waste and others³ (13%) sectors (ECCC, 2018d). The substantial decline in electricity sector emissions, in particular, is expected to continue as provinces accelerate the phase-out of their coal-fired power generation assets as mandated under the PCF—in favour of more non-emitting sources or natural gas.

Declaration of Ambition

In signing the UN Secretary-General's June 2018 Declaration of Ambition, the Minister of the Environment and Climate Change has acknowledged the need for deeper cuts to domestic emissions (UN-FCCC, 2018). For now, however, the federal government remains focused on achieving Canada's current target through policy measures announced as part of the PCF (Rabson, 2018).

Yet it is worth noting that, in addition to facilitating the creation of the PCF, the federal government was also amongst the first Paris Agreement signatories to submit its "long-term low-GHG development strategy" as required under Article 4.19. While cautioning that it is neither "a blueprint for action" nor "policy-pre-





scriptive," this mid-century strategy (as it has become known) outlines a long-term intent to achieve deep decarbonization (>80%) of the economy **(see Figure 1)**, in line with scientific findings that a 50-50 chance of staying within the Paris Agreement's 1.5-degree temperature target requires global emissions cuts of 70-95% by 2050 (Government of Canada, 2016a).

Canada's Contribution

Canada was responsible for about 1.7% of total global emissions in 2014 (WRI, 2018). While Canada's share of overall GHGs is much smaller than that of major emitters like China or the United States,

on an absolute basis, Canada is nonetheless one of the top ten global emitters (Figure 5) (ECCC, 2018d). Moreover, on a per person or per capita basis, Canadians are one of the very highest-emitting peoples of the world. Though estimates vary, we are certainly in the top three (Figure 3) (Ritchie and Roser, 2019; Robins, 2016; Boothe and Boudreault, 2016)⁴. Canadians' high emissions are partly due to the country's vast northern geography and cold climate, its relatively small and dispersed population, and its traditional economic base: it takes a great deal of energy to move people and goods across the country, to heat buildings through cold winters, and to extract



Data Source: World Resources Institute, Climate Watch, CAIT Climate Data Explorer.

and process raw materials (Robins, 2016).

Still, amongst other top-ten national emitters, Canada is the only country with a population under 100 million, and it outranks the United States, Russia, Japan, China, India, and the European Union as one of the highest per-capita emitters in the world (Frank, 2018). In other words, on any reasonable measure of global equity with respect to climate action, Canadians emit much more than their fair share.

With that said, according to ECCC, Canadian per capita GHG emissions have declined from 22.7 tonnes (t) CO_2eq per person in 2005 to 19.4 t CO_2eq per person in 2016 (ECCC, 2018b, 13). This is the lowest level since 1990, when the record began. ECCC's modelling suggests per capita emissions will continue to decrease over the next decade and reach

16.7 t CO_2 eq per person in 2030. However, this expected improvement is mainly driven by a projected 16% increase in population from 2016 to 2030, rather than by policy-driven cuts to GHG emissions, which fall by only 0.5% over the same period (in the government's main "reference case" projection scenario) (ibid.).

Per Capita and Provincial-Territorial Contributions Across Canada

It is also important to note that, when calculated on a national basis, Canada's per capita emissions mask substantial variation between the per capita GHGs of different provinces and territories.⁵ The national average flattens differences in the population size, energy sources, emissions levels, and industrial activities



Figure 6: Provincial greenhouse gas emissions, 1990-2016. Graphic provided by Pembina.

characterizing the economies of each subnational jurisdiction (see provincial and territorial profiles for jurisdiction-specific information on per capita emissions). On a per capita basis, Alberta and Saskatchewan would rank among the world's highest national emitters, while Québec, Ontario, and British Columbia would qualify among the least GHG-intensive countries in Western Europe (Boothe and Boudreault, 2018, 12). Taken together, these five provinces constitute 90% of Canada's total emissions; Alberta and Ontario alone are responsible for 60% (ECCC, 2018d).

Figure 6 presents time series data showing the historical contribution of each Canadian province to the national GHG inventory, as well as each province's relative ranking in terms of their absolute emission levels (note that territories are not included due to their very low emissions profiles). As the figure shows, Alberta and Ontario are the highest and second-highest provincial emitters, respectively. Progress by the latter in achieving reductions since 2005—mainly from its coal phase-out in the electricity sector—has been offset by increased emissions in the former—mainly from increased oil and gas production, but also to a lesser extent from growth in heavy-duty trucking (ECCC, 2018d).

The provincial and territorial profiles in the following pages provide a quick reference for the major emissions sources and trends in each of Canada's sub-national jurisdictions. Unless otherwise stated, emissions data cited are drawn from ECCC's 2018 National Inventory Report, Parts 1 and 3 (ECCC, 2018d). Population data are from Statistics Canada's annual estimates.

British Columbia

British Columbia is Canada's fifth-highest emitting province and its third most populous. In 2016, the province emitted just over 60 Mt CO_2eq , or approximately 9% of Canada's total GHG emissions. On a per capita basis, British Columbians emit 12.4 t CO_2eq per year, placing the province at the low end (ninth) amongst all the provinces and territories.

Under its Climate Change Accountability Act, British Columbia has legislated targets to reduce GHGs by at least 40% below 2007 levels by 2030, 60% by 2040,



Oil tanker in Burrard Inlet, Vancouver BC. Photo by Lewis Pratt.

and 80% by 2050. The main contributors to its provincial emissions inventory are



Figure 7: British Columbia GHG emissions by economic sector, 1990-2016. Graphic provided by Pembina.

British Columbia



Figure 8: British Columbia GHG emissions by economic sector, 1990-2016. Graphic provided by Pembina.

the transportation, oil and gas, and buildings sectors, which together make up nearly three-quarters of provincial GHGs.

From 1990 to 2016, emissions from transportation, including both passenger and heavy-duty on-road freight vehicles, grew nearly 40% (6.2 Mt), with most of the growth occurring by 2005. Over the full period, oil and gas sector emissions grew 77% (5.8 Mt), driven exclusively by the expansion of the province's natural gas industry (production, processing and transmission) (ECCC, 2018d).



Transport truck on the Coquihalla highway in B.C. Photo by BC Ministry of Transportation

Alberta

Alberta is Canada's fourth most populous province and by far its highest emitting. In 2016, the province emitted nearly 263 Mt CO_2 eq, or about 37% of Canada's total GHG emissions. On a per capita basis, Albertans emit 62.7 t CO_2 eq, more than the people of every other province except Saskatchewan.⁸

Alberta's GHG inventory is dominated by oil and gas extraction and production, which account for nearly half of provincial emissions. From 1990 to 2016, while annual emissions from conven-



Air pollution from coal industry. Photo by Veeterzy on Unsplash.

tional oil production actually declined, emissions from oil sands (open pit min-



Alberta

ing, in situ extraction⁹, and bitumen upgrading) increased by 85% to 120 Mt.

In addition, Alberta's electricity sector generates more GHG emissions than that of any other province, due to its size (3rd largest electricity producer behind Quebec and Ontario) and its reliance on coal-fired power. Approximately 89% the province's electricity is generated from fossil fuels: about 50% from coal and 39% from natural gas. The remaining 11% is produced from renewables, such as wind, hydro, and biomass (NEB, 2019). In 2016, Alberta's power sector generated 45 Mt, or 57% of total Canadian GHG emissions from electricity production. As a key pillar of its Climate Leadership Plan, the province has indicated it will phase-out coal-fired power by 2030.

Finally, emissions from transport in the province have nearly doubled since 1990, particularly on account of increased activity (and a more than tripling of GHGs) from heavy-duty trucking (ECCC, 2018d).



Aerial footage from space of Millenium Open Pit Mine in Alberta that produce oil sands processed to recover bitumen. Photo by NASA Jet Propulsion Laboratory.

Saskatchewan

Saskatchewan is Canada's sixth most populous province and its second highest emitting. In 2016, the province released over 76 Mt CO_2eq into the atmosphere or nearly 11% of Canada's total GHG emissions. On a per capita basis, Saskatchewanians emit 67.1 t CO_2eq , more than the inhabitants of any other province and 244% above the national average of 19.4 t CO_2eq per capita.

Emissions from Saskatchewan have increased 71% since 1990. The single largest contributor to this trend was the oil and



Wheat. Photo by Nitin Bhosale on Unsplash.

gas sector, which saw upstream emissions more than double (from 10.9 Mt to 22.8 Mt in 2016)—mostly from increased pro-



Saskatchewan



duction of conventional oil, but also from the emergence of a small oil sands upgrading industry. Downstream emissions also rose steadily as a result of greater petroleum refining. Saskatchewan's emissions growth also resulted from increases of emissions from agriculture (including on-farm fuel use, crop production and fertilizer use, animal housing, and manure production), transport (where emissions from freight transport increased by 325%) and electricity generation. The province's electricity sector produces the second highest amount of GHG emissions after Alberta, primarily because of its reliance on coal-fired generation. In 2016, Saskatchewan's power sector emitted 15 Mt of emissions, or 19% of total Canadian GHG emissions from power generation. The southern part of Saskatchewan has some of the highest wind energy and solar photovoltaic (PV) generation potential in Canada (NEB, 2019).

Manitoba





Manitoba is Canada's fifth most populous province and one of its lowest emitting. In 2016, the province emitted about 21 Mt CO_2eq , or just under 3% of Canada's total GHG emissions. On a per capita basis for that year, Manitobans emitted 15.9 t CO_2eq —less than Nova Scotians and the Canadian average, but more than British Columbians. The largest emitting sectors in Manitoba are agriculture (36%), transportation (33%), and residential and commercial buildings (12%). Manitoba generates virtually all of its electricity from renewable sources. For this reason, it emits less than 0.1 Mt of GHGs from its electricity sector (approximately 0.1% of total Canadian GHG emissions from power generation).





Ontario

Ontario is Canada's most populous province and consequently one of its highest emitting. In 2016, the province emitted just under 161 Mt CO_2eq or about 23% of Canada's total GHG emissions. On a per capita basis for that year, Ontarians emitted 11.6 t CO_2eq . Thus, while the province is Canada's second-highest emitter on an absolute level, in per capita terms, it is third lowest in Canada, bested only by Quebec and the Yukon.

Ontario's emissions have fallen 10% since 1990. The three largest emitting sectors

in Ontario are transportation (35%), buildings (residential and commercial) (21%), and heavy industries (19%), including iron, steel, and chemicals. In the transportation sector, emissions grew 34% between 1990 and 2016 (from 41.6 Mt to 55.8 Mt), with passenger transport climbing to 33.9 Mt or 60% of provincial transport emissions, and freight transport growing 118% to 18.3 Mt, or fully one-third of provincial transport GHGs (11% of the overall provincial total).

Over the past quarter-century, emissions



Ontario





from heavy industry in Ontario declined by 30% (to 30 Mt in 2016); the share of this sector in provincial GHGs fell by 5%. While iron and steel production, pulp and paper, and smelting and refining all reduced their GHG output, the majority of the overall decrease in industry emissions was achieved through reductions from chemical and fertilizer manufacturing. In 2016, Ontario's electricity sector emitted 4.5 Mt or 6% of total Canadian GHG emissions attributable to power generation. The province's electricity sector emissions peaked in 2000 at 42.6 Mt before a substantial decline that was prompted by the government decision to phase out coal-fired generation. The phase-out took approximately a decade and was complete by 2014.

Quebec

Quebec is Canada's second most populous province and the third most significant contributor to national emissions. In 2016, the province emitted 77.3 Mt CO₂eq or 11% of Canada's total GHG emissions. Quebec's annual emissions per capita are the lowest amongst all Canadian provinces at 9.4 t CO_2 eq-52% below the Canadian average of 19.4 t per capita. The province has set a GHG reduction target for 2030 of 37.5% below 1990 levels.

The largest emitting sectors in Quebec are transportation (41%), heavy indus-



Traffic on Jacques-Cartier Bridge. Photo by Abdallahh.

tries, including smelting, cement, and chemicals (19%), and buildings (residential and commercial) (14%). Power



Quebec



Figure 17: Quebec GHG emissions by economic sector, 2016. Graphic provided by Pembina.

production in the province is virtually emissions-free, and Quebec is Canada's largest electricity producer, with hydroelectric stations constituting 99% (45,036 megawatts) of its total installed generation capacity in 2017 (NEB, 2019).

Transportation sector emissions in Quebec increased almost 28% from 1990 to 2016. In terms of power production, nearly all of the electricity produced in Quebec comes from renewable sources, hydro in particular. In 2016, Quebec's power sector generated 0.3 Mt emissions or approximately 0.4% of Canada's overall electricity sector GHG emissions.



Centrale de Beauharnois, au Québec. Photo by Gilles Douaire.

New Brunswick

New Brunswick is Canada's eighth most populous province and among the smaller contributors to national emissions. In 2016, the province emitted 15.3 Mt CO_2eq , or 2.2% of total Canadian GHG emissions. The province's annual emissions per capita, at 20 Mt CO_2eq , are slightly above the Canadian average.

New Brunswick's emissions have declined by 5% since 1990. The largest emitting sectors in New Brunswick are electricity generation (32% of GHGs), transportation (28%), and oil and gas



Irving Oil Refinery, Saint John NB. Photo by Cusack5239.

(primarily petroleum refining) (17%).


New Brunswick



Figure 19: New Brunswick GHG emissions by economic sector, 2016. Graphic provided by Pembina.

In 2016, New Brunswick's electricity sector emitted 4.9 Mt or 6% of Canada's GHG emissions from power generation. The province and its Crown-owned utility plan to increase the portion of non-nuclear renewables in electricity generation from 28% in 2015 to 40% in 2020 (NEB, 2019). New Brunswick's major coal-fired power plant, Belledune Generating Station, will also be affected by the federal government's national 2030 coal phase-out policy.



Coal plant. Photo by koushik das on Unsplash.

Prince Edward Island

Prince Edward Island is Canada's least populous province and the smallest provincial contributor to national emissions. In 2016, the province emitted 1.8 Mt CO_2 eq or 0.3% of total Canadian GHG emissions. On a per capita basis, Islanders emit 12.3 t CO_2 eq annually, placing them 37% below the Canadian average. The province's total emissions have decreased 6% since 1990.

The largest emitting sectors in PEI are transportation (48% of emis-



Potato. Photo by Photo by Agence Producteurs Locaux Damien Kühn on Unsplash.

sions), agriculture (25%), and residential and commercial buildings (16%). From a decarbonization perspective,



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Prince Edward Island



Figure 21: Prince Edward Island GHG emissions by economic sector, 2016. Graphic provided by Pembina.

Prince Edward Island is notable in that virtually all electricity produced in the province (98% in 2016) is supplied by renewable wind power. However, the Island's wind resource supplies only about 25% of PEI's electricity demand, and the province remains heavily dependent on power imports via submarine cables from New Brunswick.



Wind power. Photo by Photo by Gustavo Quepón on Unsplash.

Nova Scotia

Nova Scotia is Canada's seventh most populous province and a relatively small contributor to overall national emissions. In 2016, the province emitted 15.6 Mt CO-₂eq or 2.2% of total Canadian GHG emissions. On a per capita basis for that year, Nova Scotians emitted 16.5 t CO2eq and therefore fell slightly (15%) below the Canadian average. Total provincial emissions have declined by 20% since 1990.

The largest emitting sectors in Nova Scotia are electricity generation (42% of emissions), transportation (31%), and buildings (residential and commercial) (13%).



White freight truck on grey concrete road. Photo by Orlando Leon on Unsplash.

Historically, Nova Scotia has relied on coal-fired power for most of its electricity production; in 2016, 63.7% of its pow-



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Nova Scotia



Figure 23: Nova Scotia GHG emissions by economic sector, 2016. Graphic provided by Pembina.

er was generated from coal-fired plants (NEB, 2017). However, in 2010, the province committed to grow its share of electricity production from renewable sources such as wind and hydro to 25% in 2015 and 40% in 2020. In 2016, the province's power sector emitted 6.6 Mt CO_2 eq representing about 8.4% of Canadian emissions from electricity.



Lingan Generating Station located in the community of Lingan in Nova Scotia's Cape Breton Regional Municipality. This is on Cape Breton Island, in the province of Nova Scotia, Canada. Also shown are two locomotives of the SCR (Sydney Coal Railway) leaving the power station after unloading a train load of coal for the plant. Photo by Ken Heaton.

Newfoundland and Labrador

Newfoundland and Labrador are together Canada's least populous province and the second smallest provincial contributor to national emissions. In 2016, the province emitted 10.8 Mt CO₂eq or 1.5% of total Canadian GHG emissions. On a per capita basis for that year, Islanders emitted 20.3 t CO₂eq. While this is only 4% higher than the Canadian average, Newfoundland and Labrador is the third highest provincial emitter per capita (fourth highest including the Northwest Territories), behind Alberta and



Hebron Oil Platform, Newfoundland Canada. Photo by Shhewitt.



provided by Pembina.

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Newfoundland and Labrador



Figure 25: Newfoundland and Labrador GHG emissions by economic sector, 2016. Graphic provided by Pembina.

Saskatchewan. The province's total emissions have increased 16% since 1990.

In 2016, the largest emitting sectors in Newfoundland and Labrador were transportation (36% of GHGs), oil and gas production (25%), and electricity generation (14%). The province's GHG emissions from the oil and gas sector were 2.7 Mt. Of this total, 1.6 Mt were attributable to offshore oil production and 1.1 Mt were attributable to petroleum refining.



Siem Pilot, an offshore support vessel servicing major oil and gas companies. Photo by Ryan Sharpe.

Nunavut





All three of Canada's territories are, on an absolute level, minor emitters (as compared with all provinces except PEI), with populations of less than 50,000 people. In Nunavut, total emissions were 0.7 Mt CO2eq in 2016—less than in the Northwest Territories but higher than in Yukon, and about 0.1% of overall national emissions. In per capita terms, territorial GHGs for that year were 18.9 t CO-2eq or 3% below the Canadian average. Emissions from Nunavut have risen 58% since 2000, the first full year following the territory's creation. The majority of GHGs in Nunavut come from transportation (split evenly between passenger and freight) and mining operations.



Figure 27: Nunavut GHG emissions by economic sector, 2016. Graphic provided by Pembina.

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Northwest Territories



Figure 28: Northwest Territories GHG emissions by economic sector, 2016. Graphic provided by Pembina.

Total emissions in the Northwest Territories were 1.6 Mt CO2eq in 2016—the highest level of any northern Canadian territory equal to 0.2% of overall national GHGs. In per capita terms, territorial emissions were 36.1 t CO2eq or 86% above the Canadian average. The highest emitting sectors in the Northwest Territories are transportation (36% of emissions), heavy industry (specifically, mining) (33%), oil and gas production (12%), and buildings (11%). Territorial GHGs have increased 9% since 2000, the first full year after part of the Northwest Territories became Nunavut.



Figure 29: Northwest Territories GHG emissions by economic sector, 2016. Graphic provided by Pembina. Pembina.

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Yukon



Total GHGs in the Yukon were 0.4 Mt CO2eq (426 thousand tonnes [kilotonnes] CO2eq) in 2016, making it the lowest emitting of any Canadian jurisdiction and responsible for less than 0.1% of overall national GHGs.

In per capita terms, territorial emis-

sions were 11.1 t CO2eq, or 43% below the Canadian average. Total greenhouse gas emissions from the Yukon have declined 20% since 1990. The highest emitting sectors in the Yukon are transportation (69% of emissions), heavy industry buildings (11%), heavy industry (mining) (8%), and electricity (5%).





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Endnotes

- 1. One megatonne is equivalent one million metric tons or one billion kilograms.
- 2. Of course, the stability of provincial support for any federal initiative (including the PCF) may depend on the governments in power (and is thus never entirely assured).
- "Waste" includes solid waste, wastewater treatment, and waste incineration, while "others" includes coal production, light manufacturing, and construction and forest resources.
- 4. Figure 4 visualizes only per capita emissions of carbon dioxide (CO2), and not of other greenhouse gases (measured in CO2 equivalent).
- 5. Furthermore, per capita emissions are not necessarily equivalent to the average individual carbon footprint, nor are they the same as household emissions (which would include direct emissions from motor fuel use and residential fuel use for heating, as well as indirect emissions from the production of the goods and services that households consume). Because per capita GHGs are simply total national/provincial/territorial emissions divided by population, in the Canadian context this metric incorporates substantial industrial emissions (e.g., from stationary combustion sources, mobile or transport combustion sources, and manufacturing processes) in addition to emissions generated by individuals or households.
- 6. Figure 1:6 The very latest government emissions projections (ECCC 2018b) are not included in Figs. 1 and 2 but are roughly comparable in terms of the overall emissions trend. As compared with projections contained in Canada's 3rd Biennial Report to the UNFCCC (ECCC, 2017), the new projections show incremental improvement in the reference case (which is based on federal, provincial and territorial policies and measures in place as of September 2018, and which assumes no further government action), but not in the more optimistic "additional measures" case (which includes F-P-T mitigation policies that have been announced, but not yet fully implemented).
- 7. Figure 2: 1 Unless otherwise stated, all Canadian GHG emissions data cited in this module (e.g., in subsequent charts/graphics) derives from Canada's official emissions record, the 2018 National Inventory Report produced by Environment and Climate Change Canada (ECCC, 2018d). Greenhouse gas emissions reported as part of

Canada's national inventory include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

- 8. However, as with any per capita emissions assessment, it is important to note that this metric folds enormous industrial emissions into a simplistic rendering of individuals' carbon footprints; while Alberta's per capita emissions are over three times the national average, it is not accurate to imply that the average individual or household in Alberta leads a vastly more carbon-intensive lifestyle than the average Canadian.
- Typically, in situ production uses a technique called steam-assisted gravity drainage (SAGD), which allows for the recovery of bitumen resources from deep below the surface of the ground.



Climate Change Toolkit for Health Professionals Climate Change Solutions with Immediate Health Benefits

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Module 5 – Climate Change Solutions with Immediate Health Benefits

Introduction The Imperative – A Rapid Shift Away from Fossil Fuels

Current commitments by governments, including those of Canada, are insufficient to limit average global warming well below 2°C, let alone to meet the 1.5°C target in the 2015 Paris Agreement. At current global emission trends, a 1.5°C increase in average global temperatures is likely to occur between 2030 and 2052. To stay below 1.5°C, global greenhouse



English: Highway 401 at the start of the primary Collector/Express system in Toronto. Photo by PL Tam.

gas (GHG) emissions need to fall by about 45 percent from 2010 levels by 2030 and reach 'net zero' by 2050 (IPCC, 2019). It is imperative to accelerate the shift to non-carbon sources of energy in order to avoid the catastrophic health impacts that would be associated with 2°C of warming.

The Lancet Countdown on health and climate change emphasizes that a transformation is needed in the way we generate power, travel, build communities, eat and grow our food (Watts et al, 2018). Strong and predictable carbon pricing, the rapid phase-out of coal, increased access to renewable energy, the promotion of healthy living through energy efficient buildings, low-cost active transportation and increased access to green space are among the strategic directions that will reduce the impact of climate change on health (Watts et al, 2015).

Health Benefits of Climate Action

Many actions to reduce GHGs have additional heath benefits (or co-benefits) associated with them (Haines and Ebi, 2019). For example, reducing GHGs from the production and burning of fossil fuels will usually reduce air pollution, thereby providing immediate health benefits. Actions taken to increase walking, cycling or the use of transit can increase levels of physical activity and reduce emissions of air pollutants, both of which can improve public

Action	Benefits for climate	Benefits for health
 Energy use and production Replacing fossil fuels with renewable energies Reduce the demand for energy through energy efficiency and other measures Improve energy efficiency in buildings 	 Reduce emissions of carbon dioxide, black carbon, methane and other climate pollutants 	 Improve air quality by reducing exposure to outdoor air pollution with a corresponding reduction in risk of cardiovascular disease, chronic and acute respiratory illnesses, lung cancer, and preterm birth Improve indoor environments to reduce energy poverty and respiratory and cardiovascular illnesses
 Transportation Increase fuel efficiency Use alternative fuels Decrease the demand for motorized transportation Give higher priority to active transportation and transit Improve the cycling and walking environment 	 Reduce emissions of climate pollutants by reducing vehicle travel and lowering emissions from vehicles 	 Improve air quality with a corresponding reduction in health impacts (see above) Increase physical activity which reduces the risk of all-cause mortality, cardiovascular disease, obesity, type II diabetes, and certain types of cancer Fewer vehicle-related deaths and injuries from improved cycling and walking infrastructure
 Buildings and communities Increase urban density and diversity of land uses Increase urban green spaces and forests 	 Reduce emission of climate pollutants by reducing vehicle travel and emissions from vehicles Reduce atmospheric carbon dioxide (CO2) by sequestering carbon in plants and soil and reducing cooling needs 	 Improve air quality by reducing vehicle travel Increase physical activity by fostering active travel Reduce ambient temperatures and heat island effect with green space Reduce noise pollution with increased green space Improve mental health with increased access to green space Improve water quality with increased green space
 Food consumption Shift diets to emphasize foods of plant origin Reducing the amount of food that is wasted 	 Lower CO2 and methane (CH4) emissions from energy- intensive livestock systems and less food waste 	 Improve diets (less meat, more fruits and vegetables) which decreases risk of heart disease, stroke, colorectal cancer, diabetes and other diseases Improve food security Improve air quality by reducing CH4 emissions that contribute to ground-level ozone

Table 1: Highlights of Health Co-benefits of Climate Actions

(Source: Smith et al., 2014; WHO, 2011; WHO, 2018)

health, while reducing GHG emissions. Actions that increase the consumption of plant-based proteins, can reduce obesity and obesity-related chronic diseases, while reducing GHG emissions from the agricultural sector **(see also Table 1)**.

Health – Catalyst for Climate Action

Taking health and other co-benefits into account when deciding on the actions needed to implement climate solution makes the overall cost-effectiveness of these initiatives more visible. At times, the costs savings from health benefits alone can outweigh the costs of measures taken to reduce GHG emissions (Gouldson et al., 2018; Thompson et al, 2014; Markandya et al., 2018). This can make climate interventions more appealing to the public and decision-makers (Armstrong, 2012; Maibach et al., 2010; Workman, et al., 2018). This module provides information that the health community can use to strengthen the case for action on climate by highlighting the additional benefits to health that such action would bring.

Carbon Pricing Internalizes the Cost of GHG Emissions

Putting a price on carbon is a way to internalize the environmental and health cost created by the release of GHGs during the extraction, transportation, refining, and use of fossil fuels. It supports and complements sector-specific policies that will reduce the consumption of these fuels in Canada. Part of the revenues generated can also be used to facilitate the shift to a low-carbon economy and enable a just transition. At the same time, it is also necessary to ensure policy coherence and to remove subsidies and incentives that encourage the use of fossil fuels.

Health, Environment And Climate – The Connections **Our Air**

Health Canada (2017) estimates that air pollution in Canada results in 14,400 premature deaths per year. In addition, about 10 million Canadians – or 32 per cent of the population – live within 500 metres of highways or 100 metres from major urban roads, exposing them to higher levels of air pollution from traffic (Brauer et al., 2013).

Air Pollution & Fossil Fuels

In addition to GHGs, fossil fuels emit various air pollutants when burned. Air pol-

Between 1990 and 2016, emissions from transportation increased by 42% ... while emissions from the oil and gas sector increased by 70%

lution is linked to a wide range of adverse health outcomes including heart and lung disease, cancer in children, lung cancer, adverse birth outcomes, neurodevelopmental impacts, reduced cognitive function, dementia, and chronic conditions such as diabetes (TPH, 2014; Toronto 2017).

Chronic exposure to fine particulate matter (PM2.5) from the burning of fossil fuels, a major component of air pollution, is estimated to result in 7142 premature deaths per year in Canada with welfare-related costs valued at \$53.5 billion:

- 345 of those deaths were attributed to coal-fired power plants,
- 105 to coal-related industries,
- 2762 to non-coal industries,
- 1063 to land-based transportation, and
- 1282 to the agricultural sector (Howard et al., 2018)

Fossil Fuel Extraction & Health

An air monitoring study conducted by Environment Canada found that pollution from the Alberta oil sands resulted in the creation of 45–84 tonnes per day of airborne particulate matter (PM). This compares to 67 tonnes per day from the greater Toronto area as a whole. The oil sands contribute a large proportion of PM in Edmonton's air and this pollution can travel as far as Ontario (Chung, 2016; Liggio et al., 2016).



Figure 1: Premature deaths per year in Canada attributed to particulate matter air pollution.

There is mounting evidence of the adverse impacts of shale gas drilling (fracking). Pollutants from shale gas development include diesel PM, nitrogen oxides, hydrogen sulfide, volatile organic compounds and radon. Studies have found that emissions from gas wells can result in concentrations of air pollutants that exceed exposure guidelines for both carcinogenic and non-carcinogenic health risks. Fracking can also contaminate surface and groundwater (Glauser, 2014; Shonkoff et al. 2014).

Sources of Methane

The production, distribution and use of oil and gas also releases methane (CH_4) , a short-lived climate pollutant with 84 times the warming potential of CO_2 . Agriculture and food waste are also major sources of methane (Scovronick et al., 2015). In addition to being a GHG, methane contributes to the formation of ground-level ozone. Ground-level ozone contributes to a wide-range of adverse



Fossil fuel pump. Photo provided by Thinkstock.

impacts including: an increase in respiratory and cardiorespiratory mortality; an increase in asthma incidence and severity; adverse impacts on lung function growth, cognitive development and reproductive health, including preterm birth (TPH, 2014). In addition, the switch away from fossil fuels could result in less crop damage from ground-level ozone and fewer occupational injuries (WHO, 2018).

These emissions can be reduced through the recovery and use of methane from coal mines and in oil and natural gas production and distribution. While flaring of methane from oil and gas production reduces the climate impact, it creates black carbon and other air pollutants including hydrogen sulphide and various volatile organic compounds such as benzene, toluene, ethyl-benzene and xylene that are of concern for health (CAPE, 2018; Scovronick et al., 2015).

Our Communities

Chronic diseases like diabetes, cancer and cardiovascular disease are the leading causes of death in Canada. Unhealthy diets, low physical activity, and higher rates of overweight and obesity are contributing factors to these (Tam, 2017).

Obesity & Health

Obesity increases the risk for premature death and chronic diseases, such as cardiovascular disease, cancer and diabetes. In Canada more than one quarter (25%) of people 18 years and older were living with obesity in 2015 (Tam, 2017). A study that looked at eight chronic diseases estimated the cost associated with obesity in Canada to be \$4.6 billion in 2008. Another study that considered 18 diseases put that cost at \$7.1 billion per year (PHAC and CIHI, 2011).

Many factors influence the prevalence of obesity. Transportation systems, urban design, land use, and food systems, which have a strong impact on GHG emissions, have a significant impact on obesity by influencing levels of physical activity and diet (Lowe, 2014; Swinburn et al., 2019).

Physical Activity & Health

Physical activity is associated with improved heart and mental health, healthy child development and aging, and reduced risk of premature deaths and various health conditions such as obesity, some cancers, diabetes, dementia and osteoporosis (Tam, 2017). The cost of physical inactivity in Canada was estimated at \$6.8 billion in 2009 or 3.7% of health care costs. In 2013 only 10% of Canadian children and youth and 20% of Canadian adults met the Canadian Physical Activity Guidelines of a minimum of 60 minutes of moderate- to vigorous-intensity activity per day for children, and 150 minutes of moderate to vigorous physical activity each week for adults aged 18 and over (Tam, 2017; TPH 2012).

Community Design & Health

About three quarters of Canadians live in cities of 100,000 people or more. Improving the design of our communities can help reduce the rates of chronic diseases in Canada (Tam, 2017). Active neighbourhood design promotes physical activity and reduces dependence on automobile travel which reduces emissions of GHGs. At the same time, these neighbourhoods can improve access to nutritious foods, which are less carbon intensive in their production. Cities can curb GHG emissions by reducing energy use through changes in the urban fabric - housing, transit, land use, buildings. Reducing the distance between home, workplace, services and other amenities as well as improving transit and active

transportation infrastructure help reduce the demand for automobile travel and thereby reduce transport-related emissions (Cohen, 2018; Tam, 2017).

Our Food

In the past 50 years, there have been large changes in both the way food is produced and what people eat. While these changes have improved access to food, they have also been accompanied by a shift to unhealthy diets that are calorie-dense, highly-processed, with a high proportion of animal products (Willett et al, 2019).

Factors that have promoted this shift in diets are numerous and intertwined. They include rapid urbanisation, increasing incomes, inadequate access to nutritious foods, and fiscal and agricultural policies (Lowe, 2014; Willett et al., 2019; Swinburn et al., 2019). This change in diets is contributing to the increasing burden of obesity and diet-related chronic diseases and environmental degradation, including climate change.

Healthy Diets & Climate

Studies that have analysed measures to reduce GHG emissions associated with food production have concluded that dietary changes towards diets rich in plant-derived foods and reduction in food waste would have the largest impact on GHG emissions (Ranganathan et al., 2016; Willet et al., 2019). Such a shift would promote health by shifting food consumption patterns to conform with guidelines for a healthy diet and improve cardiovascular health (Friel et al., 2009; TPH, 2017; Health Canada, 2019).

Where Canada Stands

Canada's 2018 GHG inventory reports emissions of 704 megatonnes (Mt) of GHGs (CO₂eq). This is a 3.8% decrease GHG emission between 2005 and 2016 instead of the 15% needed. The two top emitting sectors were the oil and gas sector which was responsible for 26% of total emissions (183 Mt CO₂eq¹) and the transportation sector which was responsible for 25% of total emissions (173 Mt). Emissions from other sectors ranged from 6 to 12% (41 to 81 Mt). The transportation sector was the largest contributing sector in eight of the provinces/territories (ECCC, 2018c). (See Module 4 for more details on emissions.)

Emissions in 2016 were more than 100 Mt higher than GHG emissions in 1990. While there have been decreases in emissions from electricity generation, heavy industry and waste, emissions have increased from vehicle travel, the production of crude oil, and the expansion of the oil sands. During this period, emissions from transportation increased by 42% while emissions from the oil and gas sector increased by 70% CO_2 eq (ECCC, 2018c).

Canada has made some initial steps. In



The coal industry. Photo by Sam Jotham Sutharson on Unsplash

2015, the Canadian government indicated that it would reduce its GHG emissions by 30% of 2005 levels by 2030. Coal-fired power plants are scheduled to be closed by 2030 and there is a commitment to have 90% electricity generation from non-emitting sources by 2030. The federal government has instituted a carbon tax and many provinces and territories have introduced various carbon-pricing schemes. Improved fuel vehicle efficiency and energy efficiency requirements in appliance and buildings are among other initiatives that will reduce GHG emissions. However much more needs to be done, especially to address emissions from transportation and the oil and gas sector, if Canada is to achieve "net-zero" GHG emissions by 2050 as the

IPCC (2019) has identified as necessary.

Energy Production Energy Transition

As the IPCC (2019) special report indicates an accelerated shift to non-carbon sources of energy is needed if average global warming is to be limited to well below 2°C. These include renewable energy such as wind and solar, geothermal energy, and micro-hydro². In addition, smart grids, distributed/decentralised energy production, and increased energy productivity/efficiency are needed. During the transition, control of methane releases and the elimination of flaring from oil and gas production will also reduce the carbon footprint of energy production.

The transition to a low-carbon economy requires changes to the global energy system. In addition to carbon pricing, governments have a role in accelerating the creation of sustainable markets for low-carbon technologies and preventing investment in high-polluting technologies. Policies that support innovation, removal of institutional barriers, public spending reallocations, and policies that encourage investment in low-carbon infrastructure can contribute to the transition (IEA, 2015; OECD and World Bank, 2015).

Health & Coal Phase-Out

Coal-fired electricity releases more air pollutants, GHGs, and mercury than any

Biofuels are not necessarily low carbon.

While wastes, winter cover crops and sustainable forestry can be sources of biofuels, large scale conversion of land to crops for biofuels competes with land needed for food production and increases pressures to clear forests and other natural ecosystems for agriculture. "Avoiding increased use of bioenergy from energy and food crops is critical to a sustainable food future... Governments should phase out subsidies currently in place for bioenergy that is grown on dedicated land. Governments also need to correct 'flawed accounting' in renewable energy directives and emissions trading laws that treat bioenergy as 'carbon-neutral'" (Searchinger et al., 2018).

other source of electricity. The Pembina Institute estimated that if all Canada's coal-fired plants were shut down after 40 years of operation (rather than 50) or by 2030, whichever was sooner, and coal power was replaced by two thirds renewables and one third best-in-class gas-power, additional health benefits valued at \$5 billion would be created and GHG emissions would be reduced by an additional 31 Mt CO₂eq (Israël and Flanagan, 2016). The associated reduction in mercury emissions would result in \$1.3 billion in health-related benefits. Encouraged by the advocacy work of CAPE, the Pembina Institute and environmental groups in Saskatchewan, New Brunswick and Nova Scotia over the last four years,

the federal government has passed legislation to phase-out of coal-fired power plants by 2030 (ECCC, 2018a).

Health & Low-carbon Energy

A report from the New Climate Institute estimated the co-benefits of climate action for the United States. It found that by 2030, current US commitments would prevent around 7,000 air pollution-related premature deaths each year and create an additional 470,000 full-time equivalent green jobs in the domestic renewable energy sector. It also found that if the US made the commitments required to meet the 2°C Paris Agreement target, an additional 20,000 air pollution-related premature deaths each year would be avoided and an additional 180,000 full-time equivalent green jobs would be created (Höhne et al., 2015).

Jacobson and colleagues (2017) explored the rapid transition to 80% wind, water and solar energy by 2030 and 100% by 2050 for 139 countries. They estimated that by 2050, such a shift could lead to USD \$110 billion savings in annual health costs or nearly 4% of GDP, including a reduction of about 9,900 air pollution-related deaths in Canada. The cost of this investment could be recovered from the savings related to reduced air pollution and climate impacts in 4.1 years.

Beware - Low-Carbon Fuels

Transition away from fossil fuels can be associated with new or different challenges in environmental and health protection that require consideration and planning for mitigation. Conflicts can arise between climate change mitigation and air quality. For example, the use of diesel engines has been promoted because it emits less CO₂ than gasoline, but it contributes more to local air pollution. Similarly, the use of biofuel emits air pollutants which can impact local air quality (Scovronick et al., 2015). There are also concerns with methane emissions from large hydropower dams (Magill, 2014). Renewable energy technologies such as batteries and solar panels can expose workers to nano-materials and certain toxic materials. They also create wastes at the end of their life-cycle that need to be managed appropriately (Scovronick et al., 2015).

Energy Conservation

Conservation reduces the demand for energy. This means less energy needs to be produced which reduces pollution related to both production and use. It also reduces the overall need for power generation making the transition to renewable energy easier. In addition, meeting energy needs through energy efficiency is often cheaper than building new power supply (Castro-Alvarez et al., 2018).

Untapped Potential in Canada

The International Energy Agency (IEA 2018) indicates that the Canadian energy system has large energy efficiency savings potential, especially in buildings, transportation and industry. For the past 15 years, energy demand has grown by an average of 0.8% per year. Without additional policies energy demand is expected to continue to grow at this rate. IEA (2018) projects that under current policies, GHG emissions in Canada would be 17.5% higher in 2050 than in 2016. Emission reductions modelled for Canada, based on economically and technically feasible energy efficiency investments alone, would result in a 30% decrease of GHG emissions in 2050 compared to 2016. More than 90% of avoided energy demand would be from reduced use of oil and gas (IEA, 2018).

Reducing Energy Use from Buildings

Buildings in Canada use about one third of primary energy production (IEA, 2018)³. Opportunities to reduce emissions include: increasing energy efficiency of buildings, lighting, appliances, and other energy-using equipment; requirements for net-zero energy ready buildings; passive energy design; green roofs; reusing



Solar Panel - Haliburton, ON. Photo by Kim Perrotta.

or renovating buildings rather than demolition to build new; retrofitting existing buildings; improving heating, ventilation and air conditioning (HVAC) systems, including district energy; installing more efficient water heaters; and improved lighting, automation and controls (Day et al., 2018; IEA, 2018; Scovronick et al., 2015).

IEA (2018) estimates that compared to today, by 2050 it would be possible to reduce GHG emissions from buildings by 60%. Emissions reductions would be achieved as households switch away from oil- and gas-based heating towards high-efficiency, electricity-based technologies. Improved building envelopes and switching to electric heat pumps could reduce space heating energy requirements by 85% by 2050 (IEA, 2018). Requirements for public disclosure of energy ratings of buildings could serve as an incentive to improve performance. Increasing urban density, reducing the amount of floor space per occupant in homes and businesses, and decentralisation of energy production which reduces transmission losses, would also reduce energy requirements (IEA, 2018).

Health Benefits & Indoor Environment

Energy retrofit measures that reduce exposure to extreme heat, cold, mould and dampness and improve indoor air quality through better ventilation can reduce the risk of cardiovascular disease, strokes, asthma and other respiratory diseases. Immediate health gains of low-carbon housing include reduced energy costs to households, including reduced energy poverty, reduced illness, fewer medical visits and sick days off work and school (Thomson et al., 2013; Vardoulakis et al., 2015; WHO, 2011a). Interventions that improve thermal comfort lead to better general health, respiratory health, and mental health especially among people with chronic respiratory disease or with inadequate heating (Thomson et al., 2013; Scovronick et al., 2015).

An assessment of strategies to reduce GHG emissions from housing in the UK housing found that overall these would benefit health (Wilkinson et al., 2009). A strategy that combined improvements to the building envelope and ventilation, fuel switching, and behavioural changes was estimated to result in 850 fewer disability-adjusted life-years (DALYs) and a saving of 0.6 Mt of GHGs per million people per year. Another modelling study of building envelope and ventilation retrofits installed with adequate ventilation estimated a reduction in net mortality and morbidity of 2,241 quality-adjusted lifeyears (QALYs) per 10,000 persons over 50 years in England (Hamilton et al., 2015).

Health Benefits & Outdoor Air Quality

In addition to reducing energy costs, building energy efficiency measures improve outdoor air quality that are estimated to be worth approximately 8 to 22% of the value of the energy savings. Improved insulation in US homes alone could reduce GHG emissions by 110 Mt and prevent 320 deaths per year, a benefit estimated to be equivalent to US\$12 to 390 per tonne of GHG reduced (Gouldson et al., 2015).

In the USA, LEED® certified buildings make up about 3.5% of commercial floor space. From 2000 to 2016, the improved environmental performance of these buildings is estimated to have accumulated US\$1.28 billion in climate-related benefits and \$2.68 billion in direct health benefits from reductions in air pollution. They prevented 172 to 405 premature deaths, 171 hospital admissions, 11,000 asthma exacerbations, 54,000 respiratory



Solar Panel on Multi-Unit Residence, Dundas, ON. Photo by Kim Perrotta.

symptoms, 21,000 lost days of work, and 16,000 lost days of school were during that period (MacNaughton et al., 2018).

Home Energy Retrofits & Energy Poverty

On average Canadian households spend around 3% of their income on energy. The National Energy Board (NEB) estimated that 8% of Canadian households spent more than 10% of their income on energy and thus were considered energy-poor in 2015. When the cost of fuel used for automobiles is included, the number of households classified as energy-poor doubles. Low-income households are twice as likely to experience energy poverty (IEA, 2018). Energy poverty is associated with an increased incidence of respiratory problems and mental stress. Children and the elderly are more vulnerable to these impacts. Improvements in the energy efficiency in housing and passenger cars allows households to meet energy needs at a lower cost, reducing the incidence of energy poverty. Low-income households are also likely to benefit most from improved energy efficiency of their homes (OECD and World Bank, 2015; WHO, 2011a).

Beware – Energy Retrofit Complications

It is necessary to ensure that energy retrofits are done properly; that adequate ventilation is maintained to prevent the risk of increasing concentrations of pollutants such as PM2.5, CO and radon and to avoid biological contamination such as mould (Vardoulakis et al., 2015). Improving energy efficiency of buildings, including heating and cooling, will also reduce pollution from electricity generation and heating fuel. However, such improvements can increase land and real estate values which then leads to population displacement and greater socio-economic disparities (Cohen, 2018).

In addition, market failure is a barrier to widespread adoption of energy efficiency in buildings. This includes inadequate information on the benefits and potential long-term savings. As well, an owner of a rental property may not benefit from energy efficiency improvements. Policies and programs need to be put in place to ensure that up-front costs of energy efficiency retrofits or installation of more efficient heating are not a barrier to adoption of measures especially for lower income households and small businesses (Kossoy et al., 2015; OECD and World Bank, 2015).

Transportation

Transportation is a major and increasing source of GHG in Canada and globally. As mentioned above, the transportation sector accounts for about 25% of total GHG emissions (ECCC, 2018c) and at least 1,063 air-pollution related premature deaths per year in Canada (Howard et al., 2018). Action taken to reduce GHG emissions from transportation can lower emissions of several air pollutants. The mag-



Streetcars on Spadina Avenue in Toronto. Photo by Kim Perrotta.

nitude of air quality co-benefits depends on the approach taken to reduce GHGs. Areas with more pollution would likely see greater co-benefits (USGCRP, 2018).

To successfully reduce the impact of transportation, there is a need to transition to low- or zero-emission vehicles, reduce the demand for motorised transportation, and shift a greater proportion of personal transportation to walking, cycling and transit (WHO, 2011b). Improved fuel efficiency in vehicles would also drive reductions of GHGs from transportation in Canada (IEA, 2018).

Reducing Emissions from Transportation

Improved fuel efficiency, low-emission vehicles such as hybrids, and electric vehicles are important ways to reduce the emissions of GHG emissions and air pollutants from the transportation sector. However, gains in efficiency can be lost as vehicle use and distance travelled increase. Therefore, it is equally important to reduce the distance travelled by motorized vehicles (Gouldson et al., 2018). An integrated approach to GHG emissions reduction, air quality improvement, and active travel will maximize the health benefits of actions taken (Brauer et al., 2013; Gouldson et al., 2018).

Approaches to promote greater active travel include: modifying existing infrastructure; changing land-use planning processes to integrate active city principles; transportation demand management for passenger, freight and commercial vehicles; and road or distance-based pricing. Setting ambitious walking, cycling and transit policies and targets can catalyze actions (Brauer et al., 2013; Day et al 2018; Rodier et al., 2014; TPH, 2012; TPH, 2014). (See CAPE's Active Travel Toolkit for resources on the health benefits of active travel.)

Benefits of Transportation Policies

Co-benefits of actions to reduce emissions of GHG emissions from transportation include: reduced exposure to traffic-related pollution especially along transportation corridors; reduced crop damage and extreme weather; increased physical activity; reduced noise; fewer vehicle-related injuries and deaths; greater equity of a less-car dependent transportation system (Brauer et al., 2013; WHO, 2018). The outdoor air quality, physical activity, congestion and travel time co-benefits of actions to reduce GHGs from transportation have been well studied. Fewer studies are available on the co-benefits related to indoor air quality, ambient noise, and motor vehicle crashes. Overall, studies show that climate actions are associated with positive health and economic co-benefits, with the greatest benefit related to the increase in physical activity (Gouldson et al., 2018).



An electric car outlet. Photo by John Cameron Unsplash.

Transit, Health & Climate

A 2014 study of the Greater Toronto and Hamilton Area (GTHA) examined the health benefit of transit improvement in the region that would require an investment of \$50 billion over 25 years (Mowatt et al., 2014). Without this investment, it was projected that emissions of PM2.5 and GHGs would increase by 27% and 30% respectively as traffic in the GHTA increased. It concluded that the transit investment could produce \$2.2 billion in health-related benefits per year and prevent 328 premature deaths per year by improving air quality and increasing physical activity in the GTHA.

A study of land use, transit, and vehicle pricing policies in California estimated that distance-based vehicle pricing could increase walking by about 10% and cycling by about 17% with a 16% reduction in GHG emissions. It also estimated that transit expansion and supportive development patterns could increase walking and cycling by 2-3% with a corresponding 4% decrease in vehicle distance traveled (Rodier et al., 2014).

Walking, Cycling & Health

Another study estimated that replacing short car trips with walking or cycling could help people meet physical activity guidelines and almost eliminate obesity in the US in the absence of dietary change and result in large reductions in GHG emissions (Higgins and Higgins, 2005 as cited in Lowe, 2014).

In 2006, 7.1% of trips in Toronto were taken by walking and 1.7% by cycling. It was estimated that these modes of transportation were preventing about 120



Urban cycling can help health and climate change. Photo by Photo by Viktor Kern on Unsplash.

deaths per year and producing health benefits valued at \$130 to \$478 million per year. Savings in direct medical costs arising from residents staying active by walking and cycling are estimated to provide a further economic benefit of \$110 to \$160 million per year. Measures that would increase walking and cycling would add to these benefits (TPH, 2012).

Active Travel, Health & Climate

The use of sustainable transportation approaches to climate mitigation can result in substantial health benefit. When Woodcock and colleagues (2009) examined different scenarios to reduce GHG emissions transportation in London, England, they concluded that a combination of lower-emission vehicles, reduced distance travelled, and increased active travel would maximise GHG emissions reductions. The shift to safe active travel provided more benefits to health than the adoption of low-emission vehicles alone. The authors estimated a reduction in 7,332 disability-adjusted life-years (DALYs) in one 1 year from increased active travel and 160 DALYs from the use of lower-emission motor vehicles; most of the health gains were related to reduction in ischaemic heart disease

(estimated to be between 10 and 19%).

Beware – Low Emission Vehicles

Historically, diesel has been promoted as a more climate friendly fuel than gasoline. Though use of diesel releases 20% less CO₂, diesel engines emit more nitrogen oxides (NO₂) and PM, including back carbon, resulting an increase in health risks (USGCRP, 2018). While electrical vehicles themselves do not emit carbon, if the electricity used is generated from coal or other fossil fuels, it may actually increase the release of GHG and air pollutants on a regional scale (Gouldson et al., 2018; Scovronick et al., 2015). Also, as noted above, gains related to increased fuel efficiency can be lost if vehicle use and distance travelled increase.

While electrical vehicles will reduce the amount of GHGs and air pollutants and noise emitted, it is equally important to reduce the amount of vehicle travel. In addition to particles in the exhaust, vehicles emit particles from the friction between the tires and the road, use of brakes and engine wear. A switch to electrical vehicles would likely result in only about 1-3% reduction in PM2.5 (Gouldson et al., 2018). Also important to consider is that while electric and other low-emission vehicles will reduce GHGs and air pollution, by themselves, they will not provide the added benefit of increased physical activity that compact, mixed-use communities promote (Cohen, 2018).

Community Design And Land Use

The shape of our communities, including its green space, influences how we travel and the amount of physical activity we engage in. This has an impact on both climate emissions and health. As mentioned above, climate interventions that encourage more active travel will provide the most health benefits.

Community Design & Climate

The features of neighbourhood a person lives in influences the amount of GHGs emitted. Studies that have compared low-density development to high-density ones find that more compact communities use less energy, release fewer GHGs, and are less dependent on car for travel. An assessment of the proposed redevelopment of the West Don Lands neighbourhood in Toronto showed that transforming the area into a walkable neighbourhood would reduce GHG emissions from vehicle use by 60% compared to a low-density neighbourhood (TPH and UD4H, 2013).

A study of households' emissions in Toronto and the surrounding area



Sparks Street in Ottawa. Photo by Tony Webster.

found the lowest emissions were 1.31 t CO₂eq per capita for a dense inner-city neighbourhood with good access to public transportation, compared to 13.02 t CO₂eq per capita in an outlying suburban area (Vande-Weghe and Kennedy, 2007). It also found large variations within Toronto itself; census tracts in wealthy neighbourhoods, characterized by high automobile use and older, inefficient homes, had emissions as high as those of the suburbs. This suggests the neighbourhood and home people live in are important factors that influence a household's GHG emissions.

A study by the Urban Land Institute

(ULI) showed that more compact development designed for lower reliance on automobiles could reduce vehicle distance travelled by 20-40%; residents of the most walkable neighborhoods drove 26 percent less than those living in more sprawling neighbourhoods (Flatow, undated).

Another study found that in employment areas with 50 to 75 employees per hectare (20-30 per acre) 90 percent of the employees use single-occupancy vehicles as their main source of transportation, while with densities of 300 employees per hectare (125 per acre), 65 percent of employees take public transit or walk to work. A shift from travel in automobiles to walking or transit occurs when residential densities are above 32 people per hectare (13 per acre) (Frank and Pivo, 1994).

A travel survey in the Québec City Region found that residents in the city centre (the highest residential density) had the lowest travel-related emissions. Residents living in the older denser suburbs, newer suburbs, and the least dense periphery produced 19%, 27%, and 70% more emissions respectively. A 10% increase in density was associated with a 1.2% reduction in emissions (Barla et al., 2011 as



Park in Halifax, Nova Scotia. Photo by Kim Perrotta.

cited in Sallis and Spoon, 2015).

Mixed Land Uses & Climate

A study in the Puget Sound region (Washington State) found that greater residential density, land use mix and intersection density were associated with lower GHG emissions. A doubling of these factors was estimated to reduce transportation emissions by about 31 to 34% (Hong and Goodchild, 2014 as cited in Sallis and Spoon, 2015).

Various studies have compared residents of suburban neighbourhoods to residents of more urban neighbourhoods. These studies indicate that urban residents make twice as many trips walking, mostly for utilitarian travel (Gouldson et al., 2018). Levels of walking and cycling among residents of Toronto's core, which has a higher population density and shorter distances to local shops and services, are over three times higher than among residents of the suburbs (TPH, 2012).

Communities that are more walkable, have cycling infrastructure, and easy access to transit make it easier for people to get around through active modes of transportation (Designed to Move, 2015; TPH et al., 2014). (See CAPE's Active Travel Toolkit for more information and resources on how community design can affect active travel.)

Community Design & Health

In a health impact assessment of six cities, in which land-use density and diversity were increased and distances to public transport decreased, modelling predicted a reduction in diabetes, cardiovascular disease, and respiratory disease. The overall estimated health gains were 420-826 DALYs per 100,000 people. The modelling also showed a small increase in road trauma for cyclists and pedestrians (health loss of between 34 and 41 DALYs per 100,000 population) in moderate to highly motorized cities such as Melbourne, London, and Bos-

Example: City of Freiburg, Germany:

Over the past three decades, interventions in the City of Freiburg (Germany) tripled the number of bicycle trips, doubled public transport ridership, and decreased the share of trips by automobile from 38% to 32%, which has significantly reduced GHG emissions from transportation in the city. This was accomplished through the implementation of a number of transport and land-use policies which have encouraged more walking, cycling and public transport use. An extensive network of bicycle paths and lanes was built, thousands of bicycle parking spots were created, and the city centre became a pedestrian only zone. Transit was expanded and a land-use plan adopted that identified areas around public transport stops as places for higher density development. The city also introduced a transferable flat-rate monthly public transport pass (Buehler and Pucher, 2011).

ton (Gouldson et al., 2018). A review of the literature indicates that the health benefit of dedicated bike lanes ranges between USD\$0.33-1.45 per kilometre (Gouldson et al., 2018).

Green Spaces, Climate & Health

Improving urban green spaces not only helps cities adapt to climate change it also contributes to climate mitigation. Urban greenery and tree canopies sequester and store carbon and by their cooling effects reduce energy use (Gouldson et al., 2018). There is increasing evidence of the health benefits of urban and peri-urban green space, including natural areas.

Green spaces such as parks or sports fields facilitate physical activity and relaxation. They can also provide safe routes for walking and cycling, either for travel or recreation, and may reduce child pedestrian injuries. They are associated with neighbourhood social cohesion and reductions in crime and violence. Additional benefits of urban green space include reduced exposure to noise and air pollution, reduced cardiovascular disease, depression, anxiety, and stress. Green spaces may also reduce health disparities as people living in deprived neighbourhoods benefit more from their presence (Gouldson et al., 2018; Scovronick et al., 2015, WHO, 2016).

A study in Toronto found that the health benefit of living in a neighbourhood with 10 more street trees was equivalent to the health benefit of having an extra \$10,000 in income per year. People living in the more treed areas had better self-reported health and fewer cardio-metabolic conditions (Kardan et al., 2015). Urban forests within Halifax, Montreal Vancouver and Toronto provide environmental benefits of over \$330 million per year. For example, the value of a tree in Toronto was estimated to be \$7.95 per year, of which \$1.87 was due to air quality improvements, \$0.12 to carbon sequestration and \$0.06 for reduction in energy-related pollution (Alexander and DePratto, 2014).

Beware - Community Design Complications

Increasing density may have some negative consequences. These include increased traffic congestion, increased risk of flooding due to reduced capacity to absorb rainfall, less green space and increased noise and air pollution (Gouldson et al., 2018).

Overall the health benefits of cycling more than outweigh the increased exposure to air pollution or the risk of collisions. Providing designated routes away from the roadside and/or ensuring that these shifts are made at large scales sufficient to reduce air pollution levels would reduce these risks. Providing safe walking and cycling infrastructure, such as protected cycle lanes, can also reduce the risk of collisions. Once active travel mode shares are high enough (20%), risks of collision are expected to decrease due to the "safety in number" effect (Gouldson et al., 2018).

The potential adverse impact of mix-use

and density on road safety can be reduced by implementing road safety measures and increasing the availability of playgrounds, recreation facilities, parks, and open space. Overall if an integrated approach is taken that reduces traffic volumes and major thoroughfares, increases transit service, and provides safety measures to protect more vulnerable users, than this should result increased travel safety and reduced collisions (Gouldson et al., 2018).

While tree cover can reduce exposures to air pollution, in certain configurations, trees can trap the pollution in the breathing zone of people by reducing wind speeds and ventilation along street canyons (Scovronick et al., 2015). While urban greening may decrease health disparities, it may result in higher housing costs that reduce affordability (Gouldson et al., 2018).

Given the evidence that dense urban neighbourhoods with low carbon footprints are those that include both affordable housing and good access to transit, it is important to address these pressures which help cities reduce emissions while increasing quality of life (Cohen, 2018).

Promoting Climate-friendly Agriculture

To reduce the cost to farmers and consumers, fuels used in farming or fishing in Canada have been exempt from fuel taxes and are also exempt from the carbon tax (Canada, 2018a).

"Some farmers, particularly in the Prairies, are using different techniques that keep carbon in the soil. One witness estimated the value of this trapped or "sequestered" carbon at \$1 billion, if carbon dioxide were valued at \$15 a tonne" (Canada, 2018b).

If fuel tax exemptions were replaced by incentives for carbon sequestration, this would contribute to climate action in two ways – encouraging a reduction in fuel use and increasing the incentive for farmers to sequester carbon.

Agriculture And Food

In 2014, Canada's agriculture and agrifood sector accounted for 6.7% of Canada's gross domestic product (GDP) and one in eight (12.5%) jobs in Canada, employing 2.3 million people. Half of this sector's GHGs come from livestock, with the rest from crops and on-farm energy and transport (Canada, 2018b).

Climate Change & Food Production

The relationship between climate and food is multi-faceted. On one side, chang-

es in the climate impacts agricultural production, and on the other, the way food is produced, how it is transported, the type of food that is eaten, and the amount that is wasted, contribute to climate change (Ranganathan et al., 2016; TPH, 2017). Globally, agriculture uses about 70% of freshwater, around 40% of land, and contributes up to 30% of greenhouse-gas emissions (Willett et al., 2019). The main GHGs from agricultural production are short-lived climate pollutants – methane and nitrous oxide (Scovronick et al., 2015).

There is a wide range of estimates of the contribution of agriculture and food to global GHG emissions (15-30%). Estimates that include onfarm energy use, land use change, food distribution, processing, retail, preparation and/or waste attribute a larger proportion of total GHGs to the food and agriculture sector (Willett et al., 2019; Swinburn et al., 2019).

Food & Climate

Emissions from agriculture (livestock and crop production) and forestry accounted for about 10% of Canada's GHG emissions in 2014. These are projected to remain relatively constant until 2030 (Canada, 2016). The EAT-Lancet Commission and the World Resources Institute both indicate that achieving healthy diets for everyone requires a shift to healthy diets, with large reductions in food losses and waste, preservation of ecosystems and improvements in food production practices (Searchinger et al., 2018; Willet et al., 2019).

The World Resources Institute estimates that the average American diet causes emissions of nearly 17 t CO_2 eq per year – similar to the per capita emissions from energy use in the United States. While beef provide just 3% of calories, the production of beef uses about half of land-use and releases about half of the GHG emissions related to diets. Simply moving from eating beef, veal, or lamb to chicken or pork would greatly reduce GHG emissions (Searchinger et al., 2018). **(See Figure 2)**

Increasing the consumption of plant-derived foods while reducing meat, as appropriate, is an affordable approach to improving nutrition (TPH, 2017). The EAT-Lancet Commission identified a healthy diet as one that is rich in fruits, vegetables, and plant proteins with some animal proteins. Such a diet would mean more than a 50% global re-



Figure 2: Impact of different diets on land use and carbon emissions Source: https://www.wri.org/ blog/2016/04/sustainable-diets-what-you-need-know-12-charts

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duction in consumption of unhealthy foods, such as red meat and sugar, and a 100% increase in consumption of healthier alternatives, including fruits, nuts, vegetables, and legumes (Willet et al., 2019).

Food & Health

Canadians eat more meat and fewer vegetables and fruits than is recommended for health. Lowering meat intake and increasing intake of foods of plant origin would be beneficial for the health of many people in Canada. Foods of plant origin are health protective in many ways and plant proteins, including pulses, legumes, nuts, and seeds, are good sources of magnesium, fibre, and unsaturated fats (TPH, 2017).



Child holding blueberry. Photo by Markus Spiske on Unsplash.

An assessment of diets in different regions of the world found that moving towards diets rich in plant-derived foods could reduce global mortality by 6 to 10% and food-related GHG emissions by 29 to 70% by 2050 (Springmann et al, 2016; Willet et al., 2019).

Milner and colleagues (2015) concluded that if the average UK dietary intake were optimised to comply with the WHO recommendations, it would reduce GHG emissions by 17%, and save almost 7 million years of life lost prematurely in the UK over the next 30 years and increase average life expectancy by over eight months. Greater reductions in GHGs with additional benefits to health would also be possible with a more substantial change in diets. However, diets that would reduce GHG emission reductions by more than 40% could compromise health by reducing the variety of foods eaten and limiting intake of healthy foods such as fruits and nuts. Aleksandrowicz and colleagues (2016) reviewed the available evidence and concluded that a higher reduction in GHGs is possible - as high as 70-80%.

Food Waste & Climate

Food loss and food waste occur at the production, handling and storage, processing, distribution and marketing and consumption stage. This loss and waste contribute to emissions of GHG – from the use of fossil fuels during the production and handling of food to the creation of methane when waste food is disposed in landfills, the most common form of waste disposal in Canada (Boston et al., 2017). In Canada, landfill disposal contributes about 4% of GHGs, most of which is due to food waste.

In Canada, one third of food produced for human consumption is wasted: consumers account for 47% of this waste. The other 53% of wasted food is generated along the value chain when food is produced, processed, transported, sold, and prepared and served in commercial and institutional settings. About 60% of the food that is thrown out could have been eaten and considered avoidable food waste. Avoidable food waste can increase the cost of food by 10% or more (Boston et al., 2017; Gooch and Felfel, 2014).

Supportive Policies Carbon Pricing Encourages Transformation

There is broad agreement that putting a price on carbon is essential if we are to transition to a low-carbon economy.

"Carbon pricing helps level the playing field between activities that impose climate change damages and low- or zero-emissions activities that

Approaches to Carbon Pricing

There are essentially two approaches to carbon pricing – a carbon tax and emissions trading (also known as cap and trade). They can be used independently or in combination.

- A carbon tax sets a price on carbon emissions but does not set a target for the quantity of GHG emissions allowed. While they are no assurances that emissions will reduce, it provides more certainty on the price of carbon which helps businesses and others plan their investments accordingly. It is relatively easy to administer.
- An emission trading system (ETS) sets the maximum release of GHG that is allowed but does not set a price, which is set by the market. While it provides more certainty on the reductions to be achieved, the cost can fluctuate very widely. It is more difficult to administer and usually limited to certain industrial sectors of the economy.

Regulations that set performance standards or limits on GHG emissions indirectly increase the price on carbon (Kossoy et al., 2015; OECD and World Bank, 2015).

do not. [Emphasis added] Carbon prices can gradually lead to structural transformations by enhancing the competitiveness of low-carbon firms and increasing the costs of emissions-intensive activities. Ensuring that carbon pricing schemes are fair requires policies and temporary protection measures that support a smooth transition for affected people" (OECD and World Bank, 2015: p.4).

The Canadian government has set a carbon price of \$10 per t CO2eq in 2018 that will increase to \$50 in 2022 (Canada, 2018a). While progress is being made globally, the carbon price in most jurisdictions, including Canada, are substantially lower than those needed to be consistent with the goal of the Paris Agreement. Various factors, including the make up of a national economy and the cost of alternative energy, influence the rate needed for a carbon tax to be effective in reaching the desired reduction in GHG emissions. Higher carbon prices will be needed to meet the 1.5°C global warming target. According to the High-Level Commission on Carbon Prices (2017), to meet the goals of the Paris Agreement, prices would need to be in the range of US\$40-80 per t CO₂eq by 2020, rising to US\$50-100 per t CO₂eq by 2030, as long as they were accompanied by other supportive policies (World Bank and Ecofys, 2018).⁴

Carbon Pricing, Economy & Equity

A common perception is that carbon pricing, either through a carbon tax or emissions trading scheme, will have a negative impact on the economy. Early evidence from California, British Columbia, and Québec suggests that the adoption of carbon pricing does not impede industrial growth, nor result in a shift of production to other jurisdictions (Carbon Pricing Leadership Coalition, 2016). In British Columbia the tax resulted in 5-15% reduction in GHG with no negative impact on the economic growth (Narassimhan et al., 2017). Sweden, which introduced a carbon tax in 1991 that is now approximately US\$125 per tonne, has seen its GDP increase by 78% while GHG emissions decreased by 26% since that time (Sweden, 2019).

Concerns about equity impacts can be a barrier to the adoption of carbon pricing. However, negative effects can be mitigated through effective policy design and revenue redistribution. For example, British Columbia provides a tax credit for low-income households. A review found that, on average, the Low-Income Climate Action tax credit received was more

Taking into account uncollected tax on externalized costs such as air pollution, carbon emissions, transport fuels, and traffic congestion, the International Monetary Fund (IMF) estimated that Canada's fossil fuel subsidies were effectively \$26 billion in 2011, \$34 billion in 2013 and \$46.4 billion in 2015 (Climate Scorecard, 2018; Touchette, 2015). than the amount paid in the carbon tax by low-income households, making them better off overall (Kossoy et al., 2015; OECD and World Bank, 2015).

Fossil Fuels Subsidies

A price on carbon will encourage reduction in the use of fossil fuels and act as an incentive to invest and deploy lower-emitting sources of energy, including renewable energy. In contrast, fossil fuel subsidies and other incentives that encourage fossil fuel use, slow the transition to a low-carbon economy. Misaligned or counter-productive policies undermine the intent of carbon pricing and need to be scaled back. This will then provide a consistent signal to consumers, producers and investors (Funkhouser, 2018; World Bank and OECD, 2015).

While subsidies to the fossil fuel industry are declining, they continue to be substantial and larger than subsidies to renewable energy (Shirai and Adam, 2017). Between 2013-2015 Canada paid an average of \$3.314 billion per year to the oil and gas industry in various forms of incentives or subsidies associated with production, field development, extraction, and exploration (Climate Scorecard, 2018).

Policies Harmful to Climate & Health

Current regulations as well as economic and financial policies continue to privilege carbon-intensive activities, rather than promoting sustainable development. Policies that reduce the cost of energy, especially fossil fuels, increase energy demand and associated GHG emissions. Other examples of climate-harmful subsidies include incentives for gas and diesel vehicle production, parking provisions, and agricultural support for animal husbandry (NCE, 2018; OECD and World Bank, 2015).

Over the last 70 years, urban planning,

The majority of emission reductions need to come from individuals and countries that have the highest emissions.

The World Bank (2019) estimates that in 2014 global GHG emissions were 4.97 tCO₂eq per person, while in Canada 15.12 tCO₂eq per person.

Oxfam (2105) estimated that the richest 10% of people were responsible for 49% of global emissions, while the poorest 50% released only about 10% of GHGs.

Just Transition Task Force

In 2018, the Canadian government created a Task Force on the Just Transition for Canadian Coal-Power Workers and Communities. A "just transition" aims to minimize the impact on workers and communities in the transition to a low-carbon economy. It involves workers and their communities to enable them to succeed and benefit from the transition (ECCC, 2018b).

transport and fiscal policies have all contributed to communities that make people reliant on automobiles for transportation. Fiscal policies, such as development charges, low fuel excise tax, and assistance to automotive and oil and gas industries, have encouraged automobile and fossil fuel use, as well as the creation of low-density communities (Blais, 2011; Gouldson et al., 2018; Lowe, 2014; Sewell, 2009).

Coady and colleagues (2017) estimated that on a global level, subsidies (including the cost of externalities) were 6.5% of global GDP at \$4.9 trillion in 2013 and \$5.3 trillion in 2015. Of these, 22% were societal costs of climate change and 46% were the costs of air pollution. Had such subsidies not been in place, global GHG emissions in 2013 could have been 21% lower and deaths from air pollution related to the use of fossil fuel 55% lower. At the same time, government revenues and social welfare would have increased by 4% and 2.2% of global GDP, respectively.

Ensuring a Just Transition: Fairness & Climate Reductions

To address fairness, it is important to know who is responsible for the GHG emisisons: Is it the producer or the consumer of the product or service? It could be argued that the consumer should bear this responsibility. However, producers also benefit from income or revenues related to their activities.

In addition, people or organisations have more control over emissions they control directly compared to indirect emissions such as those released during the production and distribution of a good or service. This suggests a joint-responsibility between producers and consumers. It is important that people and organizations who benefit from the production and consumption of goods and services that release GHGs each take their full share of the responsibility.

GHG Emissions Per Person

GHG emissions can be estimated based on production or consumption. The IPCC



Wind turbine by the ocean. Photo by Anna Jiménez Calaf on Unsplash.

compiles information on emissions from production which is useful to estimate the total amount of GHGs released into the atmosphere. From a production perspective, GHG emissions emitted per person (i.e. per capita) in Canada vary widely. Canada's average per capita GHG emissions was 20 t CO₂eq in 2016. Quebec had the lowest per capita emissions at 9.5 t CO₂eq while Saskatchewan had the highest at $69.5 \text{ t } \text{CO}_2 \text{eq}$. The high per-capita emissions of Alberta and Saskatchewan reflect the GHG emissions from the oil and gas sector in those provinces; for products which are mostly exported. So, the per-capita GHG emissions in these provinces reflect the heavy emissions from industries in these provinces rather than from individual households.

A different measure is the carbon footprint which estimates releases of GHGs due to consumption. It takes into account both the emissions produced directly (for example fuel used) and those that were released during the production of the goods or services consumed (the emissions used during the extraction, refining, and distribution of the fuel) (Hoornweg et al., 2011). There is a strong association between income and carbon footprint: people and societies that have higher incomes have larger footprints (Simas et al., 2017; Wiedmann et al., 2015). Growing income inequality that is occurring increases this inequity (Kenner, 2016).

Transition to Low-Carbon Economy

The phase-out of fossil fuels will have major impacts on people and families involved in the fossil fuel industry, as well as communities where industry facilities are located. By using some of the revenues from carbon pricing and savings from the elimination of subsidies, we can ease the transition for workers and foster economic diversification to transform the economies in their communities.

An Energy Transition Plan can provide a framework for strategic assistance, retraining and targeted social protection that will be needed. Involvement of energy companies, workers, and civil society in this process will also facilitate the transition (Gerasimchuk et al., 2018; NCE, 2018).

Potential for New Opportunities

The transition to a low-carbon economy, if managed well, offers the potential for new opportunities; it can support economic diversification, the creation of decent jobs, and more equitable growth. For example, in Australia's Port Augusta, workers were able to get an agreement to replace a dying coal-fired power station with a solar thermal plant. This allowed local energy workers to transfer their skills to the new technology and the community to remain an energy hub (NCE, 2018). As the Lancet Commission on health and climate change noted in its report: "Achieving a decarbonised global economy and securing the public health benefits it offers is no longer primarily a technical or economic question - it is now a political one" (Watts et al, 2015: p.1862).

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Endnotes

- 1. CO₂eq: Carbon dioxide equivalent converts greenhouse gases to the same warming potential as CO₂
- 2. Micro-hydro is a type of hydroelectric power that typically produces from 5 kW to 100 kW of electricity using the natural flow of water. https://en.wikipedia.org/wiki/Micro_hydro (accessed 2019-02-25).
- 3. Primary energy refers to energy sources in their natural or original form, such as coal, oil, natural gas, wind, water, and sun. Secondary energy refers to energy that has undergone some form of transformation from its primary form to the form in which it is used, such as coal to electricity, crude oil to gasoline, or hydro to electricity (Robins, 2017).
- 4. The range reflects in part that, to be effective, carbon prices need to be higher in high-income countries as compared to low- and middle-income countries.

Module 5

Climate Change Toolkit for Health Professionals Factsheet: Climate Change Solutions with Immediate Health Benefits

Canada Must Do More

Current commitments by governments, including those of Canada, are insufficient to limit average global warming well below 2°C, let alone to meet the 1.5°C target in the 2015 Paris Agreement. To stay below 1.5°C, global greenhouse gas (GHG) emissions need to fall by about 45 percent from 2010 levels by 2030 and reach 'net zero' by 2050. It is imperative to accelerate the shift to non-carbon sources of energy in order to avoid the catastrophic health impacts that would be associated with 2-degrees of warming.

The Lancet Countdown on health and climate change emphasized that a transformation is needed in the way we generate power, travel, build communities, eat and grow our food. Strong and predictable carbon pricing, the rapid phase-out of coal, increased access to renewable energy, promotion of healthy living through energy efficient buildings, low-cost active transportation and increased access to green space are among strategic directions that will reduce the impact of climate change on health.

Many Climate Actions Benefit Health

Actions to reduce GHGs can contribute to multiple health benefits by improving air quality, increasing physical activity, improving nutrition, reducing obesity and decreasing chronic diseases. At times, the health benefits alone can outweigh the costs of measures taken to reduce GHG emissions.

In Canada, the two top emitting sectors in 2016 were oil and gas (26% of total emissions) and transportation (25%). Transportation was the largest contributing sector in eight of the provinces/territories, while the oil and gas sector was the greatest contributors in Alberta and Saskatchewan.

Air Pollution

Chronic exposure to fine particulate matter (PM2.5)(a major component of air pollution) from the burning of fossil fuels is estimated to result in 7,142 premature deaths per year in Canada with welfare-related costs valued at \$53.5 billion with 345 attributed to coal-fired power plants, 105 to coal-related industries, 2762 to non-coal industries, 1063 to land-based transportation, and 1282 to the agricultural sector.

The extraction of fossil fuels also causes significant pollution. The oil sands contribute a large proportion of PM in Edmonton's air and this pollution can travel as far as Ontario. There is mounting evidence of the adverse impacts of shale gas drilling (fracking). Emissions from gas wells can result in concentrations of air pollutants that exceed exposure guidelines for both carcinogenic and non-carcinogenic health risks. The production, distribution and use of oil and gas also releases methane, a short-lived climate pollutant with 84 times the warming potential of CO_2 .

Physical Inactivity

Physical activity is associated with improved heart and mental health, healthy child development and aging, and reduced risk of premature deaths, some cancers, diabetes, dementia, osteoporosis and obesity. In 2013, only 10% of Canadian children and youth and 20% of Canadian adults met the Canadian Physical Activity Guidelines.

Obesity

In the past 50 years, there has been a shift to unhealthy diets that are calorie-dense, highly-processed, and rich in animal products. This is contributing to an increasing burden of obesity and diet-related chronic diseases and environmental degradation, including climate change. Canadians eat more meat and fewer vegetables and fruits than is recommended for health. Lowering meat intake and increasing intake of foods of plant origin would be beneficial for the health of many people in Canada.

In Canada more than one quarter (25%) of people 18 years and older were living with obesity in 2015. Obesity increases the risk for premature death and chronic diseases, such as cardiovascular disease, cancer and diabetes. Transportation systems, urban design, land use, and food systems, which have a strong impact on GHG emissions, have a significant impact on obesity by influencing levels of physical activity and diet.

Climate Solutions that Benefit Health Transition to Renewable Energy

An accelerated shift to non-carbon sources of energy is needed. These include renewable energy such as wind and solar, geothermal energy, and micro-hydro. In addition to carbon pricing, governments have a role in accelerating the creation of sustainable markets for low-carbon technologies such as minimum requirements for renewable sources of power in the energy mix.

Coal-fired electricity releases more air pollutants, GHGs, and mercury than any other source of electricity. In 2016, it was estimated that \$5 billion in air pollution-related health benefits could be created and 31 Mt of GHGs could be reduced over if Canada's coal-fired power plants were phased out by 2030 with two thirds of that power replaced by renewable energy.

A study that explored the rapid transition to 80% wind, water and solar energy by 2030 and 100% by 2050 estimated that by 2050, such a shift could lead to USD\$110 billion in savings in annual health costs or nearly 4% of GDP, including a reduction of about 9,900 air pollution-related deaths in Canada. It would only take 4.1 years of savings from reduced air pollution and climate impacts to pay for this shift.

Reducing Energy Use in Buildings

The International Energy Agency estimates that by 2050, we could reduce GHG emissions from buildings by 60%. This could be achieved by replacing oil- and gas-based heating with improved building envelopes, high-efficiency, electric systems including heat pumps. This would improve outdoor air quality and indoor conditions. It would reduce energy costs to households, energy poverty, and illnesses, medical visits and sick days off work and school.

Reducing Emissions from Transportation

To successfully reduce the impact of transportation on climate change, there is a need to transition to low- or zero-emission vehicles, reduce the demand for motorized transportation, and shift personal transportation to walking, cycling and transit. Health co-benefits include: reduced exposure to traffic-related air pollution especially along high volume traffic corridors; increased physical activity; reduced noise; fewer vehicle-related traffic injuries; and greater equity because of less dependence on automobiles.

Increased density and diversity of land uses with improved access to transit reduces GHG emissions and can contribute to a reduction in diabetes, cardiovascular disease, and respiratory disease through increased physical activity and reduced levels of air pollution.

Promoting Green Spaces

Improving urban green spaces not only

helps cities adapt to climate change, it also contributes to climate mitigation. Urban greenery and tree canopies sequester and store carbon and their cooling effects reduce energy use. Green spaces such as parks or sports fields facilitate physical activity and relaxation. They can increase social cohesion, reduce crime and violence, and decrease noise and air pollution – all of which reduces cardiovascular disease, depression, anxiety, and stress. Green spaces may also reduce health disparities; providing more benefits to those in low income neighbourhoods.

Shift Toward Plant-Based Foods

Studies that have analysed ways to reduce GHG emissions associated with food production have concluded that dietary changes towards diets rich in plant-derived foods and reduction in food waste would have the largest impact on GHG emissions. This would promote health by shifting food consumption to conform with guidelines for a healthy diet and improve cardiovascular health. Increasing the consumption of plant-derived foods while reducing meat, as appropriate, is an affordable approach to improving nutrition.

Carbon Pricing is an Essential Tool

There is broad agreement that putting a price on carbon is essential if we are to transition to a low-carbon economy. A price on carbon levels the playing field between fossil fuels and alternative forms of energy by incorporating the cost to health and the environment into the cost of the use of energy sources. While progress is being made globally, most jurisdictions, including Canada, have carbon prices that are much lower than those needed to be consistent with the goal of the Paris Agreement.

Fossil Fuel Subsidies Sending Wrong Signal

While subsidies to the fossil fuel industry are declining, they continue to be substantial and larger than subsidies to renewable energy. Between 2013-2015 Canada paid an average of \$3.3 billion per year to the oil and gas industry in various forms of incentives or subsidies associated with production, field development, extraction, and exploration. A study estimated that without subsidies, global GHG emissions in 2013 could have been 21% lower and deaths from fossil fuel-related air pollution 55% lower. At the same time, government revenues and social welfare would have increased by 4% and 2.2% of global GDP, respectively.

GHG Emissions per Person

In Canada, on average, individuals were responsible for 20 tonnes of GHGs (20 t CO2eq) each in 2016. Quebec had the lowest per capita emissions at 9.5 t CO2eq while Saskatchewan and Alberta had the highest at 69.5 and 64.6 t CO2eq respectively. The high per capita emissions of Alberta and Saskatchewan reflect the GHG emissions from the fossil fuel industry in those two provinces, the products of which are mostly exported.

Ensuring a Just Transition

The phase-out of fossil fuels will have major impacts on people and families involved in the fossil fuel industry, as well as communities where industry facilities are located. By using some of the revenues from carbon pricing and savings from the elimination of subsidies, we can ease the transition for workers and foster economic diversification to contribute to a just transition.

Note: References for this factsheet can be found in Module 5 of <u>CAPE's</u> <u>Climate Change Toolkit for Health Pro-</u> <u>fessionals.</u>

Module 6

Climate Change Toolkit for Health Professionals Taking Action on Climate Change at Health Facilities April 2019



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ACME Association Canadienne des Médecins pour l'Environnement CAPE Canadian Association of Physicians for the Environment

Module 6 – Taking Action on Climate Change at Health Facilities

Introduction

This module is intended for health care professionals such as doctors, nurses, administrators, emergency responders, and other front-line health workers who are interested in learning more about how climate change will impact health care organizations and their facilities. Information is included on strengthening the health care facilities to be better prepared for climate change as well as reducing greenhouse gases (GHGs). Within this module are examples of initiatives, projects, policies and programs which can be promoted and implemented to help health care facilities become more sustainable and resilient as they adapt to anticipated climate-related impacts.

Support for Health Care Facility Action on Climate Change

While recognizing the important and vital link between health and climate change in general, the World Health Organization (WHO) and the Pan-American Health Organization (PAHO) are calling for health care facilities (HCFs) specifically to be more engaged in several specific ways (PAHO, 2017):

- Developing initiatives to become more resilient;
- Leading by example through reducing health systems' emissions of GHGs while promoting change in the entire health system supply chain;
- Making HCFs safer and more environmentally-sustainable;
- Focusing on making policies and processes adaptable to the changing climate;
- Training health personnel to recognize and understand the effects of climate

NANAIMO HOSPITAL BUILDS RESILIENCY INTO NEW EMERGENCY DEPARTMENT

Nanaimo Regional General Hospital responded to future climate uncertainty by designing resiliency into its new building's fabric.

INTRODUCTION

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A growing number of Canada's health care organisations are seeing first-hand the impacts climate change is having on their facilities and are responding accordingly to ensure their infrastructure is as robust and capable as possible to withstand events such as floods, ice storms, and heat waves that can compromise access to critical resources, the delivery of care, and the safety of patients, staff and visitors.

sam and visitors. The Nanaimo Regional General Hospital (NRGH), a 247-bed facility that opened in 2012, responded to future climate uncertainty by designing resiliency into its building's fabric. Serving more than 160,000 people on Central Vancouver Island, and referral centre for some 400,000 additional residents on, NRGH has incorporated a number of measures that help mitigate risk in the event of an extreme weather incident when it constructed its 6,200 m² Emergency Department addition.

DESIGN FOR RESILIENCE

To reduce energy consumption and GHG emissions, the building's designers incorporated the use of displacement ventilation, wood products with lower associated GHG emissions, extra roof insulation, solar shading, and digital controls.

The building's dedicated heat recovery chiller, complete with a subterranean labyrinth for heat storage, provides preheat for the domestic hot water and heating when required by exterior zones. One hundred percent redundancy is provided by the main hospital's existing heating plant.

Design and technology is in accordance with LEED Gold and the BC Hydro New Construction Standard. The Nanaimo Regional General Hospital employs extensive use of day lighting and natural light which helps decrease reliance on electricity. Improves patient outcomes and reduces staff stress.

Resiliency Profile 2

The building energy performance index (BEPI) is 524 kVM/m2/yr and an annual savings of 939 GJ gas; 1,071,892 kWh electricity and a 39 kW demand reduction for a total annual savings of \$59,815.

During the daylight hours, the majority of the building operates with very little artificial light in comparison to the did Emergency Department, which was completely devoid of natural light. The use of courtyrards assist in maximizing the amount of natural light brought into patient and staff areas. Even the trauma room benefits from natural lighting and throughcut the building operable windows allow for natural ventilation.

High tech blinds self-adjust throughout the day, automatically lowering or rising, and opening or closing as conditions demand.

Thanks to the design of the negative pressure isolation rooms and decontamination space, infection control has also been improved, particularly when handling patients believed to have infectious airborne diseases.

Resliency profile #2 of Healthcare Energy Leaders Canada (HELC). Photo provided by Canadian Coalition for Green Healthcare. change, and

 Using health personnel to advocate and act to reduce the climate footprint.

The Lancet Countdown on health and climate change report (Watts et al., 2018) states that "The public and the health systems they depend on are clearly unprepared to manage the health impacts of climate change" and calls on countries to increase the climate resilience of health infrastructure. At the same time, the Lancet authors call for health care sector emissions reporting and monitoring to "ensure a full transition to a healthier, more sustainable model of climate-smart and increasingly carbon-neutral health care".

In Canada, both the Canadian Medical Association (CMA) (CMA, 2010) and the Canadian Nurses Association (CNA) (CNA,



St. Peter's Hospital in Melville SK. Photo by Derek Keller.

2017) have policy statements on climate change and call on their members to be advocates and champions. Canadian health-related organizations such as the CMA, CNA, CAPE, Canadian Public Health Association (CPHA), Canadian College of Health Leaders, Canadian Pharmacists Association, and the Canadian Coalition for Green Health Care (CCGHC), also support actions for an environmentally-responsible health sector, including carbon reduction, through signing on to the 2009 Joint Position Statement (JPS) (JPS, 2009).

The JPS also calls for action by governments (to understand and address links between health and the environment and to incorporate these links into policy through legislation and budgetary actions), health care organisations (to take action by minimizing the negative impact on the environment and seek solutions to existing barriers), and those who work in the health sector (to both model and advocate for environmentally responsible approaches to delivering health care without compromising patient safety and care).

Climate-related Impacts on Canadian Health Care Facilities

Climate-related events are already impacting health care facilities (HCFs) in Canada (Waddington et al. 2013). The frequency and magnitude of severe weather events such as extreme heat, cold, rain, ice, snow, winds and storms are multiplying, as forecast with climate change. Increasing, global temperatures will also result in rising sea levels, melting permafrost and droughts and dry conditions which will spur on wildfires. While some climate-related events may be smaller or incremental events experienced at the level of HCFs, others may have the potential to impact entire communities.

HCFs in the provinces of British Columbia (BC), Saskatchewan, Manitoba, Quebec, New Brunswick and the cities of Toronto and Windsor in Ontario, have all experienced the impact of flooding within their HCFs causing major disruption to health services delivery (CCGHC, 2019). The 2013 southern Alberta floods were one of the largest natural disasters in Canadian history, resulting in HCF clo-



Toronto's Hospital for Sick Children - a view of the atrium. Photo by Dhodges.

sures, evacuations and infrastructure damage (MNP, 2013 and Roles, 2013).

Another climate-related event with the potential to disrupt HCF operations is melting permafrost. Melting permafrost in Canada's far north means HCFs in those regions will need thermosyphons to maintain cooler ground temperatures that prevent the building from sinking (Holubec, 2008). Wildfires are an additional concern for public health and HCFs. In addition to "Very High Health Risk" air quality impacts due to smoke felt all the way into Alberta, the BC wildfires in 2017 and 2018 resulted in HCF closures, patient transfers, and health services disruptions (Legassic, 2018).

Other examples of Canadian HCFs that have been impacted by climate-related events have been documented in the <u>CCGHC's Resilien-</u> cy Profiles available on their website.

Impact on Delivery of Health Care Services

Climate-related events can affect the delivery of health care services at HCFs in many ways. Multiple impacts often can occur simultaneously. These impacts include, but are not limited to:

- Physical, emotional and mental health impacts among health care workers;
- Damage to the building envelope, internal infrastructure, electrical and mechanical systems (including heat-

ing, ventilation and air conditioning
(HVAC) systems);

- Reduced access to critical support services including transportation, power, water supply, and tele-communications;
- Reduced access to non-medical supplies and services such as food, linen and site cleaning, waste disposal storage and services, data management and patient record systems, and sterilization services;
- Reduced access to medical supplies and products including local sources of products including blood services, and global manufactured medical products sourced from areas affected by climate-related events;
- Reduced access to health and clinical services during temporary closure periods, delays in treatment such as surgical treatment and delayed access to outpatient services such as dialysis;
- 7. Increase in emergency room visits and hospital admissions as the result of climate-related events, including heat stress or frostbite, respiratory distress, exposure to climate-sensitive diseases, physical and psychological trauma due to extreme weather events and rapid weather alteration and patient transfers from other HCFs experiencing service disruptions;
- Activation of the HCF emergency plan; and
- 9. Increased costs.



Resliency profile #5 of Healthcare Energy Leaders Canada (HELC). Photo provided by Canadian Coalition for Green Healthcare.

The Health Sector

The sheer scale of Canada's commitment to the health care sector highlights its potential importance in efforts to address and respond to climate change. The health sector is a significant contributor to the Canadian economy representing a 11.3 % of the gross domestic product (GDP) in 2018 (CIHI, 2018), and a health and social services workforce of 1.9 million people in 2017 (SC, 2019). Across Canada, health sector spending represents the largest budgetary outlay for each of the provincial and territorial governments. An estimated total of \$253.5 billion was allocated to the health sector in 2018. Hospital costs were the largest component of this expenditure (\$71.7/28.3%), followed by pharmaceuticals (15.7%), and physician fees for services (15.1%) (CIHI, 2018a).

Notably, growth in hospital spending has slowed over the last several years to an annual rate of 1.9% in 2016-2017. One of the ways hospitals have responded to limited funding is by changing how care is delivered, with more people treated as outpatients to reduce high costs associated with inpatient treatment. In terms of extent and capacity, there were 798 hospitals across Canada with approximately 90,000 hospital beds according to 2014 figures (CIHI, 2018b). HCFs like hospitals are often one of the largest employers in a community and employ trusted community members with the potential to provide leadership on climate-related concerns.

Canadian Health Sector GHG Emissions

GHG emissions from the Canadian health sector were reported in a study (Eckelman et al. 2018) that linked economic-environmental-epidemiological modeling framework to quantify emissions based on Canadian national healthcare expenditures over the period 2009–2015. The researchers found that GHGs emitted from Canada's health care sector life-cycle, which includes direct emissions from HCFs and indirect emissions from their supply chain, represented an estimated 4.6% of the total national GHG emissions in 2015 or 0.0330 Gigatonnes (GT) CO² eq.



GHG emissions based on 2015 expenditures. Provided by PLOS Medicine.

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Medical supplies are a contributor to GHG emissions. Photo by Photo by Marcelo Leal on Unsplash.

However, GHG emissions in the health sector are increasing at double the rate of the national average; 10% compared to 5% between the years 2009 to 2015. Given its increasing annual contribution to Canada's total GHG output, targeted support programs to reduce emissions in the health sector could play an important role in national climate change mitigation efforts. The most significant GHG emissions in the health sector are: prescribed and non-prescribed pharmaceuticals (25%);hospitals (24%); and physician services (13%).

In the same study, Eckelman's team further identified each of the economic sectors contributing to Canada's health care life-cycle total GHG emissions. Hospitals as an economic sector represented 3.1%

of the health care life-cycle's GHG emissions - together with health care and social assistance (6.4%) and nursing and residential care (0.4%) comprising only 10% of the total. This means that 90% of health care life-cycle GHG emissions are generated upstream by non-health economic sectors. Energy was shown to be the largest contributor comprised of electricity (22%) and oil and gas (17%). Other key economic sectors as potential targets for mitigation efforts included crop and animal agriculture (5%), pulp and paper industries (5%), and petroleum product manufacturing (4%) representing materials employed within the health system. Figure 1 provides an illustration of this data (from Eckelman et al., 2018).

As part of its life-cycle emissions, Canada's health care system is further responsible for generating more than 210,000 metric tonnes of non-GHG pollution into air, water, and soils. Amongst the largest emissions to the atmosphere are ammonia, carbon monoxide, methanol, nitrogen oxides, non-methane volatile organic compounds, particulate matter, and sulfur dioxide. As service providers with a leadership capacity in Canadian society, the health sector needs to step up and take responsibility for the health effects related to these pollutants (Eckelman et al., 2018).

From Canada's national reporting on GHG emissions, the transportation sector and oil and gas sector combined represent 50% of the national GHG emissions, and

Climate-related Risks:

- 1. Extreme heat, including extended heat periods
- 2. Extreme cold
- 3. Extreme rain and floods
- 4. Extreme snow
- 5. Extreme winds
- 6. Ice storms
- 7. Droughts
- 8. Wildfires
- 9. Tornados
- 10. Extreme storms; thunderstorms, lightening
- 11. Hurricanes and related storms
- 12. Avalanches, rock/mud/land-slides, debris flows
- 13. Rising sea levels; coastal flooding, storm surges
- 14. Permafrost melt
- 15. New and emerging climate-related diseases

are the ones that have increased the most since 1990 (ECCC, 2017). The health sector relies heavily on these two sectors.

The health sector and HCFs use significant resources across numerous supply chains that are contributing to climate change, and are already being impacted by climate-related events. These next sections describe initiatives that help identify climate-related vulnerabilities, prepare HCFs for future impacts, and describe initiatives to address and help mitigate climate change that health care professionals can advocate for implementation at HCFs.

Resilience, Vulnerability & Adaptation Assessments

HCFs personnel will need to identify what impacts their facility will likely experience, understand the current strength or vulnerability of their facility, and work with their stakeholder community to implement initiatives that will make them more sustainable and resilient, and allow them to adapt to expected climate-related conditions. HCF initiatives can help lessen climate change impacts both by advancing the development of low-carbon facilities, and by changing behaviours around the extensive use of products and services contributing to GHG emissions.

Climate-related Risks

Many types of climate-related risks have been identified across Canada, requiring the health sector to assess which of these risks will potentially apply to each HCF. There are many reliable sources of climate-related risk information available in assessing local risk, including information from public health departments, municipal governments, and provincial/ territorial or regional climate strategies and plans. A key online tool is the Climate Atlas of Canada which presents information tailored to identifying the spe-

HCF Resiliency Checklist used at Children's Hospital of Eastern Ontario:

Dr. Curtis Lavoie is an Emergency Room Physician at the Children's Hospital of Eastern Ontario (CHEO), Chair of the Hospital Green Team, and a member of CAPE.

Working with CHEO's Facility Manager Kim Greenwood, Dr. Lavoie took part in the Climate Change Resiliency Mentoring Program, obtaining the services of a summer student to help complete the Health Care Facility Climate Change Resiliency Checklist.

Through this physician's leadership initiative, CHEO now has the baseline information it needs to understand its particular climate-related challenges, enabling this HCF to move forward and take the necessary steps to become more resilient.

cific climate-related risks facing many communities across Canada. Examples of how some HCFs have summarized their climate-related risks can be found in the Ontario HCF Climate Change Factsheets available on the Canadian Coalition for Green Health Care (CCGHC) website.

HCF Resiliency Assessment

The CCGHC in partnership with Health Canada developed the Health Care Facility Climate Change Resiliency Checklist (CCGHC, 2014; Patterson et al. 2014) to assist HCFs assess their resilience to climate change. Guidance on how to complete the resiliency checklist for a HCF is available through The Climate Change Resiliency Mentoring Program which offers an online learning resources, including webinar recordings. The checklist includes questions in areas such as emergency management, facilities management, health care services, and supply chain management.

Officials with knowledge and experience in these subject areas can complete HCF assessments using the checklist, in order to increase awareness and inform resiliency activities. By entering the HCF resiliency checklist assessment results online, a score can be generated that then can be used as a baseline to compare with results obtained in future years. Other HCF resiliency toolkits that have been developed include The Sustainable and Climate Resilient Health Care Facilities Toolkit in the United States, and the Smart Hospital Toolkit, developed by PAHO for HCFs in the Pan-American regions (Balbus et al. 2016 and Velislava et al. 2015).

Other ways in which HCFs can increase their resiliency is by engaging in broader community discussions and initiatives around climate-related issues, considering climate change during the development of strategic plans and activities, and mainstreaming climate change considerations into ongoing risk assessments.

Risks can be greatly reduced through

Interior Health, BC Vulnerability Assessment:

After experiencing major wildfire events for two summers in a row, the Strategy and Risk Management Council of the Interior Health region in BC endorsed a pilot climate change vulnerability assessment to understand potential impacts and resulting risks and opportunities at their Golden and District Hospital.

"Our ability to support health services over time is dependent on our facilities being able to operate under 'new normal' climate conditions," said Tanja Stockmann, Manager of Sustainability who is taking the lead on the pilot.

Information gleaned from this vulnerability assessment will help senior leadership, capital project managers, and operational staff make better-informed decisions on how to prepare for the climate-related events Interior Health is already experiencing, as well as to plan for expected and unanticipated impacts during the lifespan of its facilities.

proper management of critical resources (e.g. pharmaceuticals, food, energy, transportation, medical supplies, and equipment) that consistently incorporates climate change considerations.

Another aspect of HCF resilience is its level of commitment to sustainable practices, including water and energy conservation, promoting active transportation, and local food procurement. By making a commitment to promoting these and other practices, HCFs can reduce their operating costs, and increase awareness of the need for climate change resilience in

the broader community. Examples of how HCFs have taken these steps can be found in the resources below – Safe haven in the storm, and, Protecting lives and margins with climate-smart health care, Climate-smart healthcare: low carbon and resilience strategies for the health sector.

Resources:

- Health Care Facility Climate
 <u>Change Resiliency Checklist</u>
- <u>Climate Change Resiliency</u> <u>Mentoring Program web page/</u> <u>other resources/presentations</u>
- <u>Sustainable and Climate Re-</u> silient Health Care Facilities <u>Toolkit (U.S.)</u>
- Smart Hospital Toolkit, PAHO
- <u>Safe haven in the storm: Pro-</u> tecting lives and margins with climate-smart health care
- <u>Climate-smart healthcare:</u> <u>low-carbon and resilience strat-</u> <u>egies for the health sector.</u>

HCF Vulnerability Assessments

The purpose of HCF vulnerability assessments is to identify any infrastructure that will be potentially vulnerable as a result of climate-related impacts. Engineers Canada and Natural Resources Canada supported development of the Public Infrastructure, Engineering

Health Canada – Capacity Building:

Health Canada has a new multi-year program to support the health sector to prepare for and adapt to the impacts of climate change in order to protect the health of Canadians and increase climate resiliency of the health system. Approximately \$3 million will be provided to 10 health authorities across Canada, in which health care facilities are partners, to assess climate change vulnerabilities, establish adaptation plans and evaluation strategies.

Vulnerability Committee (PIEVC) protocol, which is a tool that reviews historical climate information in order to projects the nature, severity, and probability of future climate change events.

The PIEVC protocol includes an estimate of the severity of climate impacts on specific components of infrastructure in terms of their deterioration, damage, or destruction to enable identification of higher risk components. This information can be used to make informed engineering judgments to prioritize components requiring adaptation, as well as for understanding the best ways of adapting them - whether through design adjustments, or changes to operational and/or maintenance procedures.

As one example for its use in HCFs, the PIEVC protocol was applied to conduct a vulnerability assessment of the Nanaimo Regional General Hospital in BC. (Please see the Climate Change Vulnerability Assessment Report referenced below for further details.) Other examples of characterizing vulnerable Canadian health care infrastructure are available from Procyk and Dhariwal (2010).

Resources:

- <u>PIEVC Engineering Protocol</u>
- <u>Nanaimo Regional General</u> <u>Hospital, Climate Change Vul-</u> <u>nerability Assessment Report</u>

Vulnerability and Adaptation (V&A) Assessments

From a public health perspective, vulnerability and adaptation (V&A) assessments can further examine population-level vulnerabilities to climate change in the community. These vulnerability assessments can be used to identify vulnerable populations and map the location of potential health risks, employing climate data to inform adaptation and planning (Ebi et al. 2016).

Undertaken from local to national levels, V&A assessments can help prepare health systems for the impacts of climate change by informing the need for development of tailored policies and programs to enhance resilience and adaptation (Bell, 2011). Ford et al. (2010) describe the climate change vulnerability of the Aboriginal health systems in Canada. Guidance in performing V&A assessments is provided in the Ontario Climate Change and Health Toolkit referenced below.

At the local level, V&A assessments should be conducted with high levels of engagement and participation from stakeholders in the community including representatives from the HCF, critical infrastructure and emergency management and response, patient populations, and the general public. Information provided by HCFs to the V&A assessment should include the current and future resiliency of buildings and clinical services to climate-related events, as well as patient admission data, in order to ensure that critical health care services will be available even during disaster periods. The HCF representation within V&A assessment processes will help to ensure that community climate adaptation plans include this critically important perspective, especially as HCFs rely heavily on municipal infrastructure with the potential to be impacted during climate-related events, particularly transportation, power, and water and wastewater services.

Resources:

• <u>Ontario Climate Change and</u> <u>Health Toolkit.</u>

HCF Adaptation Assessments and Plans

The National Health Service (NHS) in England has shown remarkable leadership in requiring HCFs (known as 'Trusts') to develop climate change adaptation assessments and plans, known as 'Sustainable Development Management Plans' (SDMP), for their organizations.

The required assessments and plans summarize the set of adaptation actions specific to the individual circumstances and locations of each Trust. Examples of adaptation actions contained in the assessments and plans include training health care professionals on climate-related impacts, increasing levels of urban greening and green infrastructure, building retaining walls to keep flood waters out, and developing redundancies to ensure ongoing access to transportation, power, and water and wastewater services in the event of an emergency.

Some of the Trusts' plans and assessments have been developed in partnership with local governments to help build community-wide adaptation strategies. Some NHS Trusts combine their climate change adaptation assessments and plans with their Environmental Sustainability Plans, which are described in greater detail in below. NHS England and Public Health England jointly fund the Sustainable Development Unit which provides guidance to the Trusts to embed and promote the three elements of sustainable development - environmental, social and financial - to ensure that the health and care system fulfils its potential as a leading sustainable and low carbon service. Examples of the support provided by the Sustainable Development Unit includes planning guidance and sample plans. Examples of how nurses and physicians have engaged in climate change and specific examples of green infrastructure and the role of these in climate change and health are provided in the Resources below.

Resources:

- <u>Adaptation to Climate Change</u>

 <u>Planning guidance for health</u> and social service organisations, and sample plans
- <u>Nurses Climate Challenge</u>
- <u>A Physician's Guide to Climate</u> <u>Change, Health and Equity</u>
- <u>Climate Action for Healthy</u> <u>People, Healthy Places,</u> <u>Healthy Planet: Urban Green-</u> <u>ing & Green Infrastructure,</u> <u>Climate Change and Health</u>

Stress Testing

Climate and health "stress tests" can be undertaken to gain further information on potentially disruptive climate-related shocks and stresses that might otherwise be missed in a V&A assessment. Stress testing uses the development of hypothetical scenarios to understand cases where



Stranded Ambulance. Photo by Alec Perkins from Hoboken, USA.

the health system would be stressed to such a degree that it might not be able to provide services to the public. Understanding this state and how it could come about provides an opportunity to evaluate and consider vulnerability and adaptation from a new perspective (Ebi et al. 2018).

Low Carbon Sustainability & Resiliency Measures at HCFs and their Supply Chain

Sustainability and resiliency measures are highly linked. For example, by using less energy, a facility can remain operational longer should power outages occur because of the finite amount of energy available once stand-by energy sources are activated. A new energy-efficient boiler should not be placed in any location where it would subject to flooding in a changing climate. An operational decision to size a heat recovery ventilation unit (HRV) on the basis of outdated weather data may mean earlier, higher cost, replacement in the event of longer, hotter periods due to climate change. Employing fewer toxic chemicals and reducing the level of waste in a facility would reduce the hazards that could be realized during clean up after a climate-related disaster results in potential disruption or damage to waste storage areas. Purchasing locally-sourced, sustainable foods would help to build capacity and resilience in local agricultural communities, which could further ensure a stable food supply in the event of climate-related disruption to global supply chains providing imported foodstuffs to the facility. Examples of how hospitals in Europe are addressing sustainability and resiliency can be found in the resources document Reducing healthcare's climate footprint. Opportunities for European hospitals and health systems.

Sustainability Support for HCFs

Having adequate support to implement new initiatives is critical, since health care professionals have limited time and resources to consider priorities outside of their stated responsibilities. Fiscal restraint is a constant concern, as the overall level of resources available for attaining non-priority objectives is low. New initiatives have to compete with other pressing matters within health systems on a periodic basis, such as influx of patients during the flu season. Factors that enable the success of new initiatives include existence of a regulatory backdrop, leadership making it a priority, having an action plan, the availability of resources, and co-benefits for the health system.

Support for HCF sustainability initiatives can be located at many levels, including a facility-led green committee, the regional health system, provincial /territorial government departments or programs, national-level frameworks, and international agencies. Trusted organizations located outside the HCFs and even the health system can provide complementary support through their own initiatives.

One example is the Green office toolkit for clinicians and office managers, created through the joint efforts of the Canadian Coalition for Green Health Care, Canadian Association of Physicians for the Environment (CAPE), Synergie Santé Environnement (SSE), McMaster University Department of Family Medicine, and Women's College Hospital in Toronto.

Sinai's Health's Green Committee:

The Toronto based Sinai Health System's Green Committee was formed in the mid 90's. One of its integral members was Hilda Swirsky, a nurse in Antenatal who has been on the committee for the past eight years. Today, Sinai Health has its first full-time Manager of Infrastructure and Sustainability, Mark Reynolds, and first Environmental Sustainability Coordinator, Tracey Clatworthy, who co-chairs the Green Sinai Health Committee with nurse Brenda O'Connor. The committee is comprised of several departments. The sustainability priorities of Sinai Health are reducing resource consumption and impacts on the environment, especially its carbon footprint. Focus areas for these priorities include waste diversion, energy and water conservation, as well as sustainable construction and procurement practices. Importantly, reducing utility consumption saves dollars that can go right back into providing patient care – the heart of their mission. The 30 members of Sinai Health's Green Committee engage frontline staff by championing environmentally-friendly behaviour changes, and ask all staff to sign a Green Pledge stating that they will try to power-down computers, unplug electronics and equipment, and turn off lights in empty rooms. The Green Sinai Health Committee further engages employees through outreach events like Smart Commute Month, encouraging employees to start thinking about sustainable ways to travel to work. In 2017, notable successes included halving water consumption, and increasing waste diversion from 30% to 45%, resulting in Sinai Health receiving a silver ranking on the Canadian Coalition for Green Healthcare's Green Hospital Scorecard. (Yardley, 2018)

HCF Green Committees and Champions

Facility-led green committees can be their most effective when they are made up of staff from a broad range of backgrounds and incorporate the insights and efforts of personnel with a strong interest in seeing their facility become more `green'.

Directly involving staff in the development of initiatives that reflect the unique interests of a facility can produce greater buy-in and increase participation for initiatives like waste reduction and recycling or changing energy use behaviours. In some cases, green committee initiatives have led to the creation of new staff positions, as the value of these activities becomes apparent to leadership.

Fostering the developing of internal "Green Champions" throughout an HCF can help extend a green committee's presence facility-wide. The Green+Leaders Network is one such example of an initiative to foster environmental stewardship by providing training and resources for success to over 400 volunteer champions across BC's Lower Mainland Health Organizations (LMHO), calling itself a "collection of engaged staff volunteers who help create healthy workplaces on a healthy planet by improving environmental performance of health care operations".

Regional Sustainability Support Programs

Regional sustainability support programs can be embedded within a group of HCFs to take advantage of economies of scale by compiling information and sharing resources. The GreenCare program in BC's LMHO is one example of such a program, overseeing environmental sustainability initiatives which include Smart Energy and Water, Zero Waste and Toxicity, Regenerative Design, Active and Clean Transportation, and Culture Change programming. Each of these program categories outline corresponding areas of focus, key performance indicators, and targets to help smoothly implement initiatives between LMHO facilities.

Province-wide and National Support

Alberta Health Services (AHS) is the provincial health organisation in Alberta responsible for HCFs across the province. As one example of a centralized provincial sustainability support, a new Office of Sustainability has been developed and is currently being launched in

CAPE Alberta Committee, Alberta Health Services:

Alberta Health Services (AHS) is the provincial overseer of a \$14.7 billion health care operation encompassing more than 400 hospitals and 100,000+ employees.

With such a large organization and knowing that the health care sector has a significant impact on the environment through energy and water use, products used, and air and water emissions among other impacts, it only made sense to Dr. Joe Vipond and the CAPE-Alberta Committee of 50 doctors, nurse, medical students and academics to advocate for a Sustainability Office at AHS.

The new office at AHS will focus on decreasing GHG emissions for heating and cooling and electricity, waste management and recycling and employee engagement and education.

Alberta, with staffing and resources provided from AHS funding.

While there is no national funding support for such a program in Canada, the NHS and Public Health in England, which is the publicly funded national healthcare system, created the Sustainable Development Unit in 2008 as described in the section on HCF Adaptation Assessments and Plans above. Another example of a national sustainability support program for hospitals is Practice Green Health in the USA, which is described in the section below.

Many benefits can flow from sustainability support program being embedded within health systems, including secure funding for staff, access to health system data and information, guidance from health system experts, ability to require reporting under health regulations, and the credibility associated with working with funders of the public health system.

External Sustainability Support from Trusted Organisations

External health care-related organisations can help provide expertise and manpower to support the sustainability efforts in HCFs, as needed. This support can take the form of partnerships on programs, consultation contracts for energy management services or special projects,



Cover of Green Office Toolkit for Clinicians & Office Managers. Cover Design by Louis Aubin.

and providing training and education services. Some examples of external sustainability support that have been provided to HCFs in Canada include:

Québec: Synergie Santé Environnement (SSE) is a not-for profit organisation formed by Quebéçois health care professionals in 2006 to help health care organisations reduce their negative impacts on the environment and health. SSE provides environmental health and sustainable development consulting services to health and social service institutions in Quebec with a focus on waste management, responsible procurement, policy and action plan development, and implementation of action plans, committee support, training, situation reports, and sustainable development report writing. SSE currently has 20 members representing 53 hospitals, 176 long-term care facilities, and more than 250 other types of health care buildings.

Canada-wide: The Canadian Coalition for Green Health Care (CCGHC) was established by CAPE members and several health care facilities and organizations in 2000, with a focus on promoting environmental health and addressing environmental sustainability in the health sector. CCGHC develops toolkits, offers workshops and training, and undertakes projects with members, with a focus on the areas of climate change, energy and water, safer chemicals, green purchasing, sustainable food, and waste management and benchmarks these initiatives through the Green Hospital Scorecard and offers an awards program. CCGHC also developed a social enterprise platform (HealthCare Energy Leaders Canada) providing energy management services to CCGHC members at reduced rates. A key area of engagement for the CCGHG is the Green Health Leaders Initiative, which was developed to engage health care senior leadership on environmental sustainability and climate change. Membership includes health care organisations representing approximately40% of hospital beds in Canada.

Outside of Canada sustainability support organisations include:

France: Comité pour le Développement Durable en Santé (C2DS) is a health care support organisation based in France with offices in Germany. It was set up by a group of hospitals in order to establish a healthcare community committed to environmentally responsible healthcare. C2DS is endorsed by the French Ministry of Health and has around 500 hospitals in their network. C2DS is associated with a private company with expertise in GHG audits and when members use this company they are eligible for cost savings. C2DS offers training, workshops, sustainability toolkits, and best practices.

United States of America (USA): Practice Green Health (PGH) is a non-profit and the USA's leading membership and networking organization for institutions in the healthcare community that have made a commitment to sustainable and eco-friendly practices. It was established in 1998 through a memorandum of understanding between the American Hospital Association and the US Environmental Protection Agency and was first known as Hospitals for a Health Environment (H2E). in 2006 Health Care Without Harm took a leadership role in helping H2E become an independent not-for-profit and formed PGH. PGH provides practical and cost-effective guidance, tools, resources and expertise to its members, and also has an awards program and an annual conference known as CleanMed.

Global: Health Care Without Harm (HCWH) and the Global Green Healthy Hospitals (GGHH) networks seeks to transform health care worldwide so that it reduces its environmental footprint, becomes a community anchor for sustainability and a leader in the global movement for environmental health and justice without compromising patient safety or care. HCWH leads programs in Lat-

Resources:

- <u>Reducing healthcare's climate</u> footprint. Opportunities for <u>European hospitals and health</u> systems.
- <u>Green office toolkit for clini-</u> cians and office managers
- <u>Green+Leaders Network</u>
- <u>Sustainable Health Care The</u> <u>BC GreenCare Community</u> <u>website</u>
- <u>Sustainable Development Unit</u> (SDU), National Health Service (NHS) England
- <u>Synergie Santé Environnement</u>
 (SSE)
- <u>The Canadian Coalition for</u> <u>Green Health Care (CCGHC)</u>
- <u>Comité pour le Développement</u> <u>Durable en Santé (C2DS)</u>
- Practice Green Health (PGH)
- <u>Health Care Without Harm</u> (HCWH)
- <u>Global Green Healthy Hospitals</u>
 <u>(GGHH)</u>

in America, Europe, Asia and leads projects and initiatives around the world. GGHH, a program of HCWH, is an international network of hospitals, health systems and health organizations dedicated to reducing their environmental footprint and promoting public and environmental health by providing online platforms, awards, and networking opportunities.

Environmental Sustainability Plans for HCFs

In England's National Health Service (NHS), HCFs are required to complete a Sustainable Development Management Plan (SDMP). The SDMP initiative was a joint effort between the SDU national sustainability support program and NHS England Sustainable Improvement Team, aiming to integrate other health care priorities with sustainability ones.

In their SDMP, HCFs address issues such as air pollution, energy use, green spaces, carbon emissions, and climate change adaptation. Organisations are required to consider both their potential for direct impacts and indirect influences on their supply chains, as well as local communities. The HCFs are provided with key mes-



Carbon Footprint. Photo by Louisa Potter on Unsplash.

sages to help shape an understanding of the importance of these plans for their employees and community stakeholders, with an example being: "SDMPs form a key part of sustainable health care delivery to ensure services remain fit for purpose today and for the future". The SDMP also asks that HCF organisations incorporate ideas about prevention and improving the wider determinants of health in the community they serve and ways of achieving financial savings.

Carbon Footprints

England was the first country to undertake a detailed carbon footprint of their health system in 2009. The NHS England and the SDU (its national sustainability support program) established standardized measurement systems and identified carbon 'hotspots', so that HCFs could implement GHG emissions reduction initiatives that then could be re-evaluated every few years. Notably, even though system utilization increased by 18% between 2007 and 2015, GHG emissions dropped by 11% during these years. The emission reductions were achieved by improving procurement activities for a 16% reduction, realizing a 5% reduction in transportation emissions, and obtaining a 4% reduction in energy emissions (NHS SDU, 2016).

In Canada, without a similar commitment from the government and without a national program to support HCF sustainability, health care sector emissions increased 10% between 2009 and 2015 (Eckelman et al. 2018). A comparable level of detail on Canadian carbon emissions is lacking; however, the designation of 'hotspots' as in the English system could be used as a guide for initiatives to address HCF carbon emissions in Canada. Carbon 'hotspots' for goods and services identified at NHS acute care sites included building energy, medical instruments, and business services. Other less GHG-intensive but still significant contributors included construction, food and catering, manufactured chemicals and gases, pharmaceuticals, and travel.
For additional consideration, further carbon footprints of interest in the health care sector as identified by research studies include operating rooms (Mac-Neil et al. 2017), renal services (Connor et al. 2010), laparoscopic surgery (Theil et al. 2018), and emergency services systems (Blanchard et al. 2010). Supply chains are also significant GHGs emission contributors in these studies, as are the anesthetic gases employed during surgical operations.

Resources:

- <u>Sustainable Development</u>
 <u>Management Plan (NHS)</u>
- <u>Good and services carbon</u> hotspots, NHS SDU

Energy

Out of all the commercial and institutional buildings in Canada, HCFs have the highest energy use intensity (2.45 Gigajoules [GJ] per m2), particularly hospital campuses. Despite accounting for only 0.2% of commercial and institutional buildings, hospitals account for 4.1% of total energy used by the building sector in Canada. In 2014, the total energy used by all hospital buildings was 38.8 petajoules (PJ) with a 40% to 60% electricity to natural gas split. Notably, over 40% of HCF buildings are older than 50 years, presenting a great deal of potential for improving the energy efficiency of Canada's health care building stock, even though older buildings can often pose challenges with retrofitting (NRCan, 2014).

Energy Reporting

In BC, the Carbon Neutral Government Regulation requires that health authorities submit an annual 'Carbon Neutral Action Report' to document and summarize actions they have taken to combat their identified carbon footprint, which is defined as the fuel used in both their buildings and transportation fleets, as well as GHG emissions related to paper use. In Ontario, HCFs must complete an En-



Snow at Sunnybrook Hospital, Toronto. Photo by Laura Berndt.

Vancouver Coastal Health passive house for hospital staff:

The staff housing complex at the RW Large Memorial Hospital in Bella Bella, BC burnt down in 2014 requiring a replacement facility. Vancouver Coastal Health (VCH) took advantage of new building technology by building a modular structure to the Passive House standard which requires about 80% less heating and cooling energy than an average building.

The modular building was built off-site and installed in 2016. On the coldest day of the year, each unit in this complex has a peak heating load of about 600 watts, which is equivalent to the heat generated from six 100-watt light bulbs. No additional heating (such as a furnace or boiler) is required. On a long-term basis, this building will use 75% less energy and produce 80% fewer GHG emissions than a similar sized standard construction building, thereby saving VCH significant operational costs for this location (Greencare Community).

ergy Conservation Demand Management plan every five years, which consists of a description for previous, current, and proposed measures to conserve energy and manage energy demand. In addition, Ontario HCFs must submit their facilities' energy and water data onto Natural Resources Canada's ENERGY STAR® Portfolio Manager platform annually.

Setting Targets

Setting targets for GHG emission reductions will help to achieve results, especially targets which are supported by the senior leadership, and made public. This has been demonstrated by GHG emission reduction targets for carbon neutral and net energy generating systems that have been announced by health systems in the United States. Some examples include:

• Kaiser Permanente, the largest

non-profit integrated health care system in the US will achieve its goal of being carbon neutral in 2020. Kaiser Permanente's power purchase agreement for 180 megawatts (MW) of clean energy — enough to power 27 of its 39 hospitals — will enable the construction of utility-scale solar and wind farms, as well as one of the country's largest battery-energy storage systems. Kaiser Permanente has publicly pledged to become carbon net positive by 2025 (Kaiser Permanente, 2018).

 Advocate Aurora Health intends to operate its facilities in Wisconsin and Illinois with fully renewable energy sources by 2030. Reaching this goal would reduce its carbon emissions by 392,657 metric tons annually, or the equivalent to removing 84,000 cars from the road each year (Advocate Aurora Health, 2019).

 Gunderson Health System in Wisconsin achieved the first energy-independent hospital in the US. Its \$30 million system uses wind turbines, dairy farm methane digesters, and a facility that captures biogases released from a nearby county landfill. They expect that their investment will have an eight-year payback (Gunderson Health, 2019).

Benchmarking Tools

Many HCFs in Canada and the US voluntarily submit their energy and water usage data to the ENERGY STAR® Portfolio Manager program every year. These HCFs are the provided with a score that allows them to benchmark their results to compare with similar facilities, or to their own past performance. The United States Environmental Protection Agency (US EPA) reports in over 20 years, Portfolio Manager users have saved more than \$192 billion in energy costs. The ENERGY STAR Certification can also be attained for high performing buildings in Canada.

The Canadian Coalition for Green Health Care's Green Hospital Scorecard (GHS) is the only health care-specific environmental benchmarking tool developed in Canada. Originally focused on energy, GHG emissions, water, waste, pollution, and leadership indicators, the GHS program has expanded to include climate change, transportation, food, and energy behaviours. One half of Ontario HCFs participate in the GHS program, alongside organisations in other provinces and from outside of Canada. Based on their Scorecards, program participants are designated as gold, silver, or bronze. The average GHS score attained by participants across all indicators has been increasing over the past five years.

Energy Managers and Energy Efficiency Support

There are several examples of programs in Canada that are helping to enable HCFs to become more energy efficient. Energy manager programs funded by the utility providers in BC and Ontario have helped HCFs to embed dedicated staff focused on energy savings within their organisation. Efficiency Nova Scotia is the first energy efficiency utility in Canada and also works with HCFs to help them become more energy efficient.

Greening Health Care, with the Toronto and Region Conservation Authority based in Ontario, helps hospitals to become leaders in energy efficiency to reduce their impact on the environment and contribute to mitigating climate change. Since 2004, Greening Health Care has helped to conserve 1.5 million gigajoules of energy, saving \$28 million, and reducing GHG emissions by 85,000 tonnes.

HealthCare Energy Leaders Canada (HELC) and Ontario (HELO) was developed by the CCGHC in partnership with the Ontario Chapter of the Canadian Healthcare Engineering Society. HELC aids HCFs with conducting energy consumption audits, identifying energy efficiency opportunities, preparing business case content to secure buy-in from senior management for project formulation

Resources:

- <u>Sample Carbon Neutral Plan,</u> <u>BC: Fraser Health Carbon Neu-</u> <u>tral Action Report</u>
- <u>Sample Conservation Demand</u> <u>Management (CDM) plan, On-</u> <u>tario: University Health Network</u>
- Portfolio Manager US
- <u>ENERGY STAR® Portfolio Man-ager: Canada</u>
- <u>BC Energy Mangers Ontario Energy Managers</u>
- <u>Efficiency Nova Scotia</u>
- HealthCare Energy Leaders Canada
- Green Hospital Scorecard

and execution, and providing guidance for completing energy incentive forms to receive potential funding assistance.

GHG Emission Audits

Auditing GHG emissions should be undertaken using the GHG Protocol (www. ghgprotocol.org) as one of the most globally recognized accounting standards in this area. The GHG Protocol divides HCFs GHG emissions into three scopes, based on how the nature of those emissions. Scope 1 emissions include onsite energy, fleet vehicles, waste anesthetic cases, and refrigerants. Scope 2 emissions include purchased electricity and purchased steam. Scope 3 emissions include GHGs emitted along the supply chain and incorporate transportation and distribution (emissions from staff, freight, and business travel), waste disposal, food-related commodities (i.e. meat), pharmaceuticals, and medical devices and equipment.

In France, the private company Primum Non Nocere, which is associated with the non-profit Comité pour le Développement Durable en Santé (C2DS), has been conducting GHG emission audits with HCFs for the past 5 years, as required by French reporting regulations. Primum Non Nocere's work indicates that 90% of the GHG contribution made by HCFs come from scope 3 emissions, that is, indirectly from supply chains. Their audit reports contain action plans to reduce these GHG emissions tailored to the specifics of each audit. By implementing these action plans, some HCFs have been able to reduce their GHG emissions by more than 20% over a 3-year period, even though the number of patients increased and new buildings were added (Personal communications, Primum Non Nocere).

One of the benefits of taking this tailored action plan approach is that over the course of working collaboratively with their employees, partners, and suppliers to achieve highly relevant GHG reductions, these HCFs transform into climate leaders armed with pertinent information for their communities. Having more site-specific information on the areas where

Dr. François Reeves, interventional cardiologist at the Cité-de-la-Santé in Laval, is the founder of the Day of Tree Health, which is an event in Québec combining health and the environment through tree planting activities conducted primarily on the grounds of health facilities, as part of the Montréal urban forest action plan.

A total of 8,275 trees has been planted over six years, in Montreal alone. The Francophone Doctors of Canada group is also involved in the Day of Tree Health and have created a kit to help orient new participants, including a draft invitation to employees, a press release, and an organization guide for leadership. Dr. Myles Sergeant is a family physician, CAPE supporter, and founding member of the charitable organization Trees for Hamilton who has planted trees at several health care sites in Hamilton, Ontario. In his words, "We believe that trees are important to human health. The closer trees are to people the better. It can be challenging to find places downtown to plant trees so we're grateful to have hospitals to partner with."

emissions are generated permits the customization of GHG reduction plans for each HCF. It can also reveal shifting patterns of GHG emissions at sites, such as moving from direct to indirect sources of emissions.

Carbon Offsets and Tree Planting

In BC, public sector facilities such as HCFs are required to purchase carbon offsets from the provincial government in order to maintain carbon neutral facilities. There are other voluntary carbon offset programs in Canada, such as the 'Carbone boreal' greenhouse gas offset program, which is both a tree planting initiative and research project housed by researchers at the Université du Québec à Chicoutimi in Québec.

Tree planting initiatives have taken

root within various health care systems. The Centre for Sustainable Healthcare in England coordinates the National Health Service (NHS) Forest program, which aims to build a long-term legacy of forests for health by engaging people with their immediate environment and forested space that will be used and continually improved by staff, patients and the local community.

Doctors in both Montreal, QC and Hamilton, ON have taken the initiative to plant trees at HCF locations in Canada. Studies have shown that trees have numerous benefits besides absorbing carbon dioxide and reducing GHGs including health benefits such as improved respiratory health by cleaning the air, helping to reduce stress, creating a sense of calm, and providing shade during hot sunny days, as well as increasing resilience of the HCF by assisting with controlling floods. For a bibliography of evidenced based research see the NHS Forests resource below.

Resources:

- <u>Greenhouse Gas Emissions Off-</u> set Projects BC
- <u>Carbone boreal</u>
- <u>NHS Forests: Bibliography of re-</u> search evidence of the benefits of green spaces and trees
- <u>Trees for Hamilton</u>
- Day of Tree Health kit

Approximately 25% of hospitals in Ontario voluntarily use some kind of waste anesthetic gas collection and recovery system. Sunnybrook Hospital in Toronto, Ontario has participated in a waste anesthetic gas collection program for 13 years. Staff estimate that approximately 780 tonnes of waste anesthetic gases are collected annually, representing an estimated 4% of GHG emissions from their facility (Carss, 2018)

Inhalation Anesthetic Gases

The primary inhalation anesthetic gases used in HCFs are Desflurane, Isoflurane, Sevoflurane, and nitrous oxide, which also acts as a carrier gas. These anesthetics are potent GHGs, with over 95% of the gas that is administered to patients being directly vented into the environment during use, owing to their low metabolization rates and some of them remain in the atmosphere for years (Sulbaek-Andersen et al. 2010). The 2014 global release of anesthetic gases totaled 3 million tonnes of CO₂e, 80% of which were Desflurane and of the total global nitrous oxide emissions, 1% is reported from medical sources (Charlesworth, 2017).

In Canada, inhalation anesthetic gases are not included in reporting

requirements, even though these are direct emissions from HCFs; as a result, total emission quantities are unknown. Studies from the Sustainable Development Unit at the NHS in England (SDU, 2013) have determined that anesthetic gases represent 5% of the carbon footprint of acute care organizations, equivalent to approximately 50% of GHG emissions from heating buildings and water. Nitrous oxide represents the highest volume gas of all the anesthetics that are used, and therefore is the largest component of GHG emissions from anesthetics, making it a prime target for tracking and reduction.

Recommendations from an anesthetic gas life-cycle study by Sherman et al. to reduce GHG emissions include: utilizing low fresh gas flows; avoiding high impact inhaled anesthetics like Desflurane and nitrous oxide; consid-

Personnel in the Anaesthetic Department at Western Health in Melbourne Australia voluntarily reduced their Desflurane and nitrous oxide use, aiming to use lower flows of gases in general. These efforts lowered annual costs by \$22,500 USD, and reduced greenhouse gas emissions by 140 tons per year (Hospital and Healthcare, 2018). ering the use of intravenous and regional techniques; investing in Waste Anesthetic Gas (WAG) trapping technology for volatiles only and WAG destroying technology for all inhaled anesthetics including nitrous oxide by updating anesthesia machines.

The American Society of Anesthesiologists have launched the Inhaled Anesthetic 2020 Challenge program to reduce inhaled anesthetic greenhouse gas emissions 50% by 2020. The Royal Society of Anaesthetists and researchers in the Department of Anesthesiology at Yale University have developed carbon calculators that can help HCF staff calculate the GHG equivalents of the anesthetic gases used in their facilities. See resources below.

Resources:

- <u>SDU Carbon Calculator anes-</u> thetic gases
- Inhaled Anesthesia Climate Initiative: Inhaled Anesthetic 2020 Challenge and Calculator

Sustainable Procurement

In Canada, the large majority (90%) of GHGs in the health sector originate upstream from the HCFs (Eckelman et al. 2018). Although there is no comprehensive sustainable procurement initiative in

Canada, some HCFs have developed their own green purchasing policies, while others are beginning to ask about the sustainability of products in their requests for proposals.

With the majority of GHG emissions coming from supply chain sources, waste recycling will not significantly reduce a facility's carbon footprint, so waste reduction approaches will

Students can be empowered to take direct actions that will improve sustainability at health care facilities. After winning a social innovation contest that provided seed funding, Alec, a second-year medical student at the University of British Columbia and his colleague Iman, a biology and anthropology student at Simon Fraser University, have been conducting research and quality improvement work on medical waste and sustainability at a BC Hospital over the past two years.

Their work has included both developing a methodology for waste quantification and conducting a national survey of environmental sustainability in critical care units. Next steps include helping the hospital implement changes in their intensive care unit. The team sees significant potential in helping to reduce waste and lower costs at hospitals via greater emphasis on purchasing and stocking processes that take waste volumes and associated costs into consideration. By reducing the quantity of medical devices purchased, the hospital will also be able to reduce its GHG emissions. need to take precedence. Programs to address the operating room, as the most product intensive area of in HCFs, should be considered (Kagoma et al. 2012). By adopting sustainable procurement policies, strategies, and practices, the health sector and HCFs have an opportunity to spearhead a significant shift in the manufacturing sector to develop greener products throughout their lifecycles.

Sustainable procurement program references can be found in the resources below, and include those in the US and Europe which support HCF participation:

- The Greenhealth Exchange is an environmental purchasing catalogue and exchange for health care facilities in the United States owned by Practice Green Health and includes health care organisations as members, aiming to accelerate the development and adoption of new, more environmentally-friendly products. As a first step, the Exchange lists products that would enable hospitals to meet purchasing targets outlined in the Healthier Hospital Challenges, a program that identifies key activities which HCFs can undertake, and which if undertaken by many HCFs, will result in shifts in the health care sector supply chain.
- The Sustainable Health in Procurement Project (SHiPP) is a program developed by the United Nations Development Programme in collaboration with Health Care Without Harm,

and funded by the Swedish International Development Agency. The SHiPP program is designed to reduce the harm to people and the environment caused by the manufacture, use, and disposal of medical products and by the implementation of health programs, mainly targeting lower and middle-income countries.

- The EKU Swedish tool is for ecologically sustainable procurement that supports public organisations.
- The Procuring for Carbon Reduction tool, developed by the SDU national sustainability support program in England, bases purchasing on a hierarchy of interventions including (from highest to lowest) reduce demand, reduce in-use emissions, substitution and innovations, and supply chain management.

Resources:

- Greenhealth Exchange
- <u>The Sustainable Health in</u> <u>Procurement Project (SHiPP)</u>
- <u>EKU Swedish Tool</u>
- <u>Procurement for Carbon Re-</u> <u>duction</u>

Pharmaceutcals & Medical Devices

The Eckelman et al. (2018) research team study of the Canadian health sector identified pharmaceuticals as a primary source of GHG emissions, although Canada will need to look abroad for examples of strategies in this area. In England, the NHS Sustainable Development Unit (SDU) carbon footprint reporting identified pharmaceuticals (21%) and medical devices (11%) both to be 'hotspots' (NHS SDU 2012).

The SDU national sustainability support program has engaged with these sectors to establish greater uniformity in GHG emissions accounting and reporting across pharmaceutical and medical device 'life-cycles' from manufacturing through usage to disposal. As part of this engagement, the SDU created a list of the top 20 pharmaceuticals with high GHG emissions accounting for 60% of their carbon footprint, which then have been targeted for reductions. Optimization of medical device use can begin with an examination of where large volumes of unused medical devices are being discarded, often in operating rooms and surgical theatres, and explore opportunities for medical device reprocessing (Kagoma et al. 2012).

Resources:

- <u>Carbon footprinting pharma-</u> <u>ceuticals and medical devices</u> <u>from SDU</u>
- <u>Guidelines for the procurement</u> of safer medical devices from <u>SDU</u>

Transportation

Transport systems are key resources for HCFs, which rely heavily on these networks to move supplies, contractors, patients, staff, laboratory samples, and wastes. For some facilities, transportation systems are required for offsite services such as laundry, sterilization, and the preparation of food. Climate-related events such as floods, severe storms, and wildfires can restrict access to transportation services, with the potential to disrupt the delivery of critical health care.

Notably, the transportation sector is the second largest source of GHG emissions in Canada, accounting for 25% (173 Mt CO² eq) of the national total. Transportation GHG emissions grew by 42% between 1990 and 2016, largely due to an increase in freight trucks and passenger light trucks. In addition to carbon dioxide, transportation sector activity produces other air pollutants like nitrogen oxides

Seattle Children's Hospital has been leading sustainable transportation efforts in the area of its workforce commuting by reducing drive-alone trips among staff traveling to and from the facility from 73% to 38% between 1995 and 2015.

This achievement was accomplished by charging daily parking rates, offering generous subsidies and incentives to use lower-impact commuting options, working with the city and county on local bicycling, pedestrian, and transit improvements, and providing personalized commute planning to every new employee.

that convert into atmospheric ozone and contribute to the greenhouse effect, as well as particulate matter, volatile organic compounds, and other substances known to be harmful to health (ECCC. 2018).

There are many simple transportation initiatives that health care workers can support to be implemented at HCFs, including anti-idling initiatives, ride-share programs, and hospital-sponsored public transit incentives.

Active Travel

Active travel in the context of HCFs refers to using public transit and physically active modes of transportation like walking and bicycling to reduce the frequency of single-occupancy vehicle commuting. Supporting active travel can have many co-benefits for HCFs, including reduced need for staff parking areas, reduced traffic congestion allowing for easier emergency vehicle access, improved local air quality, and more physically fit and healthy staff.

Active travel initiatives undertaken by HCFs could include surveying staff about their current commuting habits and interest in alternatives, offering bicycle repair workshops and providing bicycle racks, parking cages, and shower areas for cyclists, developing incentives and/or subsidies for staff to use lower-impact options such as transit, charging daily parking rates, providing shuttle buses between campuses, and supporting car-pooling initiatives. CAPE's Active Travel toolkit found in the resources below, provides additional information on these types of programs.

Cleaner Transportation and Fleets

Electric vehicles, or 'low emission' vehicles, can contribute to lowering overall GHG emissions. These vehicles can be encouraged at HCF sites by educating staff on the benefits of electric vehicles, installing electric vehicle charging stations, and providing preferred parking areas for these types of vehicles. Greening HCF fleets by switching to electric and/or hybrid vehicles could further Energy saving ambulances: The Peterborough County-City Paramedics will be the first emergency responders in North America to use custom-designed, eco-friendly ambulances which mimic models used in Europe. Peterborough County-City Paramedics purchased three New Era ambulances in 2018 that have solar panels on the roof and a mechanism that puts the vehicle to sleep when its idling and monitors battery systems, reviving it up when needed (Nyznik, 2018).

contribute to lowering GHG emissions.

Support Suppliers who are committed to Green Transportation

The US EPA's SmartWay program helps companies apply sustainability to their supply chains by measuring, benchmarking, and improving freight transportation efficiency. This American-based program also collaborates with organizations in Canada to help reduce their emissions for a more sustainable freight transportation supply chain throughout North America, overall.

In England, the Sustainable Development Unit (SDU's) Health Outcomes of Travel Tool (HOTT) helps HCF organisations to measure the impact of their travel and transportation in environmental, financial, and health terms. The HOTT facilitates the quantification of impacts, including air and noise pollution, road traffic incidents, and greenhouse trav-



Garden on Hospital Grounds, Halifax, Nova Scotia. Photo by Kim Perrotta.

el and transportation impacts from different travel modalities to help develop a plan and targeted initiatives that reduce the health sector's impact from travel and transport.

Telemedicine and Tele-health

In studies by Holmner et al.(2014), and Masino et al.(2010), telemedicine and tele-health were seen as excellent opportunities to reduce GHG emissions from health sector travel. For distances over a few kilometers, telemedicine appointments can result in a 40- to 70-fold decrease in carbon emissions compared to alternative transportation by single-occupancy vehicle. In comparison, GHG emissions produced for the energy used in videoconference units were minor.

Persuading and training potential us-

ers to adopt telemedicine and tele-health as tools to be integrated into their regular practices was identified by the researchers as an important next step. Co-benefits of this approach include increased efficiency and reduced system costs. Advancing the uptake of telemedicine also presents an opportunity to improve delivery of care in areas where access and transportation can be challenging, such as remote communities and regions in northern Canada. Accordingly, the Lancet Countdown Report Briefing for Canadian Policy Makers identified Telemedicine as a nationally-relevant opportunity for Canada to reduce its GHG emissions (Howard et al. 2017).

The Ontario Telemedicine Network (OTN) is one of the largest tele-health organizations in the world, with the mission to 'develop and support telemedicine solutions that enhance access and quality of health care in Ontario, and inspire adop-

Resources:

- Seattle Children's Hospital Comprehensive Transportation Plan
- Prescribing Active Travel for Healthy People and Planet: A Toolkit for Healthcare Professionals. CAPE, March 2017
- <u>SmartWay, U.S. EPA's Sustain-</u> able Transportation Tool
- HOTT, SDU's sustainable transportation tool
- Ontario Telemedicine Network

tion by health care providers, organizations, and the public'. Funded by the Ontario Government, OTN has extensive telemedicine networks, and has been working to mainstream virtual access for health care delivery and education over the past decade. On a smaller scale, tele-networking systems such as audio, video, and web conferencing can be effective tools for holding virtual meetings.

Food

Canadian HCFs spend more than \$4 billion on food annually, and are thought to be discarding up to 50% of the food served (Nourish Infographic). The agricultural sector (defined as non-energy crop and animal production) contributes approximately 5% of total health care GHG emissions, primarily from nitrous oxide emissions from fertilizers and methane from ruminant animals, underscoring the interlinkages between the healthcare system and the food system (Eckleman et al. 2018). Broken down further, agricultural production accounted for 30% of national methane emissions, and 77% of national nitrogen oxide emissions, with livestock and fertilizers as the main contributors (Eckleman et al. 2018).

Canada's new food guide and the EAT-Lancet Commission on Food, Planet and Health (see resources below) both stress a need to reduce the consumption of meat in our diets, to support our personal health and the health of our planet, while reducing GHG emissions. As such, HCFs have an opportunity to design menus that model sustainable, more plant-based diets which could enable a shift to low-carbon foods and healthier sourcing for people and the planet. As one example, a two-year initiative known as Nourish, which supported 25 health care food innovators across Canada up to 2019 to explore how specific sustainable food initiatives could be implemented to leverage food budgets and the reputational credibility of the health care sector in order to improve health outcomes (Nourish website).

Resources:

- <u>Nourish Health Care Food in-</u> fographic
- <u>Canadian Coalition for Green</u> <u>Health Care – Food Waste Re-</u> <u>sources</u>
- <u>The EAT-Lancet Commission</u> on Food, Planet, Health
- <u>Canada's new food guide</u>

Leadership

A report by Miller et al. (2018) concluded that health system leaders are at least somewhat aware of climate change, but very few regard it as an important factor affecting their work or patients' health. This lack of awareness presents an opportunity for action to raise awareness and build climate leadership within the health system in Canada.

A new initiative by the CCGHC to address this leadership deficit is the Green Health Leaders program, which seeks to engage and support leaders to move their organization toward new levels of stewardship in climate change and environmental sustainability. In other countries, health care leaders have already assumed a leadership role, and become advocates for climate change as a health issue. One example is the Health Care Climate Council in the United States, which was established by Health Care Without Harm in 2014 as a leadership body to coordinate health systems committed to protecting their patients and employees from the health impacts of climate change. The Council recognizes

Resources:

- <u>Green Health Leaders Initia-</u> <u>tive, a project of the Canadi-</u> <u>an Coalition for Green Health</u> <u>Care</u>
- Health Care Climate Council
- <u>Climate Action, a playbook</u>
 <u>for hospitals</u>

their organizations as anchors for resilience in their communities. Mitigation, resilience, and adaptation are important priorities for the Council. With respect to leadership, Council members agree to act as critical messengers in communicating the health impacts of climate change, and to advocate for climate-smart policies at all levels of government.

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Module 6

Climate Change Toolkit for Health Professionals Factsheet: Taking Action on Climate Change at Health Facilities

Health Care Facilities (HCFs) & Climate Change

Climate-related events are already impacting health care facilities in Canada. Warnings have been issued by a few sources that health systems around the world are not prepared to manage the health impacts of climate change. In addition, many agencies have identified the need to increase the resiliency and sustainability of health care facilities and health infrastructure. The following are examples of initiatives, projects, policies and programs which can be promoted and undertaken to help health care facilities become more sustainable and resilient in adapting to anticipated climate-related impacts.

Climate-related events can affect the delivery of health care services at health care facilities in many ways. Multiple impacts often can occur simultaneously. They can:

- Affect the physical, emotional and mental health of health care workers;
- Damage the building envelope, internal infrastructure, electrical and mechanical systems including heating, ventilation and air conditioning systems;
- Reduce access to critical support services such as transportation, power, water supply, and tele-communications;
- Reduce access to non-medical supplies and services such as food, linen and site cleaning, waste disposal and storage services, data management systems and patient record systems, and steril-

ization services;

- Reduce access to medical supplies and products including local sources of products such as blood service and globally manufactured medical products sourced from areas affected by climate-related events;
- Reduce access to health and clinical services during temporary closure periods, delay surgical treatment, and delay access to outpatient services such as dialysis;
- Increase emergency room visits and hospital admissions for impacts such as heat stress, frostbite, respiratory distress, exposure to climate-sensitive diseases, physical and psychological trauma, and patient transfers from other HCFs experiencing service disruptions;
- Activate the health care facility emergency plan; and
- 9. Increase costs.
- 10.Health care facilities are both impacted by, and contribute to, climate change but have to remain operational when emergencies strike.

Resilience, Vulnerability & Adaptation Assessments

Tools to help health care facilities become more resilient, assess their vulnerability and build adaptations include:

HCF Climate Change Resiliency Assessment

The Health Care Facility Climate Change



Resiliency Checklist can be used by health care facility staff to assess their resiliency to climate change. The checklist includes questions about vulnerabilities which could happen across the HCF such as: emergency management, facilities management, health care services including clinical areas and supply chain management. The results can be used to identify areas that need to be strengthened.

HCF Vulnerability wAssessments

Conducting health care facility vulnerability assessments focuses on identifying potentially vulnerable infrastructure as a result of climate-related impacts, and how that infrastructure could be expected respond to anticipated climate changes. This information could be used to help senior leadership and others make more informed decisions in preparing for climate-related events now, and in the future, over the expected lifespan of the facility

Vulnerability & Adaptation Assessments (V&A)

From a public health perspective, vulnerability and adaptation (V&A) assessments can further examine population-level vulnerabilities to climate change in the community. These vulnerability assessments can be used to identify vulnerable populations and map the location of potential health risks, employing climate data to inform adaptation and planning, in which health care facility staff should take part. The HCF is critically important, especially due to their reliance on municipal infrastructure such as transportation, power, and water and wastewater services with the potential to be impacted during climate-related events.

Stress Testing

Climate and health "stress tests" can be undertaken to gain further information on potentially disruptive climate-related shocks and stresses that may otherwise be missed in a V&A assessment. Stress testing uses the development of hypothetical scenarios to understand cases where the health system would be stressed to such a degree that it might not be able to provide services to the public, providing insights from a new perspective.

Sustainability & Resiliency Measures At HCFs

Sustainability and resiliency measures are inextricably linked. Initiatives which are contributing to sustainability will likely also improve resiliency. For example, by using less energy, a facility can remain operational longer should power outages occur because of the finite stand-by energy available at that time.

There are many challenges to implementing new initiatives. Health care practitioners have limited time and resources, are faced with fiscal restraints, and new initiatives have to compete with other priorities. Factors that enable the success of new initiatives include the existence of a regulatory backdrop, leadership making it a priority, having an action plan, the availability of resources, and co-benefits for the health system.

Canadian Health Sector -GHGs

The GHGs emitted from Canada's health care life cycle (directly and indirectly through their supply chain) represented an estimated 4.6% of the national total in 2015. However, GHG emissions in the health sector are increasing at double the rate of the national average - 10% compared to 5% between the years 2009 to 2015.

Given its increasing contribution, targeted support programs to reduce emissions in the health sector could play an important role in national climate change mitigation efforts. Figure 1 identifies the economic sectors which contribute to health sector GHG emissions. The energy sector is the largest contributor.

Support Programs at HCFs

On-site sustainability support initiatives can include establishing green committees or teams to work across an HCF. A larger scale sustainability and resiliency support office for Canadian HCFs could be built on the Sustainable Development Unit model implemented effectively by the National Health Services in England. It could help to accelerate GHG reductions in the health sector, and work towards improving environmental, social, and financial aspects of health care services delivery.

Energy

HCFs have the highest energy use intensity (2.45 Gigajoules/m²) of all commercial and institutional buildings in Canada. Despite accounting for only 0.2% of commercial and institutional buildings, hospitals account for 4.1% of total energy used by the building sector. Building energy used by the building sector. Building energy use is also a significant contributor to GHG emissions classified as Scope 1 (onsite energy, fleet vehicles, waste anesthetic cases, and refrigerants) and Scope 2 (purchased electricity and purchased steam) at the HCF. Traditional initiatives to assist in energy reduction include annual energy and greenhouse gas reporting requirements, use of benchmarking tools, and provision of energy manager programs with access to incentives. More progressive initiatives for Canadian health care facilities include establishing energy and greenhouse gas reduction targets for the health care sector, including increased use of renewable energy, and mandatory GHG emission audits.

Inhalation Anesthetic Gases

The primary inhalation anesthetic gases used in health care facilities are Desflurane, Isoflurane, Sevoflurane and nitrous oxide, which can also act as a carrier gas. These anesthetics are potent GHGs, with over 95% of the gas that is administered to patients being directly vented into the environment during use, owing to their low metabolization rates. In England, nitrous oxide was identified as the highest volume gas of all the anesthetics used, and therefore the largest component of GHGs emitted as anesthetics, making it a prime target for tracking and reduction. A study found that anesthetic GHGs could be reduced by: utilizing low fresh gas flows; avoiding high impact inhaled anesthetics like Desflurane and nitrous oxide; considering the use of intravenous and regional techniques; investing in Waste Anesthetic Gas trapping for volatiles only and Waste Anesthetic Gas destruction for all inhaled anesthetics, including nitrous oxide, in terms of the technology to update anesthesia machines.

Sustainable Procurement

In Canada the large majority (90%) of GHGs in the health sector originate upstream from the health care facilities. With the majority of GHGs coming from the supply chain sources, waste recycling will not significantly reduce a facility's carbon footprint, and so waste reduction approaches will need to take precedence. By adopting sustainable procurement policies, strategies, and practices, the health sector and health care facilities have an opportunity to spearhead a significant shift in the manufacturing sector to develop greener products throughout their life-cycles.

Pharmaceuticals & Medical Devices

A GHG analysis performed on the Canadian health sector identified pharmaceuticals as a significant source of GHGs for the whole health sector, based on dollars spent. In England, a carbon footprint analysis identified pharmaceuticals (21%) and medical devices (11%) as carbon 'hotspots', and the Sustainable Development Unit created a list of the top 20 pharmaceuticals with high GHGs, accounting for 60% of the carbon footprint in this area. These pharmaceuticals have been targeted for reductions. Optimization of medical device use can begin with an examination of where many unused medical devices are discarded, often in operating rooms and surgical theatres, and explore opportunities for medical device reprocessing

Transportation

Transport systems are key resources for HCFs which rely heavily on these networks to move supplies, contractors, patients, staff, laboratory samples, and wastes. For some facilities, transportation systems are required for offsite services such as laundry, sterilization, and the preparation of food. Climate-related events such as floods, severe storms, and wildfires can restrict access to transportation services, with the potential to disrupt the delivery of critical health care. Alternative transportation initiatives which the HCFs could promote to reduce GHGs include walking, cycling, public transit, fleets employing electric or otherwise 'low emission' vehicles, and contracting suppliers who are committed to green forms of transportation. Initiatives to ensure functional transportation routes in the event of a climate-related disaster should be undertaken through adaptation planning with the community.

Telemedicine & Tele-health

Telemedicine and tele-health have been identified as excellent opportunities to reduce GHGs from health sector travel. For distances over a few kilometers, telemedicine appointments can result in a 40- to 70fold decrease in GHGs compared to transportation in a single-occupancy vehicle.

Food

Canadian HCFs spend more than \$4 billion year on food and an estimated 50% of food is discarded. HCF nutrition departments could focus on plant-based diets from sustainable and local sources which would help reduce GHGs and enhance resilience both at HCF and within the community.

Leadership

A report by Miller et al 2017 concluded that while health system leaders are somewhat aware of climate change, few see it as an important factor in their work or their patients' health. This lack of awareness presents an opportunity for action to raise awareness and build climate leadership within the health system in Canada.

NOTE: References for this factsheet can be found in Module 6 of <u>CAPE's Climate</u> <u>Change Toolkit for Health Professionals.</u>



Climate Change Toolkit for Health Professionals Preparing for Climate Change in our Communities

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ACME Association Canadienne des Médecins pour l'Environnement for the Environment

Module 7 – Preparing for Climate Change in our Communities

Introduction

All levels of government are increasingly concerned about the growing risks to the health of Canadians from climate change (Berry, 2014). Cities expect climate change to seriously compromise public health infrastructure when extreme weather disrupts crucial services (Watts, 2018). Municipal and regional public health officials are concerned about how a changing climate could exacerbate existing health issues or create new health burdens (Paterson, 2012).

Regional and local governments are taking action to adapt to the risks associat-



A homeless man outside in extreme cold weather. Photo by Tedward Quinn on Unsplash.

ed with climate change. Successful adaptation requires collaboration between sectors such as health, environment, planning, transport and infrastructure as well as non-government organizations (Paterson, 2012, Berry, 2014).

This module provides an overview of adaptation policies and programs undertaken by a range of sectors within local governments and community organizations. These actions include measures associated with temperature extremes (heat and cold), floods, wildfires, vector-borne diseases, food systems and water quality. Building community resiliency will also be discussed. Each section in this module contains a summary of the associated impacts, examples of local actions and topic specific actions for consideration by health professionals.

Extreme Cold Weather

Climate change is likely to bring volatile swings in weather that may result in more frequent unusual cold spells (Ebi, 2013). Exposure to extreme cold weather can increase the immediate risk of cold-related injuries including hypothermia and frostbite. Cold weather, even with moderate temperature changes, can also increase the risk of cardiovascular-related mortality for up to several days after exposure (TPH, 2019, Canada, 2019).

Extreme Cold Weather Alerts and Response Programs

Extreme cold warnings are issued when very cold temperatures or wind chill create an elevated risk to health. While Environment Canada issues extreme cold warnings across Canada, some municipalities also issue alerts based on local criteria (Canada, 2018). For instance, Toronto's Extreme Cold Weather Alert is based on factors such as temperature, wind chill, precipitation, or several days and nights of cold weather in a row that increase the impact of cold weather on health (TPH, 2019). The Greater Vancouver Area's Extreme Weather Response Alerts are issued when temperatures are near zero with precipitation and/or sustained high winds (HSA of BC, 2019). Alerts are shared with service providers, transit authorities and other partners who can warn people about the risks of extreme cold. Alerts are often communicated to the public by media who deliver weather information via television, radio and digital platforms.

The issuing of extreme cold alerts triggers local community responses. In Montreal, the Société de transport de Montréal allows homeless people to warm up in transit stations during extreme cold temperatures and provides free shuttles to get them to shelters once the stations close for the night (STM, 2017). Additional homelessness services are initiated in the City of Toronto during cold alerts, including outreach teams who contact individuals on the street and check on their condition and offer transportation to a shelter, winter respite drop-in or their home. Shelters add temporary beds and extend their hours of operation to allow clients to stay indoors until other services in the area are open. Transit tokens are distributed to individuals at drop-in centers to allow them to reach shelters and other community service locations (TPH, 2019).

Cold Weather Services in the Winter Season

Cold-related injuries can occur at times when Extreme Cold Weather Alerts are not in place. Toronto Public Health interviews with people experiencing homelessness found that throughout the winter their health was affected by precipitation,



Université-de-Montréal Metro Station. Photo by Chicoutimi, 2010.

changes in temperature, high occupancy in shelters, anxiety, stress and worsening of pre-existing conditions. To address these issues, the City of Toronto's cold weather response includes 24-hour continuous respite drop-in services across the city during the winter months. Services include providing resting spaces, meals and service referrals (City of Toronto, 2019).

Protecting Renters from Extreme Cold

In addition to protecting the homeless population from extreme cold, some

Case Study: Keeping Warm in Vancouver

Vancouver opens warming centres in extreme cold weather as a life-saving measure. Last year, up to 100 people accessed their warming centres on any open night.

Warming centres include community centres and other public buildings. While they are not set up with beds or mats, they provide a safe, warm space for people who might be living outside.

Warming centre alerts are circulated to partner agencies, community centre staff, outreach program staff and a variety of agencies serving individuals experiencing homelessness.

(Adapted from the 2019 City of Vancouver Winter Response Strategy)

communities have temperature bylaws for rental accommodation. For example, Ontario's Residential Tenancies Act, 2006 requires landlords to maintain a minimum temperature as set by the local municipality/city. Toronto has a bylaw that requires landlords to provide heating up to at least 21°C between September 15 and June 1 of each year (Toronto, 2019).

Health Professional Tips for Taking Action

- Be aware of local extreme cold weather alerts that are issued and discuss the risks of extreme cold weather with your vulnerable clients/patients (e.g. seniors, people who have cardiovascular disease and the under-housed).
- Provide clients/patients with information on how to stay safe in the cold and provide links to resources such as <u>Health Canada's Extreme Cold web page</u>
- Be aware of and connect clients/patients who may be experiencing homelessness, or are under-housed to cold weather services in your community. These services may include warming centres and shelters that add temporary beds.

Extreme Heat

It is predicted that, in Canada, heat waves will be more severe, occur more frequently and last longer (Berry, 2014). The risk of heat-related illness and death is greatest when temperatures increase beyond values traditionally experienced, and when these high temperatures are sustained through several consecutive extremely warm days and nights (Guiobault, 2016).

Heat Alert and Response Systems

Many Canadian communities have Heat Alert and Response Systems. In Ontario, health units and municipalities use a Harmonized Heat Warning and Information System in which the issuing of heat alerts activates response plans based on the association between temperature, humidex and mortality (TPH, 2019). Gatineau's heat response plan has region-specific thresholds that reflect when higher mortality and morbidity

"Climate change is intensifying pressures on human health & wellbeing, in large part, because of the loss of natural features that support climate resilience – trees to provide shade and protect from extreme heat, and wetlands to mitigate the impacts of flooding."

(Personal communication, Environmental Health Working Group Chair, Ontario Public Health Association, 2019) rates were observed (Guiobault, 2016).

Decreasing the Impact of Urban Heat Islands

Higher temperatures occur in urban areas because of a preponderance of dark, heat-absorbing surfaces such as roads, roofs, parking lots and sidewalks, as well as the displacement of trees and green spaces that provide natural cool-The dark surfaces release stored ina. heat overnight, preventing cities from cooling off. These areas are known as Urban Heat Islands. Temperatures in urban centres can be reduced by increasing urban vegetation, the use of reflective surface materials that reflect or reduce heat conduction, and natural or constructed shade structures (TPH, 2015).

Communities are promoting cool and green roofs to reduce summer temperatures in urban settings (Guiobault, 2016). In addition to reducing the intensity of the Urban Heat Island effect, green roofs enhance air quality and public health by capturing airborne pollutants, providing green space and improving biodiversity. They also reduce stormwater runoff by retaining water and delaying the timing of any runoff that does occur (ICLEI Canada, 2012). Rosemont-La Petite-Patri, Quebec has white and green roof regulations in which property owners wishing to replace or build a new roof must install a green roof, a white roof, a highly reflective cool roof or a combination there-

Case Study- An Innovative Approach to Reducing Urban Heat: Schoolyard Oasis Project

Paris suffers from a significant lack of green space for residents – just 9.5% of Paris consists of parks and gardens. The 2017 heat waves in Paris highlighted that the city's impermeable asphalt-covered schoolyards were an impediment to ongoing efforts to battle heat in the city. With temperatures on the rise and asphalt trapping heat, schools have been forced to close due to dangerously high heat waves.

The "Schoolyard Oasis" project transformed school yards from asphalt into lower-temperature green spaces that all Parisians can use during heat waves. The schoolyards will also serve as community centers and cultural hubs that can be used during after school hours, improving community cohesion and reducing isolation amongst residents. School greening will be mainstreamed in all renovations moving forward, making it the new standard. With the average Parisian living within 200 meters of a schoolyard, the project has the potential to impact every resident in the city when fully implemented. Adapted from 100 Resilient Cities: Schoolyard Oasis Project, 2019

of (Guilbault , 2016). The City of Toronto requires the construction of green roofs on new developments. The Green Roof Bylaw affects all new residential, institutional, commercial and industrial building developments with over 2,000 m² of gross floor area (ICLEI Canada, 2012).

Greening Communities

Green spaces help to reduce the intensity of the urban heat island effect as well as provide additional health benefits. Links between health and green space include lower all-cause mortality and improved wellbeing associated with green space. Both small and large green spaces are of value, and the association between green space and health is likely stronger for disadvantaged populations (TPH, 2015). In addition, outdoor physical activity in a natural environment or relaxing in a park improves mental health and reduces mental fatigue (Vancouver, 2018).

Kingston and Peel Region are working to reduce the risk of extreme heat in urban centres by encouraging the planting of more shade trees. Surrey has developed a robust street tree management plan (Guiobault, 2016). The EcoHealth Ontario (EHO) collaborative fosters improved health and wellbeing outcomes through the provision of better ecosystem quality, increased green space and enhanced access to nature. <u>EHO's Greenspace and EcoHealth Toolkit</u> provides resources, guidance and assistance to those interested in making improvements in community health through green space provision,



Park, St. John's, Newfoundland and Labrador. Photo by Kim Perrotta.

access and design. The Toolkit includes a series of profiled case studies drawn from municipalities, public health and conservation agencies that have begun to make connections between green space and community health (Eco Health, 2017).

Official Plans Set the Tone

Zoning regulations such as the green roof bylaws and provision of green spaces are often supported by Official Plans. Official plans can be designed to incorporate climate change adaption as they provide the policy framework for all other planning decisions. For instance, the City of Winnipeg supports green design principles and construction methods for new buildings and neighbourhoods in their community sustainability plan (Winnipeg, 2019).

Maximum Indoor Temperature Bylaws

People spend most of their time indoors. This can be particularly true for the elderly and those who are chronically ill or socially isolated, for whom indoor temperature can have a substantial impact on health and well-being (TPH, 2015). Bylaws currently exist in some communities such as the City of Toronto and Town of Ajax that set maximum indoor temperatures of 26°C during the summer for rental apartments with air conditioning. Toronto Public Health suggests that from a health equity perspective, it is important that the same standards are applied to residents who do not have air conditioning in their apartment. Toronto and Durham Region are exploring the feasibility of implementing a maximum indoor temperature standard/bylaw for rental multi-unit residential buildings without air-conditioning. Considerations include the implications of adding air conditioning units to the electrical grid and requiring a cool common room where tenants can take reprieve from the heat (TPH, 2015, Durham Region, 2018).

Health Professional Tips for Taking Action

- Be aware of extreme heat alerts and sign up for email or text notifications, if available in your community. Here is the link to <u>Environment Canada public alert</u> page
- Discuss the risks of hot weather with your clients/patients and promote the use of local cooling spaces (e.g. air conditioned spaces and shaded areas). Provide them with information on how to stay safe in the heat and links to resources such as <u>Health Canada's "It's Way too Hot" web page</u>
- Discuss <u>UV index implications</u> with your clients/patients and encourage them to seek shade.
- Encourage your clients to spend time in green spaces, prescribe nature and take the time yourself to enjoy activities in natural environments. Learn more about the benefits of being outside
- Support projects in your community to decrease urban temperatures and prevent climate change impacts on health such as green roofs and increasing the amount of green spaces.
- Support initiatives in your community to protect vulnerable populations from weather extremes by supporting policies such maximum temperature bylaws.

Building Flood-Resilient Communities

In Canada, heavy precipitation events and rising sea levels will increase the risk of flooding in many communities (Berry, 2014). Along with immediate injury and death from flood water, longer-term impacts on health include respiratory illness related to an increased risk of mould developing in homes damaged by flood waters, contamination of drinking water from wells and mental illness associated with destruction of infrastructure, homes and livelihood (Watts, 2018). Psychosocial impacts associated with being displaced due to flooding include increases in alcohol and drug use and family violence, and other general symptoms of high levels of stress such as depression, anxiety, sleep disruption, post-traumatic stress disorder (PTSD) and an increase in physical ailments.

Measures can be taken to build flood-resilient communities, including the development of guidelines and policies for flood-prone areas. For instance, the Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities report provides guidance to local governments through a framework for prioritizing flood resilience efforts and suggested approaches to reduce flood risk. Actions include proactive maintenance of flood control structures, re-grading of lots and roadways, and constructing new or upgrading stormwater storage facilities. The report recommends that flood forecasting and warning protocols be put in place and include standard messaging and communication protocols (Moudrak, 2019).

After the June 2013 flood damaged homes for thousands of residents in Southern Alberta, the Government of Alberta developed flood policies that prohibit future development in floodways. The policy requires homeowners to take on future risk if they opt to stay in their homes and they will no longer be eligible for future Disaster Recovery Fund assistance. The City of Calgary is revising its zoning bylaws to limit development in flood hazard areas (ICLEI Canada, 2014).

Outreach and education to the public can increase awareness of local flooding



Caption: 2013 Calgary Flooding on Elbow Drive. Photo by Andy Van Der Raadt.

risks and associated physical and mental health impacts (CCNB, 2018). The coastal community of Annapolis Royal, Nova Scotia, developed flooding maps in response to rising sea levels and increased flood risks. The flooding maps were presented to citizens in a series of public forums. These were followed by a mock disaster scenario that engaged local fire, medical and emergency response teams. The public was also involved, allowing citizens to observe the potential effects that a flood might have on their lives and enabling them to explore how to minimize property damage and harm during a real disaster (Canada, 2015a).

Health Professional Tips for Taking Action

- <u>Be aware of local flooding risks</u> and warnings in your community.
- Provide clients/patients with information on the health risks associated with flooding and <u>link to</u> resources.
- Connect clients who have experienced flooding with local health and emergency management authorities to learn about when it is safe to return to their homes and with mental health services for those who may be experiencing psychosocial impacts associated with being displaced.
- Support policies in your community that decrease flood risks.

Preparing for the Impacts of Wildfires

Increased drought and heat, among other factors, contribute to the occurrence of wildfires and many regions of Canada are expected to see an increase in the extent and severity of wildfires as the climate continues to change (Berry, 2014). In Canada, forest fires or wildfires are common occurrences from May to September and can cause extensive damage and put lives in danger (Canada, 2018).

Health impacts associated with wildfires include direct injury from contact with fire, stress of evacuations and increases in air pollution (Berry, 2014). Adaptation measures related to wildfires include avoiding building in vulnerable locations, preparing for the health impacts of smoke and supporting the community after a wildfire.

The Community Wildfire Protection Plan in Kamloops BC specifies that before a building or subdivision is approved for development, the landowner must agree to wildfire mitigation measures, including fire-resistant roofing materials, fuel buffer dimensions and spark arresters for wood stoves. In addition, the plan specifies that a proposed development situated in the assessed moderate, high or extreme wildfire hazard classes, cannot be built upon unless the landowner submits a site-specific wildfire hazard assessment to the City (Canada, 2015b).

Health Professional Tips for Taking Action

- Consider how local wildfires, or smoke from more distant fires may be affecting your clients/patients. Natural Resources Canada provides detailed <u>information</u> <u>about wildfire conditions across</u> <u>Canada</u>
- Encourage your clients/patients to learn about how to protect themselves and their families during wildfires. Protective actions include keeping the indoor air as clean as possible by keeping the windows and doors closed and checking local air quality reports such as the Air Quality Health Index (AQHI) tool. The AQHI provides guidance about protecting health by limiting short-term exposure to air pollution and adjusting activity levels during increased levels of air pollution such as a wildfire or smog events. Visit the Government of Canada's AQHI site for more information
- Connect clients/patients who have been evacuated from their homes due to a wildfire with local health and/or emergency management authorities to get advice about safely returning to their homes.
- Connect clients/patients with mental health services for those who may be experiencing psychosocial impacts associated with the event.

Supporting Community Recovery from Wildfires

Alberta Health Services provides information to their communities impacted by forest fires. This information includes advice about returning to their homes after an evacuation; testing water quality; and the impacts of wildfire smoke on health and air quality advisories including use of the AQHI tool. In addition, a recovery plan for Addiction and Mental Health was developed in the aftermath of the 2016 wildfires in the Regional Municipality of Wood Buffalo including Fort McMurray. This plan is focused on those who were evacuated from their homes to promote a return to health and wellness (AHS, 2017).

Food Systems and Security

The food system encompasses activities related to the production, processing, distribution and consumption of food. Food systems can be impacted by climate change and related weather events such as flooding, drought and heat as they affect agriculture and may reduce the availability of some foods. This can result in increased costs for food and reduce accessibility for people, especially those with low incomes (Berry, 2014, TPH, 2015).

Extreme weather events may result in food transportation and supply-chain disruptions, thereby decreasing access to

Case Study: Preparing for Wildland Fire Smoke and Air Quality Events in Manitoba

Wildland fires occur regularly throughout much of Manitoba and communities, health disaster managers, and public health officials are often faced with the complex decision of if, or when, to evacuate residents of a smoke-impacted community. This occurs most frequently in the North, where travel into and out of a community may depend on a single road, rail line or air service. Before evacuating, health risks need to be assessed. Evacuations can also be disruptive, stressful and costly to residents as well as communities, and therefore should only occur when health benefits outweigh all other risks.

The Office of Disaster Management (ODM), a branch within the provincial department of Manitoba Health, Seniors and Active Living has developed specific smoke event health messaging, and has also tailored that messaging to be used in Environment and Climate Change Canada's Special Air Quality Statements when a smoke event forecast creates elevated AQHI forecasts. The Air Quality Health Index is a tool that can help the public understand what air quality means to their health and how to limit exposure when the air quality is poor. Manitoba ODM has also developed operational guidance for provincial entities, using smoke forecasts and associated health impacts.

Adapted from Berry, 2016: "Enhancing Preparedness around the Health Impacts of Wildland Fire".

Case Study: "Shipping Crates Bring New life to Dundas St." Toronto, Ontario

"The street outside Scadding Court in Toronto was a desolate space – an unused strip with no activity. So, we plopped down a bunch of shipping containers for smallscale businesses to set up shop at a very low cost and low risk. This simple concept has resulted in a lot of success stories for people who just needed an accessible opportunity to get started. It has rekindled street life here on Dundas St., and it even brings in revenue for the Community Centre. Today we have several community gardens, outdoor markets, food vendors, greenhouses, retailers, apprenticeship and other programs, and even a commercial-grade kitchen for affordable hourly rates. In our model, everyone gets a piece of the pie; everyone wins".

Adapted from City of Toronto RAC Zoning Success Stories, 2019.

food for many people. For example, local officials in Whitehorse, Yukon identified highway obstructions and washouts during extreme weather events as a key concern as they can prevent the delivery of food (Casello, 2017). Northern communities and the significant Indigenous populations within the region can also experience food insecurity that can result from conditions such as reduced duration and thickness of sea and lake ice and the thawing of permafrost, which make it dangerous or impossible to access local food sources (Berry, 2016).

Supporting Local Agriculture

Communities are considering the impact of climate change on food systems by reviewing and developing policies that support local agriculture through production and distribution. For instance, Metro Vancouver's Regional Food System Action Plan includes actions to better understand and mitigate the risks to the region's food producing lands and the agricultural sector, including the expansion of the local-food sector. Urban agriculture activities include improving the availability of community gardens for residents (Metro Vancouver, 2016).

Additional activities in Metro Vancouver include reviewing zoning bylaws to expand support for local food and allow market food gardening in residential areas, and encouraging agricultural production by allowing urban farming. Toronto's Residential Apartment Commercial (RAC) zoning bylaw allows for food markets and small businesses/grocers to provide yearround fresh fruit and vegetables for nearly 500 apartment tower sites which were formerly food deserts (Toronto, 2019).

Building Capacity in the Agricultural Sector

A community-based project in Arviat, Nunavut is building capacity for local food



Community Garden, Dundas, Ontario. Photo by Kim Perrotta.

production by involving researchers and community youth to monitor and collect data on optimal growing conditions in the community greenhouse and to build capacity for its ongoing operation. The Township of Douro-Dummer in Ontario with a largely agricultural community was significantly affected by a drought in 2016 due to extreme heat that led to water shortages and crop damage. In response to these concerns, the Township hosted a workshop for the agricultural community on how to adapt to, and prepare for, drought conditions (ICELI Canada, 2018).

Integrating Food Systems into Emergency Plans

Local governments can undertake emergency management planning that addresses the risks associated with natural disasters or the impacts of climate change. In many cases, emergency plans lack process and protocols to address food-related issues such as the availability of food in an emergency and food safety risks (Metro Vancouver, 2016). A study by Toronto Public Health identified significant rain and flooding, an extended heat wave, and a major winter ice storm as being the most significant extreme weather event risks to food processing, distribution and access in Toronto. The report recommends integrating food access into the City's emergency response planning, engaging with multiple partners across the city to understand and strengthen food distribution and to develop community food resilience action plans for vulnerable neighbourhoods (TPH, 2017).

Addressing Food Safety

Food safety is a concern if power outages occur and food cannot be properly stored. Local governments provide guidance to their communities through their public health departments or emergency management resources (TPH, 2017, Metro Vancouver, 2016).

Health Professional Tips for Taking Action

- Advocate for and support local policies that encourage local food production, including community gardens or Community Food Centres that encourage local food security, especially in lower income areas.
- Advocate for integration of food-related issues such as the availability of food in an emergency and food safety risks into your community's emergency plans.
- Advocate for measures that increase the resiliency of the Canadian food system.
- Educate your clients/patients about food safety concerns if power outages occur and link them to resources such as the Canadian Food Inspection Agency's
- "Food Safety in an Emergency"

Vector-borne diseases

Vector-borne diseases such as West Nile virus (WNV) and Lyme disease are of concern in Canada with changes in precipitation patterns and rising temperatures. In recent years, these diseases have seen their geographic range expand northward (Lindsay, 2016, Hierlihy, 2017). West Nile virus demonstrates patterns of "boom and bust" with outbreaks often followed by many years of few human infections. Lyme disease cases in Canada are increasing each year driven in part by the range expansion of the tick vectors that carry the disease (Lindsay LR 2016).

Surveillance Programs

By maintaining effective surveillance programs on insect- and mite-borne diseases, we increase both our understanding of the dynamics of human risk, and the effectiveness of disease-prevention strategies that are used to minimize the impact of these pathogens on the health of Canadians (Lindsay, 2016). Vector surveillance can act as an early warning system for health officials (Hierlihy, 2017).

In Ontario, the provincial and federal governments worked with public health units to develop a Lyme disease case management tool to improve human disease surveillance in the province. The tool helps to standardize the collection of exposure data for human cases by local public health units. The data will be used to identify Lyme disease risk areas and effective public health interventions (PHO, 2016).

Prevention Programs

Surveillance programs contribute to the development of vector-borne disease prevention plans. Peel Region developed a plan that emphasizes WNV disease prevention in humans and protection of the environment through public education, source reduction and larviciding. The plan includes Lyme disease tick surveillance through examination of ticks submitted by residents to identify sites where black-legged ticks are present (Region of Peel, 2016).

Health authorities across Canada provide education on preventing and seeking timely treatment for Lyme Disease, WNV or other emerging vector-borne diseases. Winnipeg's strategy with communicable disease is mainly public education at the regional level. This targets both the public and health care providers (WRHA, 2019).

Policy Considerations: Urban Design and Vector-Borne Diseases

Planners are beginning to consider vector-borne diseases as they design urban communities. For instance, suburban landscape design such as the greening of urban spaces to reduce heat islands may increase contact with mosquitoes and ticks. Exposure may also be exac-

Health Professional Tips for Taking Action

- Be aware of local vector-borne risk areas in your community by contacting the local health authority.
- Provide guidance to your clients/ patients about the risks and prevention activities associated with vector-borne diseases. Link them to Health Canada factsheets on <u>WNV</u> and <u>Lyme Disease</u>

erbated by pools of stagnant water associated with particular types of landscape and drainage design in both urban and suburban areas. Planners are promoting urban design principles that enhance healthy living while minimizing opportunities for vector breeding (Ogden, 2016).

Water Quality

Climate change is increasing health risks associated with the availability and quality of water in Canada. Health can be affected when water-borne illnesses results from contamination of food and drinking and recreational waters due to exposure to chemicals and microbes. This can result from many pathways including severe storms, floods, droughts, permafrost melt, sea level rise and landslides. Climate change may also increase health risks from cyanobacteria (i.e., blue-green algae) that can taint drinking and recreational waters (Canada, 2018).

Stormwater management plans are important in urban environments. Cities with large paved areas like surface parking lots and roads displace natural ground surfaces that can absorb heavy rainfall, thereby increasing stormwater runoff. The Township of Nipigon, Ontario's stormwater master plan includes the use of low-impact development strategies that rely on natural infrastructure, such as rain gardens, to reduce peak runoff during rain and melting events and to improve stormwater discharge quality (ICLEI Can-
Case Study: Disconnect to Protect Rebate Program

Stormwater is a large concern for the City of Barrie, especially as extreme rainfall events continue to become more frequent and intense, and mid-winter snowmelts become more commonplace. The impacts of this increased rainfall are compounded by the fact that many residents have downspouts or sump pump/foundation drains that are illegally connected to the sanitary system. These systems discharge directly into the Wastewater Treatment Facility and can cause sewage backup during extreme rainfalls.

The City's Climate Change Adaptation Strategy in March 2017 includes the recommendation to increase the uptake of the City's Disconnect to Protect Rebate Program. The City hosted a workshop with real-estate agents, home inspectors and plumbers in order to build partnerships for the communication and implementation of the program. As these participants return to their positions and companies, they'll have the information to share with their members and clients concerning Barrie's Disconnect to Protect program, bylaw compliance and possible rebates available. This was an advantageous way of capitalizing on existing networks to disseminate the information.

Adapted from ICLEI Canada, Case Study Series, 2018

ada, 2018). Guidelines were developed in Quebec to manage stormwater and reduce the urban heat-island effect by improving the design of surface parking lots. The guidelines include design criteria to expand the proportion of permeable to impermeable surface (Eyzaguirre, 2015).

Toronto's Wet Weather Flow Master Plan includes a focus on improving water quality at the City's swimming beaches. In addition, Toronto provides information to the public about beaches that are safe for swimming through the Blue Flag certification program (Toronto, 2017).

Communities are also planning for water supplies during times of drought. For instance, the City of Calgary conducts ongoing watershed monitoring and analysis to inform its water treatment operations and

Health Professional Tips for Taking Action

- Be aware of drinking water advisories issued by your local health authorities and provide guidance to clients about safe drinking water practices. This may be particularly important during or after extreme weather events such as heavy rain, droughts, and floods.
- Encourage your clients to be aware of beach swimming advisories. This information may be available through the local health authority or the <u>Blue Flag certification program</u>.
- Support local governments in the development of stormwater and drought management plans as well as related public education activities.

meet Calgary's water demand. Calgary also has a Water Efficiency Plan to protect its water supply and a water utility bylaw to implement water restrictions if needed during water shortage (Calgary, 2018).

Increasing Resiliency in Communities

Many communities are approaching climate change and adaptation actions through a resiliency lens. A resilient city is one in which institutions, communities, businesses and individuals have the ability to survive, adapt and grow in response to shocks or stresses that they may experience. The Whole Community Approach to Emergency Management engages emergency managers, government officials, community leaders, local organizations and residents to evaluate the needs of their community and determine ways to strengthen their assets and capacities. Strengthening public awareness of climate-related risks and disaster preparedness practices requires strong partnerships with community organizations working with vulnerable populations to increase health and safety throughout the city (Prairie Climate Centre, 2017).

The Rockefeller Foundation, through the 100 Resilient City project, is supporting the cities of Vancouver, Montreal, Calgary and Toronto in their efforts to build their resilience. Calgary has identified their shocks and stresses as aging infrastructure, blizzards, droughts, rainfall flooding, hazardous materials accidents, hurricanes/typhoons/cyclones, lack of affordable housing, shifting macroeconomic trends and

Case Study: Resiliency and Faith-Based Organizations

The presence of faith-based communities in the City of Brampton brought to light a new method of sharing information and spreading resilience across vulnerable communities. The Lighthouse Project is a city-wide initiative that aims to involve local Faith-Based Organizations in climate change adaptation. Its purpose is to assist vulnerable populations during emergencies and improve the City's ability to respond to extreme weather events.

The project included several steps: a study that identifies and maps vulnerable populations and faithbased centers around the City; forming relationships with leaders from Faith-based Organizations around the City; and hosting training workshops for Faith-Based Organization volunteers from different religious communities. The leaders who attended the training would then disseminate the information through their own religious communities using their preferred messaging, language and materials. The project helps to build capacity in communities, so that residents can help each other in emergencies.

Source: ICLEI Canada, Case Study Series, 2018

water insecurity. Montreal's resiliency strategy identifies citizens as being the heart of their approach and the need to mobilize neighbours to build united and safe communities (100 Resilient Cities, 2019).

Managing climate risks requires coordination between actions that result from an understanding of Canada's overall progress on adaptation and climate resilience, including to what extent collective action and investments are building adaptive capacity. There is a need to better understand the health impacts associated with climate change through monitoring and evaluating progress toward increasing the resilience of people, communities and health practitioners (Canada, 2018). The health sector can help build this



Ice Fishing on Churchill River. Photo by Dan Tobias.

knowledge base by collecting and analyzing data on physical and mental health impacts after extreme weather events.

Health Professional Tips for Taking Action

 Health care professionals are important partners and leaders in responding to the health threat of climate change and building resiliency in their communities. Examples of actions that you can take to promote adaption efforts have been described throughout this module. You can partner with local governments, health authorities and community organizations to highlight the health threat of climate change and to advocate for action to be taken to reduce climate related risks. You can also volunteer with organizations involved in climate change programs, emergency preparedness and other related activities to be a resource to your neighbourhood. Finally, as the climate changes so do the health risks, you are encouraged to stay current by undertaking education/ training courses, as available.

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Climate Change Toolkit for Health Professionals Factsheet: Preparing for Climate Change in our Communities

Introduction

Climate change can affect the health of Canadians in many ways with extreme heat and cold, severe storms (e.g., hurricanes, tornadoes, ice storms, and hailstorms), floods, droughts, wildfires, avalanches, landslides, air pollution, and in zoonoses and vector-borne diseases. Climate change can also increase risks from food and water-borne diseases and insecurity and affect mental health.

The promising news is that many actions are being taken by local governments and the public health sector to reduce climate-related risks and improve community resiliency. Here are some examples of adaptation efforts that are being taken locally and actions that can be taken by health professionals to minimize the health impacts of climate change in their communities.

Extreme Heat

Many communities in Canada are already experiencing an increase in hotter days due to climate change. It is projected that the severity and frequency of heat waves will continue to increase. Heat response activities to protect health include actions such as educating the public about how to take protective measures, monitoring those most at risk such as the elderly and people who live alone, providing air conditioned spaces, and extending hours for pools and splash pads. Adaptation measures to reduce urban temperatures include increasing green spaces and the use of reflective surface materials that reflect or reduce heat conduction (e.g., green and cool roofs).

Health Professional Tips for Taking Action on Extreme Heat

- Discuss the risks of hot weather with your clients/patients and promote the use of local cooling spaces (e.g. air conditioned spaces and shaded areas).
 Provide them with information on how to stay safe in the heat and links to resources such as <u>Health Canada's "It's</u> <u>Way too Hot" web page</u>
- Discuss <u>UV index implications</u> with your clients/patients and encourage them to seek shade.
- Encourage your clients to spend time in green spaces, prescribe nature and take the time to enjoy activities in natural environments. <u>Learn more about</u> <u>the benefits of being outside</u>
- Support projects in your community to decrease urban temperatures and prevent climate change impacts on health such as green roofs and increasing the amount of green spaces.

Extreme Cold Weather

During extreme cold weather events, people experiencing homelessness are at higher risk for hypothermia and frostbite. Cold weather, even with moderate temperature changes, can also increase the risk of cardiovascular-related mortality for up to several days after exposure. Adaptation efforts include services for the homeless population and education to alert the public to the risks of extreme cold weather.



Health Professional Tips for Taking Action on Extreme Cold Weather

- Be aware of local extreme cold weather alerts that are issued and discuss the risks of extreme cold weather with your vulnerable clients/patients (e.g. seniors, people who have cardiovascular disease and the under-housed).
- Provide clients/patients with information on how to stay safe in the cold and provide links to resources such as <u>Health Canada's Extreme Cold web</u> page
- Be aware of and connect clients/patients who may be experiencing homelessness, or are under-housed to cold weather services in your community. These services may include warming centres and shelters that add temporary beds.

Floods

In Canada, heavy precipitation events and rising sea levels will increase the risk of flooding in many communities. Along with immediate injury and death from flood water, impacts on health include respiratory illness related to an increased risk of mould developing in homes damaged by flood waters, contamination of

Health Professional Tips for Taking Action on Floods

- Be aware of local flooding risks and warnings in your community
- Provide clients/patients with information on the health risks associated with flooding and <u>link to resources</u>
- Connect clients who have experienced flooding with local health authorities to learn about when it is safe to return to their homes and how to safely clean-up after a flood.
- Support policies in your community that decrease flood risks.

drinking water from wells and mental illness associated with destruction of infrastructure and homes. Adaptation includes measures such as prohibiting future development in floodways, increasing awareness of local flooding risks, flood forecasting and public warnings, mental health programs to support affected individuals, and advice on how to safely clean-up after a flood.

Health Professional Tips for Taking Action on Wildfires

- Consider how local wildfires, or smoke from more distant fires may be affecting your clients/patients. <u>Natural</u> <u>Resources Canada provides detailed</u> <u>information about wildfire conditions</u> <u>across Canada</u>
- Encourage your clients/patients to learn about how to protect themselves and their families during wildfires. Protective actions include keeping the indoor air as clean as possible by keeping the windows and doors closed and checking local air quality reports such as the Air Quality Health Index (AQHI) tool The AQHI provides guidance about protecting health by limiting short-term exposure to air pollution and adjusting activity levels during increased levels of air pollution such as a wildfire or smog events. <u>Visit the Government of Canada's AQHI site for more information</u>

Wildfires

Increased drought and heat, among other factors, contribute to the occurrence of wildfires and many regions of Canada are expected to see an increase in the extent and severity of wildfires as the climate continues to change. Adaptation to reduce health risks includes measures such as avoiding building in higher risk locations, preparing for the health impacts of smoke and supporting the community after a wildfire.



Health Professional Tips for Taking Action on Wildfires

- Connect clients/patients who have been evacuated from their homes due to a wildfire with local health and/or emergency management authorities to get advice about safely returning to their homes.
- Connect clients/patients with mental health services for those who may be experiencing psychosocial impacts associated with the event.

Food Systems and Food Security

The food system encompasses activities related to the production, processing, distribution and consumption of food. Key activities of the food system are vulnerable to climate change impacts and may face increasing challenges and stress as the climate continues to warm. Food production can be impacted by climate change and related weather events such as flooding, drought and heat as they affect agriculture and may reduce the availability of some foods. Adaptation measures include supporting local agriculture production and distribution. This could include improving the availability of community gardens for residents or reviewing zoning bylaws to allow market food gardening in residential areas and allowing urban farming.

Vector-borne Diseases

Vector-borne diseases such as West Nile virus (WNV) and Lyme disease are of concern in Canada with changes in precipitation patterns and rising temperatures. Adaptation activities include vector surveillance to act as an early warning system for health officials and public education on preventing or seeking time treatment for vector-borne diseases.

Health Professional Tips for Taking Action on Vector-borne Diseases

- Be aware of local vector-borne risk areas in your community by contacting the local health authority.
- Provide guidance to your clients about the risks and prevention activities associated with vector-borne diseases. Link them to Health Canada factsheets on <u>WNV</u> and <u>Lyme Disease</u>.

Health Professional Tips for Taking Action on Food Systems and Food Security

- Advocate for and support local policies that encourage local food production, including community gardens or Community Food Centres that encourage local food security especially in lower-income areas.
- Advocate for integration of food-related issues such as the availability of food in an emergency and food safety risks into your community's emergency plans.
- Advocate for measures that increase the resiliency of the Canadian food system
- Educate your clients about food safety concerns if power outages occur and link them to resources such as the Canadian Food Inspection Agency's <u>"Food Safety in an Emergency"</u>



Water Quality

Climate change is increasing health risks associated with the availability and quality of water in Canada. Health can be affected when water-borne illnesses results from contamination of food and drinking and recreational waters due to exposure to chemicals and microbes. This can result from many pathways including severe storms, floods, droughts, permafrost melt, sea level rise and landslides. Climate change may also increase health risks from cyanobacteria (i.e., blue-green algae) that can taint drinking and recreational waters. Adaptation measures include the implementation of stormwater management plans, boil water advisories, recreational water testing and advisories, monitoring of harmful algal bloom outbreaks, and by planning for water supplies during times of drought through watershed monitoring and analysis.

Health Professional Tips for Taking Action on Water Quality

- Be aware of drinking water advisories issued by your local health authorities and provide guidance to clients about safe drinking water practices. This may be particularly important during or after extreme weather events such as heavy rain, droughts, and floods.
- Encourage your clients to be aware of beach swimming advisories. This information may be available through the local health authority or <u>the Blue Flag</u> <u>certification program</u>.
- Support local governments in the development of stormwater and drought management plans as well as related public education activities.

Increasing Resiliency in Communities

Many communities are responding to climate change and health challenges by taking actions to increase resiliency. A healthy climate resilient community is one in which institutions (e.g., governments, health facilities, transportation systems, social programs), workers (e.g., doctors, nurses, community care givers), businesses and individuals have the ability to adapt and grow in response to shocks or stresses that they may experience.

Health Professional Tips for Taking Action on Increasing Resiliency in Communities

Health care professionals are important partners and leaders in responding to the health threat of climate change and in building resiliency in their communities. You can partner with local governments, health authorities and community organizations to educate your clients on risks and health protection measures, and advocate for action to be taken to reduce climate-related risks. You can also volunteer with organizations involved in climate change programs, emergency preparedness and other related activities to be a resource to your neighbourhood. Finally, as the climate changes so do the health risks, you are encouraged to stay current by undertaking education/training courses, as available.

NOTE: References for this Factsheet can be found in Module 7 of <u>CAPE's</u> <u>Climate Change Toolkit for Health</u> <u>Professionals</u>.



Climate Change Toolkit for Health Professionals Engaging in Climate Change Solutions as Health Professionals April 2019



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ACME Association Canadienne des Médecins pour l'Environnement for the Environment

Module 8 – Engaging in Climate Change Solutions as Health Professionals

Introduction Health Professionals are Effective Messengers

As health professionals, we must respond clinically and within healthcare and public health systems to the threat that climate change poses to the health of our patients, clients and communities. However, as health professionals we can also have a powerful influence on the views and behaviour of the public and on the actions of policy-makers and decision-makers because Canadians care about their health and the health of their families, and because we are seen as credible and trusted messengers. Hence, we are also well situated to help our patients, the public, and decision-makers understand both, the impacts that climate change is having, and will have, on human health on a global scale (Module 2) and in Canada (Module 3), and the significant and fairly immediate health co-benefits and healthcare savings that can be realized by taking action on climate change (Modules 5 and 6). Awareness of current and future health risks will also help guide necessary adaptation measures that are needed to minimise the health impacts of climate change at a healthcare facility level (Module 6) and a community level (Module 7).

Focus on Climate Policies that Provide Health Co-Benefits

At CAPE, we believe that we are most effective when we focus on climate policies and practices that reduce greenhouse gas (GHG) emissions that provide fairly immediate health co-benefits and healthcare savings and climate adaptation programs that minimize the impacts of climate change on human health.



CAPE Board Members, Dr. Warren Bell and Dr. Larry Barzelai, and their peers in the BC CAPE Volunteer Committee, have been organizing workshops, preparing educational materials, writing op-eds, and meeting with government officials to increase awareness about the adverse health impacts associated with the extraction of natural gas using a process called hydraulic fracturing (fracking) (Barzelai, L. 2019).

From a climate mitigation perspective, CAPE has been focusing on policies and practices that move us toward healthy and sustainable energy systems, energy-efficient buildings, public transit, active modes of transportation, and diets rich in plant-based proteins because these policies produce fairly immediate and significant health benefits in the jurisdictions that take action, by reducing air pollution, increasing physical activity, and/or improving the diet of our patients/clients/communities, while reducing GHG emissions. The climate policies and programs that can reduce GHG emissions in our communities are discussed in Module 5, while those that can reduce GHG emissions from our healthcare institutions are discussed in Module 6.

From a climate adaptation perspective, CAPE supports and promotes programs and practices that help us to prepare for the climate change that is coming; reduce the health impacts associated with those changes; and identify the health co-benefits associated with them. These climate programs and practices can include public health programs that are needed to respond to extreme weather events (Module 7), designing our communities to reduce the impacts of climate change (Module 7), preparing emergency response plans for our health care institutions (Module 6), and fostering an appreciation for cycling, healthy eating, or nature and greenspace among the public (Module 8).



CAPE Board Member, Dr. Melissa Lem, partnered with the BC Parks Foundation to launch the Healthy by Nature Initiative. Officially begun with "Outside & Unplugged" walks, nature walks were convened in over 30 different provincial parks across British Columbia on BC Parks Day in July 2018. Physicians and other health professionals who led the walks were provided with a two-page fact sheet from CAPE on the health benefits of green time. Healthy by Nature aims to be as inclusive as possible, enjoying a diverse range of participants from babies and grandparents to new immigrants in public events like the Outside & Unplugged walks and First Day Hikes. Dr. Lem continues to expand CAPE's work on nature and health by helping to develop the "Parks Prescription Initiative" in BC which will encourage physicians to prescribe time in nature to their patients. This initiative will be launching in British Columbia in spring 2019 with plans to expand nationally by 2021. (Lem, M, 2019).

Turning Climate Angst into Climate Action

The fight to stop climate change will require many different actions, directed at many sources, in many different ways. Some of CAPE's members do educational work with their peers, students or the general public on the health impacts of climate change, others use government relations and strategic communications to effect policy changes at a provincial level, while others still work with community groups to bring about concrete changes in their local communities. All of this work is necessary. All of this work is valuable.

The challenge for each of us is to choose the ways in which we want to engage in climate change in our workplaces or



CAPE Executive Director Kim Perrotta and CAPE President Dr. Courtney Howard meeting with Minister of Environment and Climate Change Catherine Mckenna.

communities, and to develop the skills required to do that work well. This module has been designed to start this conversation; to identify the ways in which we, as health professionals, can engage in climate change solutions; and to provide examples of health professionals who are actively and effectively doing so.

Engaging our Patients and the Public Protecting Patients and the Public from Climate-Related Health Impacts

As health professionals, we are well situated to educate our patients and the public about the actions that can and should be taken by individuals to protect themselves and their families from climate-related health risks such as heat waves, insect- and mite-borne diseases like West Nile virus and Lyme's disease, smoke from wildfires, and power outages from extreme storms. Module 3 in this toolkit provides information about the adverse health impacts that are occurring and expected in different regions of the country. Modules 3 and 7 also identify resources that: we can use to keep ourselves informed about climate-related risks in our communities, and our patients/clients can use to protect themselves and their families from those risks.

Encouraging Behavioural Changes among Patients and the Public

As health professionals, we are also well positioned to encourage our patients and the public to make behavioural changes that are healthy for them, their families, and the planet. We can, for example, encourage our patients to use active modes of transportation and public transit for their daily commutes to increase their levels of physical activity and reduce their risk of heart disease, which will also reduce their GHG emissions. We can encourage them to see hikes in nature as way of reducing stress and improving their mental and physical health, which will also build public support for greenspace which is needed to mitigate climate change and its impacts. We can also encourage them to increase their consumption of plant-based proteins to reduce their risk of chronic diseases, which will also reduce the GHG emissions associated with their diets. The health co-benefits of various climate solutions are discussed in detail in Module 5.

Use Motivational Interviewing

Motivational interviewing is an effective method for changing the behaviour of patients and clients. It uses a client-centered approach whereby the healthcare provider focuses on the patient's interests, values, and concerns as a way of increasing their motivation to change. This approach addresses and helps resolve the patient's ambivalence to change, as it is often ambivalence that stands in the way of action. Research has shown that if practitioners provide initial counselling, follow-up advice, and reinforcement, many patients will change their understanding and ultimately their behaviour (Bauman et al., 2009; Daniel K and Perrotta K, 2017).

Dr. Danielle Marentette, a family doctor based in rural British Columbia, is engaging her patients and her community around healthy, plant-based food choices. In her general practice, she tailors dietary advice to each patient. She uses the Plantrician Project Quick Start Guide as a starting point (Dice and Benigas, 2015). Working in partnership with a local holistic nutritionist and plant-based chef, Dr. Marentette convenes community workshops for everyone from pre-schoolers to physicians and runs a fourpart series for people with chronic diseases.

Connecting Patients to Resources in the Community

In addition to one-on-one counselling, health professionals are also well positioned to refer their patients and the public to trusted resources in the community that may be able to provide social support to those interested in changing their behaviour. For example, one study found that workplace-based and school-based interventions have the potential to shift the behaviour of individuals from automobiles to active transportation for commuting (Scheeepers et al., 2012; Daniel K, 2017).

Engaging our Peers on Climate Change Preparing Articles for Peer Reviewed Journals

Given that many health professionals want to be assured that they are getting their information from a credible source, it is helpful for them to see articles by other health professionals in peer reviewed journals. For example, Dr, Andy Haines and Kristie Ebi published a review article in the New England Journal of Medicine on "The Imperative for Climate Action to Protect Health" (Haines and Ebi, 2019) and Drs. Caren Solomon and Regina LaRocque wrote a response article declaring climate change "A Health Emergency" and calling for the health care system and health professionals to take action on climate change (Solomon and LaRocque, 2019).

Presentations and Workshops

Other educational opportunities are also at our fingertips. Hospitals hold grand rounds and teaching sessions for staff where we can offer lectures or run workshops on climate change. Universities and student groups provide great opportunities for evening lectures, panel sessions, seminars and workshops. Many of our profes"By far the best way to engage peers is to conduct a successful advocacy campaign and attract their attention via external media. It provides hope. It demonstrates leadership. They see you getting the job done and they want to help."

sional associations and volunteer organizations convene annual meetings where we can offer presentations or workshops and provide us with opportunities to write articles for hard newsletters and blogs.

Combine Business with Pleasure

It doesn't all have to be serious! Students are particularly great at coming up with engaging ways to educate their peers about climate change. Some examples include: Trivia nights, Film nights, Tree planting, Bike rides, Hikes, Sustainable Living Workshops, Clothing Swaps, Carbon-neutral Parties, Amazing Race Challenges to learn about political processes, Institutional Divestment Roleplays, and Sustainabili-teas (bringing your own cup for free tea). And when we organise a fun, informative, engaging activity, we should share photos on social media to encourage others to join in.

Build Climate Change into Medical Curriculum

A 2015 survey of Canadian medical schools conducted by the Canadian Federation of Medical Students (CFMS) found

Resources:

• Public Health and Climate Change Factsheets

• <u>Dr. Mike Evans' Videos</u>: Dr. Mike Evans produced a video called "23 and 1/2 hours: What is the single best thing we can do for our health?" that presents the incredible value of 30 minutes of physical activity per day.

• <u>PACE Canada</u>: PACE Canada is a comprehensive guide to counselling for healthy active living designed to assist health care providers in effectively increasing their patients' physical activity levels and improving their eating habits. The website provides research, information kits, and a step-bystep guide to assist healthcare professionals in their work with patients.

• <u>CAPE's Active Travel Toolkit for Health Professionals (English)</u>: This toolkit includes backgrounders for community meetings and decision-makers and factsheets and pamphlets for patients in English & <u>French</u>

• Healthy by Nature: This initiative aims to get more people active in nature

• <u>Canada's Food Guide</u>: Canada's new food guide promotes a diet rich in plant-based proteins

• <u>Plantrician Project Resources Quick Start Guide</u>: An evidence-based project that aims to educate, equip and empower health professionals with knowledge and resources to support patients in their adoption of plant-rich diets

• EAT-Lancet Commission: Provides information on a diet that is healthy for people and the planet

that almost no medical schools in Canada reported dedicated topics on climate change and health, or its impacts on the future practice of medicine, in their curricula (Saraswat et al., no date). Medical curricula should not only provide evidence-based material on climate change, but also the skills needed to engage institutions on the changes in programs and practices that are needed to mitigate and prepare for climate change.

The CFMS formed the Health and Environment Adaptive Response Task Force (HEART) in 2017 to work on introducing climate change into the medical curricula nation-wide with the goal of having some element of climate change in every medical school curriculum by 2020. The Task Force has developed national climate change and environmental health competencies, which are currently being reviewed by peers, experts in environmental health, and medical educators (CFMS, 2019).

At the same time, the Task Force is working on a bottom-up approach; advocating to educators, educational institutions, and environmental health leaders for the incorporation of climate change into the medical curriculum. The Task Force has developed a report card to track progress on these efforts with the first round of results for each medical school expected in April 2019. The International Federation of Medical Students' Associations (IFMSA) has endorsed HEART's efforts and committed itself to a vision of having



CAPE Board Member and Medical Student Dr. Willow Thickson.

climate change covered in every medical school globally by 2020 (IFMSA, 2018).

Folding Environmental Health into Nursing

In 2008, a group of nurses involved with the Canadian Nurses Association (CNA) released three modules on the environment and health that included a workbook on the role of nurses in addressing climate change (CNA, 2008). From there, the separate but affiliated organization, Canadian Nurses for Health and the Environment (CNHE), was formed to improve environmental health across all domains of nursing practice, policy, research and education (CNHE/IISE, 2019). Other teaching tools tailored specifically for the nursing context include lectures and webinars (Hanley, 2012; Hanley 2016) and modules developed by the National Institute of Public Health Quebec (INSPQ, 2012, 2019b)

Folding the Ecological Determinants of Health into Public Health

A multi-disciplinary steering committee of the Canadian Public Health Association (CPHA), called the Ecological Determinants Group on Education (EDGE), includes representatives from a number of public health organizations, Indigenous health groups, and environmental health groups. It has been working to integrate the ecological determinants of health – which includes climate change - into public health education, training and professional development. EDGE's website also provides links to courses, summer schools, webinars and podcasts on the topic (EDGE, 2019).

Training Public Health on Climate Change in Quebec

The National Institute of Public Health Quebec (INPHQ) is offering online training programs on climate change and its impacts on human health for francophone health professionals. The training includes six modules on different health impacts related to climate change offered over six weeks (INPHQ, 2019a).

Working for Change in our Communities Policy Change starts with Public Support

Winning policy changes in our communities requires support and understanding from policy-makers (e.g., civil servants,

Train-the-Trainer Program: Air Quality, Climate Change & Radon

A joint initiative of Health Canada and the College of Family Physicians of Canada (CFPC), this program was designed to increase awareness among health professionals about the links between human health and the environment with the goal of reducing the adverse impacts of air pollution, extreme heat and radon on the health of Canadians.

The program, which is free and open to all Canadian health professionals and health students, involves online courses hosted by McMaster University and the University of British Columbia, reading materials, and a webinar hosted by Health Canada. The program is designed to educate participants and train them how to deliver messages tailored for various populations, including other health professionals, the general population and at-risk groups.

In its first year of operation, new trainers undertook 104 outreach activities, achieving a direct reach of over 2,400 people through lectures, conferences, grand rounds, journal clubs and presentations to school students, and an indirect reach of over 16,100 people through journal articles, magazines and newsletters, displaying educational materials and social media posts (CFPC, 2017) city staff, healthcare facility administrators, public health officials) and decision-makers (e.g., city councillors, members of parliament, members of legislative assembly, senior administrators) but the support of decision-makers also requires strong support from the public.

With climate change, as with many issues we work on, there are often powerful organizations or large groups of people who do not want policies to change including corporations that will lose business from the policy change, farmers who may lose income, coal plant workers who may lose their jobs, or automobile commuters who fear their commutes may become longer or more expensive. There can also be resistance within government by civil servants who have to implement the changes or senior civil servants who fear that new policies may cut into budgets that are too tight already.

The Public Cares about Health

As health professionals, we can play a powerful role influencing public policy by educating the public, policy-makers and decision-makers about the many health benefits that can result from a public policy that addresses climate change. Opinion polls have demonstrated that Canadians are more likely to change their behaviour to address climate change if they believe that it may have benefits for their health (Comeau L and Lachapelle E, 2018). They also found that health professionals – particularly nurses and doctors – are the messengers who are most trusted by the public. Policy-makers and decision-makers are more likely to listen to health professionals when they feel that we can help move public opinion on an issue.

Often the public, policy-makers and decision-makers do not understand the health impacts associated with climate change or the health co-benefits and healthcare savings that can result from the policies needed to fight climate change. As health professionals, our role is to bring health arguments forward so that people understand the adverse impacts that can result from climate change, and the positive health benefits that can be realized with the many actions needed to fight climate change.

Our role is also to support the policies needed to address the legitimate concerns raised by those who oppose climate policies being proposed. For example, it is important that we support just transition policies and programs that would help workers from coal plants to retrain for other jobs and help their communities to transform their economies.

Using Media to Build Public Support

We can influence the views of the public with op-eds in our local newspapers, letters to the editor, blogs disseminated through social media, TV interviews, radio phone-in shows, and by speaking out at public meetings. We can also buy ads in newspapers, on transit systems, and on Facebook. This means we may have to learn how to write an op-ed, do media interviews, and use Facebook. Learning new skills #ForTheClimate, though it can be intimidating, is also one of the most satisfying parts of this work.

Audience: In both our written and verbal communications, we want to make sure that we are clear about whom we are trying to reach. Are we trying to reach local or provincial elected officials? Are we trying to reach the public or the media? When we deliver our arguments, we want to tailor the messages and our language to our audience.

Story: In addition to explaining the facts and health arguments, it can be powerful to include a personal story from our lives or the lives of our patients or clients. Facts provide the foundation for our position, but stories that make the implications of the policy real for people can help move public opinion.

Three Points: Scientifically-trained people have a tendency to rely on too many facts, which overwhelms the audience. Simple messages are best. For any piece of media, choose three main points and three statistics. That's it. Then stop talking. (We mean it).

Engaging Policy-Makers and Decision-Makers

In Modules 5, 6 and 7, we discuss the public policies, programs and practices that can be put into place to mitigate



In 2017, Health Canada proposed a new Food Guide which emphasized the value of plant-based protein. This proposal was receiving a lot of pushback from the cattle and dairy industry. Canadian health professionals acted as a counter-weight by providing strong and vocal support for the new Food Guide. CAPE President, Dr. Courtney Howard, working in collaboration with other CAPE members and the Canadian Public Health Association (CPHA), prepared several op-eds and letters to the Minister that emphasized the strong health evidence which supports the proposal, along with the co-benefits for Canada's climate commitments. In fact, 92 provincial and local organisations joined Food Secure Canada in asking the Prime Minister to exercise his personal leadership to ensure that Canada's new Food Guide would support a more just, healthy and sustainable food system (Food Secure Canada, 2018). The new Food Guide, which promotes plant-based protein, is now in place.

climate change (i.e. reduce emissions of GHGs) or prepare for it (i.e. minimize the harm that climate change has on human health) within our healthcare institutions and at a local, regional or national level.

We can engage policy-makers and decision-makers with formal submissions, letters, e-mail messages, phone calls and meetings. We can also speak at local council or board of health meetings. When working with policy-makers and decision-makers, the emphasis should be on working with them to develop and implement the policies. They will want to know that we are going to help get the public on side for a potentially controversial policy and help keep the public onside during the various stages of implementation.

Collaborating with Others

At CAPE, we have found that it can be beneficial to work with organizations that have different audiences or expertise who share our policy interests. The promotion of public policies requires different types of skills – strategic thinking, media skills, public speaking, creative writing, and researching – and different types of expertise. By collaborating with other types of professionals and organizations that have complementary expertise and/or skills, we can be more effective as advocates. In addition, organizations that focus on health, the environment, or social issues are likely to approach



For much of 2015, CAPE Board Member, Dr. Joe Vipond, was the face of the coal phase-out campaign in Alberta. Working in close collaboration with the Pembina Institute, which has strong expertise modelling the air pollution-related health benefits associated with public policies, CAPE became the messenger for the significant health co-benefits that would result from the accelerated closure of coal plants in Alberta. We prepared op-eds, issued press releases, prepared submissions, and collaborated on newspaper ads, all of which articulated again and again, the significant air pollution-related health benefits and healthcare savings that Albertans would enjoy with the closure of coal plants in that province.

When the Alberta Government announced its decision to phase-out coal plants by 2030, Dr. Vipond was of the people who stood behind the Ministers who made the announcement. But CAPE's work on coal plants did not stop there. With each announcement related to the implementation of the coal phase-out in Alberta in the three years since, CAPE staff and members have been there with press releases or op-eds to remind the public about the health benefits that will result from the action that is being taken by the Alberta Government (Perrotta K., 2019). a campaign using different messages that will appeal to different audiences. It is much harder for governments to ignore messages that are coming from a wide range of organizations and individuals (Daniel K and Perrotta K, 2017).

Working within our Institutions and Associations

We can work for climate policies and practices in many different ways. We can work to change the policies inside our workplaces. For those in healthcare facilities, this can mean setting up an Environmental Committee, initiating a waste reduction program, or promoting the use of anesthetics that are less damaging to the climate (See Module 6). For those in public health, it can mean promoting policies that reduce the heat-related impacts on low income neighbourhoods, developing Cold Alert and Response Programs that protect the homeless, or collaborating across departments to increase community resilience (see Module 7).

For medical and public health students, it can mean working to weave climate change into course curriculum or pressing universities to adopt divestment policies that move their investments away from fossil fuels. For example, medical students at Queen's University are currently running a campaign to get their university to divest from fossil fuel companies (Létourneau, S. 2019). Health



For three decades, CAPE Board Member, Dr. Éric Notebaert, has worked to promote safe cycling infrastructure in the City of Montreal: "Wearing my CAPE hat, I participated in a coalition with many groups in Montreal. For many years, we organized around the goal of getting Montreal to commit to building at least 700 km of bike lanes, then in 2016, we shifted our goal to reach a minimum of 1500 km of safe bike lanes within 3 or 4 years. During these years, my role as a doctor was often to make presentations or deputations at meetings where I spoke about the many health benefits associated with active transportation and how the absence of bike lanes was affecting the health of patients, I saw in the emergency room. I counted on members from other organizations, such as le Conseil Régional de l'Environnement and Vélo-Québec, to identify opportunities to influence policy and for policy advice. In 2016, our Coalition was thrilled when the City of Montreal announced that it would accept all of our recommendations." (Notebaert, 2017).

sionals can also work through their professional and volunteer associations to develop resolutions that would have their associations divest from fossil fuel companies, press for policies on coal-fired power plants, or national targets for climate change programs. For example, in 2015, CAPE members worked with many others to win three resolutions at the Canadian Medical Association (CMA) Annual General Meeting. They asked MD-Financial to create fossil fuel free investment funds, and for the CMA to divest its organizational funds of fossil fuels, and to explore opportunities in renewable energy investments (Lough, 2015). (See Module 5)

How CAPE Can Help

Many health professionals who are members of CAPE find it helpful to engage with local community groups in their role as a CAPE member. They find that it can add weight to their comments by demonstrating that their views are shared by others who belong to this national organization that is run by physicians and other health professionals.

Over the last three years, CAPE has established four regional volunteer committees – one in BC, one in Alberta, one in Quebec, and more recently, one in Ontario. These committees, which are chaired by a volunteer member of CAPE, are accountable to CAPE's board through the committee chair and CAPE's Executive Director. The committees provide health professionals and students, who want to engage more actively in climate change and other environmental health

Tips for Meeting with Decision-Makers

1. Be prepared. These people are generally busy, so be prepared to be flexible in terms of the time you have to meet and what you want to say. Have a clear and concise message ready.

2. *Know who you're meeting.* Do your research before the meeting. What are the politician's allegiances? What is the position of their party? Have they spoken about this issue in parliament? Do their speeches and press releases give you an indication of the kind of audience they are likely to give you? Answering these questions will help you frame your message to where this person is coming from.

3. Talk to everyone. Even if you are speaking to someone who doesn't recognize that climate change exists, it is still worthwhile to talk to these people. It helps us understand the psychology of people who can't acknowledge the threat and it helps us sharpen our arguments for other people who are skeptical.

4. Have clear asks and goals. Do you have a clear set of asks and objectives or one thing you want the politician to do as a result of this meeting? This gives the politician a clear understanding of the expectations you are placing on them and gives you something to follow up on.

5. Follow-up your meeting. Make a follow-up call a week or two following the meeting to find out if the representative did what they committed to doing.

6. Your meeting is powerful! Don't underestimate the power of meeting face-to-face. Representatives are bombarded with emails, people signing petitions. There is no substitute for sitting opposite a politician and making your views clear. Politicians know that for every person who makes the effort to do this, there are hundreds, potentially thousands, of people who feel the same way.

From former Deputy Leader of the Australian Greens, Senator Scott Ludlam

committees is supported by CAPE staff with website and social media support.

Conclusion

This module has covered a lot of territory. It has touched on our relationships with our patients, the need to weave climate change into the educational curricular for health professionals, the ways to engage our peers and our communities on climate change. It has also addressed the power that we, as health professionals, can have to influence public policy by using health arguments in an effective way and working strategically in collaboration with our allies. If this isn't enough to get your creative advocate mind buzzing, we've given you targets for action in the accompanying factsheet to focus on areas of climate-health in areas that both help with action on climate change and result in immediate health benefits and healthcare systems savings for actions.

But the key take-home message is our voices and our actions are powerful. Health professionals are among the most trusted members of society and we have a duty to ensure our communities attain the best possible health outcomes. We have the capability to shift the conversation around health and climate change and to seize the opportunities that we can achieve through strong action on climate change. Go forth and help the health of our planet.

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Climate Change Toolkit for Health Professionals Factsheet: Engaging in Climate Change

Solutions as Health Professionals

Introduction

As health professionals, we can have a powerful influence on the views and behaviour of the public and on the actions of policy-makers and decision-makers because:

- We are seen as trusted and credible messengers; and
- Canadians care about their health and the health of their families; and
- The health frame is one of the more effective way to encourage behavioural change on climate change.

At CAPE, we believe that we are most effective when we focus on climate policies and practices that reduce greenhouse gas (GHG) emissions that provide fairly immediate health co-benefits and healthcare savings (See Modules 5 and 6) and climate adaptation programs that minimize the impacts of climate change on human health (See Modules 6 and 7).

Engaging our Patients and the Public

As health professionals, we are well situated to:

 Educate our patients and the public about the actions that can and should be taken by individuals to protect themselves and their families from climate-related health risks such as heat waves, insect- and mite-borne diseases like West Nile virus and Lyme's disease, smoke from wildfires, and power outages from extreme storms;

 Encourage our patients and the public to make behavioural changes that are healthy for them, their families, and the planet.

Engaging our Peers

We can engage our peers on climate change by:

- Preparing articles for peer reviewed journals;
- Giving presentations at Grand Rounds, health-related conferences, and student workshops;
- Preparing articles for hard newsletters and blogs for our professional and volunteer associations;
- Organizing fun events such as nature hikes, bike rides, and clothing swaps;
- Building climate change and the ecological determinants of health into the educational curriculum at our universities and colleges; and
- Offering training on climate change through our professional and volunteer organizations.

Working for Change within our Communities

We can work for change within our communities by:

- Building support from the public;
- Using traditional media and social media to engage the public;
- Engaging policy-makers and decision-makers with formal submissions, letters, e-mail messages, phone calls and meetings;
- Collaborating with other organizations that have complementary expertise who share our policy interests and organizations that are likely to approach a campaign using different messages that will appeal to different audiences;
- Working within our workplaces for climate mitigation and adapation polices, programs and practices;
- Working within our educational institutions to weave climate change into our curricula;
- Pressing universities to adopt divestment policies that would move their investments away from fossil fuels; and
- Working through our professional and volunteer associations for divestment polices and positions on national targets for climate change programs.

How CAPE Can Help

Many health professionals who are members of CAPE find it helpful to engage with local community groups in their role as a CAPE member. They find that it can add weight to their comments by demonstrating that their views are shared by others who belong to this national organization that is run by physicians and other health professionals.

Over the last three years, CAPE has established four regional volunteer committees - in BC, Alberta, Quebec, and Ontario. These committees, which are chaired by a volunteer member of CAPE, are accountable to CAPE's Board through the committee chair and CAPE's Executive Director. The committees provide health professionals and students, who want to engage more actively in climate change and other environmental health issues, with peers who can support and mentor one another. The work of the committees is supported by CAPE staff with website and social media support.

NOTE: References for this Factsheet can be found in Module 8 of <u>CAPE's Climate Change Toolkit for</u> <u>Health Professionals</u>.





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