Climate, Health and COVID-19 in British Columbia

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Editorial  
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About the writing team

The writing team for this paper includes academic researchers and public health practitioners. The report is informed by a western biomedical epistemology and our team does not include any members of Indigenous communities from British Columbia or local knowledge keepers. Our intention is to gather and synthesize current knowledge from the health, social and environmental sciences in order to understand the impacts of climate change on the health and well-being of British Columbians. When referring to Indigenous people and communities, we do not presume to speak for or represent Indigenous perspectives or worldviews, but only to share publicly available peer-reviewed and grey literature when appropriate. When we refer to Indigenous populations in this paper, we have taken a strengths-based approach whenever possible, acknowledging the resilience of First Nations and Indigenous communities in the context of Canada’s colonial history.

We acknowledge, with gratitude, that we are living, working, and writing on lands that are unceded and continually occupied. Members of the writing team reside on the traditional territories of the Skwxwú7mesh (Squamish), Sélílwətəʔ/Selílwitulh (Tsleil-Waututh), xʷməθkʷəy̓əm (Musqueam), Shíshálh (Sechelt), Kwikwetlem and Qayqayt peoples and we recognize the 196 First Nations across British Columbia. We acknowledge the troubling and inappropriate ways we came to be on this land and the historical and ongoing impacts on the First Peoples who have nonetheless allowed us to remain here. We commit to taking action toward reconciliation in our daily lives.

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The Pacific Institute for Climate Solutions (PICS) develops impactful, evidence-based climate change solutions through collaborative partnerships which connect private and public sector solution seekers with experts from BC’s four leading research universities. PICS is hosted and led by the University of Victoria, in collaboration with the University of British Columbia, Simon Fraser University, and the University of Northern British Columbia.
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Executive Summary

The emergence of the COVID-19 pandemic in 2020 has illustrated how profound and complex threats to human health can be and how interconnected humans are with the environments we live in. The impacts of climate change on the quality of human life, and the strain it will put on human and ecological systems are likely to be even greater than those of a single infectious disease like COVID-19. The disruption COVID-19 has caused at every level of society has given us pause to re-assess our priorities, and highlighted the fragility of our current social, political, economic, and healthcare systems. It has also provided an opportunity to re-imagine our future.

Attention is often paid to the ecological effects of climate change and its expected impact on infrastructure. However, the effects of climate change on human health and wellbeing are less often considered, and these are complex, far-reaching, and multifaceted. Climate change is having increasingly significant impacts in British Columbia (BC) with projections of more frequent extreme precipitation, increased drought, more frequent and severe wildfires, flooding and warming oceans. These changes cut across BC’s regional health authority boundaries and will require co-ordinated and collaborative planning to address. Canada, particularly in the north, is warming faster than the global average. BC’s mainland can expect to see annual increases of over 3 °C by 2070 from baseline temperature in 1961-90, adding to the frequency of deadly heat events like we experienced in the summer of 2021.

As with COVID-19, the health impacts of climate change will result from direct and indirect exposures to catastrophic events as well as ecological and environmental changes. This paper explores how a changing climate could affect the health of British Columbians using some lessons from the COVID-19 pandemic to illustrate the disruptive effects of a public health emergency. It focuses on three areas of health and healthcare delivery that have garnered broad public attention over the course of the pandemic thus far and are likely to also be affected by climate change: telemedicine, green infrastructure, and food security.

TELEMEDICINE

Telemedicine presents an opportunity to expand health care services to British Columbians while reducing carbon emissions by avoiding unnecessary travel and bringing health services to people where they live. Developing a provincial strategy for telemedicine will create consistency and promote standardization for all five health authorities, while ensuring equity and sustainability are front and centre across both public and private initiatives.

GREEN INFRASTRUCTURE

Green spaces have been an important part of people’s health and wellness during the COVID-19 pandemic, providing opportunities for exercise, social connection,
and solace. Green infrastructure also has the potential to reduce exposure to extreme heat, improve air quality, and support mental health in a changing climate. Ensuring equitable access to green spaces and the health benefits they provide could lessen other intersecting economic and structural health inequities, particularly in urban and low-income settings.

**FOOD SECURITY**

Food security relies on complex networks of people, communities, and resources that exist within social, cultural, and ecological contexts. Climate change has the potential to disrupt any and all of these connections, creating food insecurity and inequities in access to safe, affordable, and abundant food sources. Planning for sustainable food systems under climate change will require attention to the production, processing, packaging, distribution, marketing, consumption, and disposal of food. Among other things, this will mean preparing for the effects of climate change on growing seasons and preparing for the health impacts climate change will have on agricultural workers.

— The disruption COVID-19 has caused at every level of society has given us pause to re-assess our priorities, and highlighted the fragility of our current social, political, economic, and healthcare systems. It has also provided an opportunity to re-imagine our future.

Gathering evidence for this paper has highlighted many opportunities to address current knowledge gaps about the health impacts of climate change and to design effective strategies for climate change mitigation and adaption within a public health context. Some of these opportunities include:

» Improving our understanding of the impact climate change will have on human and ecological health in BC.

» Mapping climate projections, health impacts and vulnerability across the province to inform coordinated health and equity planning for climate change across health authority boundaries.

» Developing processes that embed health equity in the design and implementation of low carbon, climate mitigation solutions in all sectors.

Briefly touched upon in this paper, but also worthy of in-depth investigation, is the potential effect of climate change on the emergence of novel infectious diseases in spillover events similar to what is likely to have occurred with severe acute respiratory syndrome coronavirus 2 (SARS CoV-2). Evidence of the escalating costs of health-related climate impacts highlights the need for a proactive, rather than reactive, approach for anticipating and mitigating climate risks equitably at a societal, economic and infrastructural level.
Climate, Health and COVID-19 in British Columbia

Introduction

The effects of climate change in British Columbia are already being felt with rising temperatures, extreme wildfire, and flooding conditions, and changing marine and ecological conditions. The direct and indirect impacts of the changing climate on health, are complex and inextricably linked to social, political, and economic factors. This paper explores some of the lessons of the COVID-19 pandemic, contextualizing them in the health challenges we are likely to face under climate change. It is written at a point in time when the lessons of COVID-19 are still emerging and understanding of the health impacts of climate change is still limited.

Recent events have illustrated the catastrophic health implications of climate change in BC. An estimated 595 people died as a result of the 2021 heatwave\(^3\), and 65,000 people were evacuated from their homes as a result of wildfires in 2017, disrupting health services and causing psychological distress\(^4\). While not as severe as 2017, the wildfire season in 2021 prompted the declaration of a provincial state of emergency lasting 56 days, triggering 181 evacuation orders and 304 evacuation alerts. Another state of emergency was declared in BC on November 2021, due to widespread flooding\(^5\). Like COVID-19, climate change is a risk multiplier, posing direct, indirect, and intersecting threats to human health and exacerbating existing health and social inequities. The provincial government has included health and well-being as a guiding principle of its draft Climate Preparedness and Adaptation Strategy in recognition of the multiple, complex impacts climate change will have on human health\(^6\).
This paper is based on a narrative review of current peer reviewed and grey literature aimed at increasing the understanding of the complexity of the relationship between our changing climate, our health and our public health systems. It is not broad enough in scope to discuss the many, interconnected, and complex health impacts we expect as a result of climate change, but rather focuses on three areas of health and healthcare delivery that have garnered broad public attention since the beginning of the COVID-19 pandemic and also have implications for climate mitigation and adaptation.

— Like COVID-19, climate change is a risk multiplier, posing direct, indirect, and intersecting threats to human health and exacerbating existing health and social inequities

We explore some of the lessons of COVID-19 regarding telemedicine, green infrastructure, and food security and the health implications of climate change for each area. We examine some of the ways in which equity could be included in the development of climate-focused advances in these three areas and highlight opportunities for increased knowledge and the development of equitable policies and practices from a public health perspective.
A Public Health Perspective

This paper is based on a public health approach, which differs from clinical healthcare or medicine. While healthcare provides medical treatment to individuals, public health is concerned with the factors that affect health and well-being on a population level.

Public health considers the structural, systemic, and ecological factors that affect health on a broad scale. These include factors such as income; access to clean air and water; safe, nutritious food; self-determination and cultural identity; education; housing; race; childhood experiences; access to green space; and environmental integrity. Public health can sometimes be referred to as population health\(^7\). Though there may be some semantic differences between public and population health, we will use the term public health throughout this paper.

Epidemiology is the science of public health, which draws connections between social, structural, economic, and environmental exposures and people’s health and well-being. The remedies offered by public health are not limited to clinical medicine, but are often focused more on structural, systemic, and ecological solutions.

— While healthcare provides medical treatment to individuals, public health is concerned with the factors that affect health and well-being on a population level.
Public health planning for climate change requires collaborative planning across sectors to act on epidemiological modeling of the complex relationships between human and non-human species and the natural, built, and social environments they inhabit. COVID-19 has highlighted how collaborative planning can impact people’s health in the face of a significant hazard.

The public health system often garners attention in the event of a new or highly contagious disease. The origins of modern public health practice are inexorably tied to the prevention of communicable disease, dating as far back as the fourteenth century\(^8\). Well-known historical disease outbreaks include the ‘black death’ or bubonic plague from 1348-1351 and the 1918 influenza pandemic, which is thought to have infected one third of the world’s population\(^9\).

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**Public health considers infectious disease transmission, the development of chronic disease and immediate health risks within social, political, economic, ecological, and built environments.**

European settlers brought waves of disease to Indigenous people in BC. Smallpox devastated First Nations communities causing population loss, displacement, and social destabilization\(^10\). Discriminatory and racist colonial structures such as Indian Residential schools and Indian hospitals amplified and exacerbated the effects of this deadly, contagious disease. Xela:ls (rock paintings) in Tsleil-Wat (Indian Arm) from the late eighteenth and early nineteenth century are thought to depict the experiences of the Tsleil-Waututh people during that time\(^10\).

Public health considers infectious disease transmission, the development of chronic disease and immediate health risks within social, political, economic, ecological, and built environments. Planetary health and one-health are branches of public health that consider how humans impact the health and well-being of ecosystems, including all forms of life and how the health of ecosystems in turn impacts human health and well-being.

Public health has historically struggled to obtain adequate funding for these critical tasks, punctuated by events like SARS and COVID-19 that cause an increase in public awareness of the value of prevention and subsequently increase temporary funding. Overall, about 95% of the healthcare dollars in Canada go to the escalating costs of diagnostics and treatment. Climate change will have a dramatic impact on health costs. A limited study by the Canadian Institute for Climate Choices\(^11\), focused on three hazards, ozone, Lyme disease and heat. Just these three hazards alone are expected to increase health costs by $90B by mid-century. This does not account for the myriad of other emerging infectious diseases, impacts from extreme rain events, flooding, fires, drought, and social disruption from food insecurity, sea-level rise, ocean acidification and loss of arctic ice. Mental health is expected to be among the highest health-related costs of climate change.
Climate Change in British Columbia

British Columbia has two provincial and five regional health authorities. The First Nations Health Authority and the Provincial Health Services Authority serve the entire province, while the regional health authorities serve specific geographic areas. Each regional health authority is expected to experience the effects of climate change differently. Figure 1. shows the boundaries of the five regional health authorities and the expected impact of climate change in each region.

**NORTHERN HEALTH AUTHORITY**
is expected to see the largest increases in annual temperature; annual, summer and winter precipitation.

**INTERIOR HEALTH**
is expected to see considerable increases in annual temperature, and growing degree-days as well as decreases in precipitation as snow.

**FRASER HEALTH**
is expected to see a considerable decrease in summer precipitation, annual precipitation as snow, and the largest decrease in spring precipitation as snow in the province. It is also expected to see the largest increase in growing degree days and frost-free days.

**VANCOUVER COASTAL HEALTH**
is expected to see a considerable decrease in summer precipitation; annual, winter and spring precipitation as snow and an increase in frost-free days.

**ISLAND HEALTH**
is expected to see the smallest increase in annual temperatures; the largest decreases in summer precipitation, annual and winter precipitation as snow; and a considerable increase in growing degree days.

* Fig. 1 Regional Health Authorities In BC
Table 1: Projected Climate Changes by Health Authority Under a High Emissions Pathway (Median Projected Change from 1961-1990 Baseline to 2040-2069)

<table>
<thead>
<tr>
<th></th>
<th>Temperature (°C)</th>
<th>Rain Precipitation (%)</th>
<th>Snow Precipitation (%)</th>
<th>Frost-Free Days (Days)</th>
<th>Growing Degree Days (GDD)*</th>
<th>Cooling Degree Days (CDD)**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANNUAL</td>
<td>ANNUAL</td>
<td>ANNUAL</td>
<td>ANNUAL</td>
<td>ANNUAL</td>
<td>ANNUAL</td>
</tr>
<tr>
<td>ANNUAL</td>
<td>+3.3 °C</td>
<td>+3.2 °C</td>
<td>+2.7 °C</td>
<td>+3.1 °C</td>
<td>+3.0 °C</td>
<td></td>
</tr>
<tr>
<td>Rain Precipitation (%)</td>
<td>+10%</td>
<td>+1.2%</td>
<td>+1.6%</td>
<td>-1.4%</td>
<td>+1.8%</td>
<td></td>
</tr>
<tr>
<td>SUMMER</td>
<td>+8.8%</td>
<td>-0.46%</td>
<td>-15%</td>
<td>-12%</td>
<td>-10%</td>
<td></td>
</tr>
<tr>
<td>WINTER</td>
<td>+8.3%</td>
<td>+0.23%</td>
<td>+3.8%</td>
<td>-1.9%</td>
<td>+1.6%</td>
<td></td>
</tr>
<tr>
<td>Snow Precipitation (%)</td>
<td>-25%</td>
<td>-26%</td>
<td>-50%</td>
<td>-50%</td>
<td>-45%</td>
<td></td>
</tr>
<tr>
<td>SUMMER</td>
<td>-16%</td>
<td>-17%</td>
<td>-56%</td>
<td>-47%</td>
<td>-42%</td>
<td></td>
</tr>
<tr>
<td>WINTER</td>
<td>-36%</td>
<td>-41%</td>
<td>-27%</td>
<td>-57%</td>
<td>-45%</td>
<td></td>
</tr>
<tr>
<td>Frost-Free Days (Days)</td>
<td>+40</td>
<td>+45</td>
<td>+49</td>
<td>+52</td>
<td>+50</td>
<td></td>
</tr>
<tr>
<td>Growing Degree Days (GDD)*</td>
<td>+494</td>
<td>+566</td>
<td>+644</td>
<td>+666</td>
<td>+586</td>
<td></td>
</tr>
<tr>
<td>Cooling Degree Days (CDD)**</td>
<td>+39</td>
<td>+77</td>
<td>+57</td>
<td>+115</td>
<td>+43</td>
<td></td>
</tr>
</tbody>
</table>

* Growing Degree Days (GDD) is the sum of the daily temperature difference above a constant base temperature, over a typical year in the period. In Plan2Adapt, a base temperature of 5 °C is assumed. GDD can be used to assess the potential growth and development of plants and pests over the course of one growing season as a result of heat accumulation. Positive values indicate faster growth & development over the course of one year. GDD can be used to predict when crops will mature, when plants will flower and when pests might emerge and require treatment.

** Cooling Degree Days (CDD) is the sum of temperature difference above a constant base temperature (in this case, 18°C) over a typical year. CDD is a compound measure of both the magnitude and duration of temperature over a threshold, and as such contains both isolated hot days and extended heat waves. It also generally reflects the indoor comfort level over the warm months in the absence of mechanical cooling.

How Growing Degree Days are calculated:
A day with an average temperature of 15 °C would contribute (10-5) = 5 GDD. If the next two days were 8 °C and 4 °C, then the total GDD for the 3-day period would be 5 + 3 + 0 = 8 GDD, and so on. Repeating for all days in each calendar year over the 1961-1990 baseline period and taking the average over all 30 years gives the baseline GDD. Doing the same for each future period, then subtracting the baseline GDD from the future GDD gives the values as shown in Plan2Adapt.

The authors wish to thank the Pacific Climate Impacts Consortium (PCIC) for the generous input and advice into using the Plan2Adapt tool.
Ecosystems including habitat, wildlife, and marine management are planned at the biogeoclimatic scale, which is based on detailed climate, topographical, soil, and vegetation criteria\(^\text{13}\). This scale is much finer than health authority boundaries, which include several micro-climates and typographies that will experience the effects of climate change differently.

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**Food system disruptions due to drought, flooding of homes and poor air quality resulting from wildfire smoke are examples of climate-related health hazards that cross health authority boundaries**

For example, extreme precipitation is projected to be more frequent and intense over mountainous regions. This would include the Coastal, Columbia, and Rocky Mountain Ranges, all of which span several health authorities. Increases in consecutive dry days, or drought, are also expected to increase over the entire Fraser River Basin, which spans parts of the Vancouver Coastal, Fraser, Interior and Northern Health Authorities\(^\text{14}\). Food system disruptions due to drought, flooding of homes and poor air quality resulting from wildfire smoke are examples of climate-related health hazards that cross health authority boundaries, requiring co-ordinated and collaborative planning to address. Mapping the effects of climate change within and across health authorities could provide the basis for evidence-informed planning and better prepare regional and provincial health services for the impacts of climate change.
Connecting Health and Climate Change

Associations between environmental exposures and health outcomes can be difficult to quantify. The inherent uncertainty in current climate models combined with the complexity of modeling the associated health outcomes makes climate health adaptation planning challenging.

The COVID-19 pandemic has illustrated some of the challenges of communicating and acting on public health threats using epidemiological modelling, even when the threat is very immediate\textsuperscript{[15]}. The impacts of climate change on human health will depend on the physical aspects of a shifting climate, as well as human preparation and behaviour, just as the spread of COVID-19 is about the SARS CoV2 virus as well as individual and societal responses to it\textsuperscript{[16]}. Both require robust and universal public education and an effective response to disinformation campaigns. COVID-19 vaccine hesitancy and refusal amid clear and compelling scientific evidence provides us with some insight into the complex relationship between people’s social and emotional reactions to information\textsuperscript{[17]}. Our experiences with vaccination campaigns over the past two years may offer valuable lessons for future conversations about climate change and climate science.

\textbf{The impacts of climate change on human health will depend on the physical aspects of a shifting climate, as well as human preparation and behaviour...}

Much of the current climate-related epidemiology examines the health impacts of climate related to extreme and catastrophic events, such as wildfires, floods, drought, and extreme heat. Such events can have direct and indirect, immediate, and long-term health impacts. Yet many of the projected health impacts of climate change are not directly related to catastrophic events. There are direct health implications for each of the projected changes in Table 1, as well as climate-related social, economic, and ecological changes that will have further direct and indirect effects on human health and well-being.

As described by the Canadian Public Health Association, social justice, attention to human rights, equity, and addressing the underlying determinants of health are central tenants of public health practice. Unequal and inequitable access to safe food, water, employment, and livable ecosystems have the potential to increase conflict, strain and fragment social systems. The mental health impacts of climate change and loss of culturally significant ecosystems are examples of health outcomes that are difficult to quantify but deeply impactful\textsuperscript{[18]}.

Wildfires affecting Vancouver, August 1, 2021.
Equity and Climate Vulnerability

Equity attempts to understand and address differences in access to resources, opportunities, and power in order to create equal opportunities and outcomes in people’s lives and across communities. It is concerned with fairness and justice. CleanBC’s draft Climate Preparedness and Adaptation Strategy includes equity as one of the six guiding principles informing a just approach to climate adaptation in the province\(^6\).

Health equity is a term that is often used to understand the unequal ways in which people can be impacted by various health hazards and issues. It is defined by the Canadian Institute for Health Information as the absence of unjust, avoidable differences in health care access, quality, or outcomes\(^6\), but is often understood more broadly. A more fulsome interpretation of health equity is that it seeks to understand how the organized efforts of our society could address the differential health outcomes that are the result of gender, race, income, housing, geographical location, ability, education, and other sociopolitical factors.

Intersectionality is a term that describes the interactions between these factors, and how they can compound or mitigate each other. A recent publication from BC’s Ministry of Environment and Climate Change Strategy provides recommendations on how to apply Gender-Based Analysis and an intersectional perspective to climate adaptation planning in BC\(^19\).

Attending to the factors that can result in inequitable health outcomes is an important part of public health practice and essential for understanding planning priorities for climate change adaptation. Achieving equitable health outcomes in the context of climate change requires considerations beyond access to and quality of healthcare services. It requires an increased awareness and understanding of how differences in environmental exposures and health vulnerabilities lead to inequitable, or unfairly different health outcomes.

Public health actions to address health inequities often centre around the idea of vulnerability. Vulnerability was first defined in public health practice as physical challenges such as underlying health conditions, disability, and states such as pregnancy, or age\(^20\). The National Collaborating Centre for Determinants of Health recognizes vulnerability as “groups and communities at a higher risk for poor health as a result of the barriers they experience to social, economic, political and environmental resources, as well as limitations due to illness or disability”\(^21\). This expanded definition of vulnerability allows us to consider issues such as gender, race, and other intersecting factors.

——“Climate change affects all, but not all people are affected equally.”

Jacqueline Patterson,
Director of the NAACP Environmental and Climate Justice Program
Lessons from COVID-19

Infectious disease outbreaks have always been part of the human condition. Historically, they have been driven by increases in human density, trade and travel, ecological disturbances and human interactions with animals.[22]

Infectious diseases have not been a leading cause of death in Canada for many years. Influenza and pneumonia were between the 6th and 8th leading causes of death between 2015 and 2019, with no other infectious diseases appearing in the top 10 list[23].

There were 1012 deaths due to COVID-19 in BC in 2020[24], accounting for 2.5% of all deaths in the province[25]. The estimated number of excess deaths reported for 2020 in BC was 2464[26], pointing to the possible indirect effects COVID-19 may have had on deaths due to other causes like illicit drug overdose, self-harm, missed or delayed medical interventions[27].

- Lockdowns, social restrictions, economic disruptions, and collective trauma due to the loss of life and human suffering from COVID-19 have further impacted mental health.

In 2019, British Columbians had the lowest self-rated mental health in the country[36]. Lockdowns, social restrictions, economic disruptions, and collective trauma due to the loss of life and human suffering from COVID-19 have further impacted mental health. For example, close to 70% of gender diverse people in Canada reported having fair or poor mental health during COVID-19, compared with 26% of females and 21% of males[37]. Even before the start of the pandemic, a 2018 report from the McCreary Society found that youth in BC were more likely to experience poor mental health if they identified as non-binary, lived in poverty or did not feel connected to their community or nature[38]. Lockdowns and school closures due to COVID-19 have had a significant impact on youth. A

Dr. Bonnie Henry, BC’s provincial health officer provided regular updates during the COVID-19 pandemic. Credit: Province of British Columbia, Flickr.
study of youth 6-18 years old in Toronto found that 70% had experienced deteriorations in their mental health as a result of the public health measures to prevent the spread of COVID-19\(^{39}\).

COVID-19 emerged while BC was already experiencing a public health emergency due to illicit drug overdose. The emergency was declared in 2016 and remains in effect at the time of writing. Rates of death due to overdose declined in 2019, but in 2020 BC experienced the most devastating year on record, losing 1,724 people to overdose; exceeding the number of deaths from motor vehicles, suicide, and homicide combined\(^{40}\). Loss of access to services, social isolation and distress associated with the pandemic are all suggested as factors that might have contributed to this disturbing increase.

COVID-19 has caused considerable disruptions to the health system. The BC Centre for Disease Control surveyed 400,000 British Columbians and found that an average of 23% had difficulty accessing healthcare services during the pandemic\(^{38}\). This ranged from 14 – 45% across BC’s regional health authorities demonstrating some of the varying geographic disparities experienced by people in different parts of the province.

The pandemic revealed and exacerbated vulnerabilities in BC’s health system; disrupting the supply of blood products, cancelling and reducing the number of surgeries\(^{42},^{43}\), and reducing access to services like harm reduction\(^{40}\). It is estimated that the pandemic has caused a backlog of over 32,000 orthopedic surgeries in the province\(^{43}\). There were also impacts on preventative care including disruptions to universal hearing and vision screening programs for children. The waitlists for early intervention and screening continue to grow, and could have long-term implications for children’s development and educational outcomes, especially for those with complex medical needs and disabilities\(^{45},^{46}\).

— Close to 70% of gender diverse people in Canada reported having fair or poor mental health during COVID-19, compared with 26% of females and 21% of males.

During the COVID-19 pandemic, 15% of Canadians experienced household food insecurity. This increased to 19% of households with children and 28% of those absent from work due to layoffs, public health restrictions, or other COVID-19 related issues\(^{47}\). Food insecurity and poor mental health are often connected. Those in households with moderate food insecurity were nearly three times as likely to report fair or poor mental health, and moderate or severe anxiety symptoms, compared with individuals in food-secure households\(^{47}\).
Climate, Health and COVID-19 in British Columbia

Applying the Lessons of Covid-19 to Climate-Health Adaptation

The COVID-19 pandemic has revealed many serious health system vulnerabilities and illustrated the complex, indirect effects of a far-reaching public health crisis.

Likewise, catastrophic climate-related events such as floods, wildfire, and extreme weather as well as periods of extreme heat and wildfire smoke pollution could all have serious implications for British Columbians’ physical and mental health. It is estimated that 595 people died as a result of the heatwave in BC in June/July 2021[3]. Such extreme heat events are likely to become more frequent under climate change, potentially causing more deaths and illness. As with COVID-19, the mental health impacts of climate change may be even greater than the impacts on physical health.

Environmental epidemiology has been investigating the ways in which the environment affects human health for decades[48]. More recently one-health and planetary health approaches have emerged that investigate the complex interactions between humans and ecosystems without putting humans at the centre or the top of a hierarchical system[49]. These new disciplines take a more ecological approach to understanding human health, not only as an outcome of environmental exposures, but of the systems themselves, which are influenced by humans and other forms of life.

— Environmental epidemiology has been investigating the ways in which the environment affects human health for decades
Ecologists have long understood the concept of landscape immunity in which favorable ecological conditions maintain and enhance immune function in multiple wild species and prevent conditions where pathogens spread easily\(^{(50)}\). Climate change and changes in land use patterns combine in many parts of the world to produce conditions favorable to spillover events where pathogens from other species move to human hosts\(^{(2)(51)}\). As the human population expands into wildlands and alters or destroys balanced ecosystems, the likelihood of spillover events increases along with inter-species spread of zoonotic diseases such as COVID-19\(^{(52)}\). Climate change could exacerbate these events by altering the range of vector-borne diseases through changing vector habitat, human migration, and environmental degradation though it is difficult to predict given the uncertainty of human behaviour\(^{(53),(54),(55),(56)}\).

The creation of walkable urban neighbourhoods and accessible community gardens are examples of policy decisions that can achieve such co-benefits.

COVID-19 has raised public awareness of the role and philosophy of public health and highlighted the many ways our environment effects our health. In responding to climate change, public health has been pushed to identify co-benefits that climate adaptation and mitigation measures can bring to already over-burdened health systems. This could involve solutions like low carbon modes of transportation or modifications to food systems. Walking, cycling and transit use that promote exercise and improve cardiovascular health\(^{(57)}\) can also reduce fossil fuel use, air pollution and greenhouse gas (GHG) production. Modifications to the food system could reduce food deserts, promote healthy eating and reduce carbon emissions from agriculture. The creation of walkable urban neighbourhoods and accessible community gardens are examples of policy decisions that can achieve such co-benefits.

The COVID-19 pandemic has reminded us of the economic and racial inequality in Canada. Infection rates and mortality are higher in racialized communities and access to health care and access to vaccines may be reduced\(^{(59)(60)(61)}\). Some of these inequities stem from the type of work and commuting to work that low-income workers have been required to do during the pandemic as well as crowded housing conditions and neighbourhood characteristics\(^{(62)}\)\(^{(63)}\). Planning with and for populations that may be disproportionately affected by a public health hazard can reduce systemic inequities and improve health outcomes for priority populations\(^{(64)}\).

Much of what we are learning from our experiences with COVID-19 also has applications for climate change planning and adaptation. In the following sections we explore what we have learned about the use of telemedicine, access to greenspaces and the importance of food security during COVID-19 and the public health implications of these issues under climate change.
Virtual Health and Telemedicine

Telemedicine is the use of information and communication technologies to enable the “exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers.”\(^{(65)}\) It includes three, broadly accepted categories: Telehealth (via telephone or virtual conferencing systems, which can be either synchronous and asynchronous in nature); Digital Care Therapeutics; and Care Navigation\(^{(66)}\). During the COVID-19 pandemic, BC’s and Canada’s healthcare systems experienced an expedited implementation of telemedicine services. Telemedicine was employed to reduce the risk of COVID-19 transmission and maintain continuity of care during widespread disruptions across the healthcare system\(^{(67)}\)\(^{(68)}\)\(^{(69)}\). The pace and scale of its implementation had never occurred before\(^{(70)}\)\(^{(71)}\). Analysis by the Provincial Health Services Authority indicated that weekly virtual visits increased from 1,500 to 20,000 as the pandemic disrupted more conventional in-person care\(^{(72)}\). At BC Children’s Hospital, 100% of all routine diabetes clinic visits transitioned to telehealth, up from approximately 5%, before the pandemic\(^{(69)}\). Despite a lack of video conferencing infrastructure, addictions medicine consult services at St. Paul’s Hospital in Vancouver, were able to rapidly implement virtual supervised...
consumption and tele-mentoring, which were developed and implemented rapidly to support substance use disorder patients at sites across North America\(^{(73)}\). Cancer care and chronic disease management, psychiatric assessment and services, general practitioner consultations, and other services all implemented various telemedicine approaches across the province.

Telemedicine is increasingly seen as having secured a place in Canada’s healthcare system in the wake of the pandemic\(^{(43),(74)}\). There is now a greater reliance on these approaches to deliver both routine and specialized healthcare\(^{(69)}\). At the same time telehealth, and telemedicine more broadly, provide opportunities and risks for both reducing and increasing health equity\(^{(75),(73)}\) while also presenting promising strategies for mitigating the healthcare sector’s carbon footprint. The 2019 Lancet Countdown on Health and Climate Change Policy brief indicates that Canada’s healthcare system has the third-highest per capita greenhouse gas emissions in the world and contributes 4.6% to Canada’s total GHG emissions. At the same time, the report notes that health sector emissions represent a key strategic mitigation target which can be achieved through the development and implementation of sustainable healthcare strategies\(^{(76)}\).

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Telemedicine presents an opportunity to reduce the health sector’s carbon footprint by reducing GHG emissions associated with travel by both patients and healthcare providers

Telemedicine presents an opportunity to reduce the health sector’s carbon footprint by reducing GHG emissions associated with travel by both patients and healthcare providers\(^{(77),(78)}\). Practices such as telescreening, teleconsultation, telementoring, diagnoses, and treatment all have the potential to reduce travel-related emissions\(^{(73),(78),(79),(80),(81),(82)}\). A recent systematic review concluded that using telehealth in place of in-person visits in hospitals and specialized care settings had the potential to reduce travel-associated emissions by 0.70 to 372 kg of CO2 per medical appointment\(^{(83)}\). A study in two Swedish rehabilitation centres found that replacing in-person with telehealth consultations resulted in a 40-70% greater reduction in emissions when travel to an appointment was over a few kilometres\(^{(84)}\). A smaller, French study of 80 patients using teleconsultations for urology care over a two-week period found a 99% reduction in emissions as compared to in-person visits\(^{(79)}\).

Emission reductions are context-specific and vary greatly depending on factors including the distance traveled by patients and their mode of transportation\(^{(77),(83)}\). Geographic location also impacts available transportation infrastructure, as well as proximity to specialist services\(^{(70),(83)}\). The extent of emissions reduction also depends on the length of

Medical consultations via the phone or internet are now common practice in Canada due to the COVID-19 pandemic.
appointment, bandwidth and whether telephone or videoconferencing is used\(^{84},(85),(86)\). Virtual or videoconferencing visits consume more energy than telephone visits, resulting in higher emissions, yet not all studies account for the emissions resulting from the technology used, technology life cycle or facility infrastructure required to support telehealth\(^{83},(70)\). Studies that account for emissions associated with use of technology have found that reductions in travel-related emissions outweighed or eclipsed the smaller increase in emissions associated with the use of computers and bandwidth by patients, although assumptions underlying the modelling vary across studies\(^{77},(79),(84),(83)\). A BC-based study is currently underway to better understand the potential for travel-related emissions reduction in cardiovascular treatment.

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**Travel-related emissions outweighed or eclipsed the smaller increase in emissions associated with the use of computers and bandwidth by patients.**

Given the current investments in and spread of telehealth approaches in BC, along with an eagerness to evaluate its impact across the health sector, there is an important window of opportunity to explore and leverage telehealth’s potential as part of a provincial climate mitigation strategy.

### Equity considerations

- Given BC’s large geography, telehealth has the potential to reduce inequities that are experienced by rural and remote populations by: reducing the burden and cost of travel for rural patients\(^{72},(80),(87)\), enhancing access to and quality of follow-up care and increasing equity of access to specialist care\(^{88},(70)\). In order for telehealth care to increase equity, rural populations must have the resources, ability, and willingness to engage in telehealth. In addition, they must have access to technology and adequate bandwidth, affordability of internet services, and broadband infrastructure\(^{89},(90)\).

- The uptake and efficacy of telehealth itself is also very dependent on contextual factors such as race, age, and socio-economic status\(^{75},(89),(63)\).

- There remains a gap in knowledge of the efficacy of telephone and virtual technologies to deliver the same quality of care as conventional, in-person care across diagnoses and disciplines\(^{71},(90)\). For example, while psychiatric virtual care has shown similar efficacy with children and youth, there are other specific conditions, such as Autism Spectrum Disorder, which may not be as conducive to telehealth approaches and will require further study\(^{91}\). The use of multiple telehealth modalities have demonstrated similar outcomes for clinical care delivered via telehealth and in-person, from oncology, audiology\(^{92}\) neurology, psychiatry and obstetrics\(^{90},(93)\).
Spending time in natural environments or greenspaces has been proposed as a nature-based solution that supports positive mental health and well-being\(^{(94)}\). Restrictions on indoor social gatherings and limited organized activities during COVID-19 have highlighted the importance of access to public outdoor and green spaces, particularly in urban areas.

Green infrastructure, or greenspace, is a common feature of urban design and has long been recognized as a contributor to the health and well-being of people living in urban and semi-urban settings\(^{(95)}\).

The benefits people derive from greenspaces are not the same for everyone, however and not always well understood\(^{(96),(97),(98),(99)}\). Health benefits can include improved mental health\(^{(100),(101)}\), lower rates of obesity\(^{(102),(103)}\), improved cardiovascular health\(^{(104)}\), and reduced exposure to violence and aggression\(^{(105),(106)}\).

Health benefits can be complicated by the introduction of hazards such as increases in pollens that can trigger asthma attacks\(^{(107)}\) and changes in the distribution of pests that can act as vectors for disease\(^{(108)}\). Inequitable access to quality green space can compound the inequities that result from differences in income, employment type and status, systemic
discrimination and educational opportunities\textsuperscript{(109),(110)}. Greenspaces are also not all the same and the health benefits can vary depending on the quantity, quality and biodiversity within them\textsuperscript{(111),(112),(113)}.

— *Eco-anxiety, solastalgia, ecological and climate grief are all terms that attempt to explain the links between climate change and mental health.*

COVID-19 disrupted people’s routines, social interactions, and working conditions. For many, it has changed the way they think about where they live and how their environment affects them, and many people sought solace in nature and green spaces to manage the stresses of the pandemic\textsuperscript{(114)}. Accessing greenspace buffered some of the negative effects of COVID-19, including on mental health, inactivity and social isolation\textsuperscript{(115),(116),(117)}. Much of the evidence for the benefits of greenspace during the pandemic is qualitative. There have, however been quantitive measures of reduced COVID-19 mortality\textsuperscript{(118)}, and reductions in mental health prescriptions due to greenspace exposure\textsuperscript{(100)}.

Greenspaces and green infrastructure have been proposed as a climate mitigation and adaptation strategy for urban environments. Human health could even be seen as a positive, unintended outcome of developing greenspaces for climate mitigation\textsuperscript{(119)}. Green infrastructure can be used to mitigate damage from flooding\textsuperscript{(120)}, cool cities experiencing the urban heat island effect and improve air quality,\textsuperscript{(121),(122),(123)} all of which are hazards that are expected to increase under climate change and have direct health implications. Green infrastructure can also contribute to carbon sequestration, and lower atmospheric CO2 levels\textsuperscript{(124),(125)}. The plants providing these ecoservices will also experience stresses due to climate change including increased temperatures, seasonal drought conditions\textsuperscript{(126)}, and increases in wind speeds and severe weather\textsuperscript{(127)}.

Eco-anxiety, solastalgia, ecological and climate grief are all terms that attempt to explain the links between climate change and mental health. Eco-
anxiety focuses on the perceived negative effects of climate change and worries regarding future safety\textsuperscript{128}. Ecological and climate grief describe the anguish and despair associated with the loss or anticipated loss of future ecosystems, cultural identity, livelihoods, and the increasing unpredictability of ecosystems and environments\textsuperscript{129}.

\textit{Green infrastructure can be used to mitigate damage from flooding, cool cities experiencing the urban heat island effect and improve air quality}

Despair in the climate context is also described as solastalgia, which describes the feelings of sadness associated with the loss of connection to natural environments or ecological systems\textsuperscript{130}. Urban greenspaces have shown their potential for supporting mental health, reducing anxiety, and offering respite in times of stress and crisis. These ecoservices are likely to become more vital as the effects of climate change become increasingly evident and begin to affect people’s physical and mental health\textsuperscript{11}.

\textbf{Equity Considerations}

\textit{» Greenspaces are not equally accessible; household income is a key indicator of access to greenspace. The higher a household’s total annual income, the more likely it is to have a park or public green space close by. In 2017, 76\% of households with an income of less than $20,000 per year reported having access to a nearby park, compared to 95\% of households with an annual income of $150,000 or more. At the same time only 40\% of lower income households had a lawn as part of their property, compared to 86\% of high income households, compounding the issue of accessible green space\textsuperscript{131}.}

\textit{» Even when greenspace was accessible, it did not offer the same degree of respite and social connection during COVID-19 for those experiencing greater financial hardship, those that could not work from home and those with existing mental health diagnosis\textsuperscript{132,133,134}.}

\textit{» COVID-19 has exacerbated and made more visible the challenges associated with homelessness in many urban centres. Greenspaces have been the sites of encampments that have sometimes resulted in conflict and raised complex questions about the rights of people to use public green spaces and the inequalities that exist within our society.}

\textit{» Resilient urban ecosystems that include green infrastructure have the potential to support resilient populations and address inequities by mitigating some of the effects of climate change and conferring other known health benefits\textsuperscript{135,136}.}
Food Security

Food systems include the production, processing, packaging, distribution, marketing, consumption, and disposal of food. These complex networks of people, communities, and resources exist within social, cultural, and ecological contexts. The security of our food system in BC is dependent on all of these variables, which are vulnerable at each stage to disruption. COVID-19 highlighted some of these vulnerabilities, ranging from empty grocery store shelves to garden centers running out of seed for home gardeners.

In 2017, BC’s agri-food industry produced $14.2B in sales of agriculture, food and seafood products (137). Agriculture in BC generated an estimated 35,100 direct and indirect jobs in 2019 (138), with temporary migrant agricultural workers (TMAW) from outside Canada filling approximately 21% of these jobs in 2018 (139). The COVID-19 pandemic has brought attention to the critical role of laborers working in essential services such as long-term care and food production. Many of these workers experience health and social inequities due to their temporary or precarious status in Canada making them more vulnerable to health challenges. During the 2020 growing season, TMAW experienced an inability to physically distance at work, inadequate personal protective equipment, increased workloads and additional work-related injuries and psychological distress (140). Crowded and substandard living conditions and poor access to healthcare made them more vulnerable to SARS CoV2.
More frequent and severe extreme heat events will create additional hazards for agricultural workers who are vulnerable to heat exhaustion and heat stroke due to the nature of their work. In its 2021 report, the Canadian Institute for Climate Choices estimates that work hours lost to extreme heat, particularly for outdoor workers, could cost our economy up to $15B annually by the end of this century.¹¹

— More frequent and severe extreme heat events will create additional hazards for agricultural workers who are vulnerable to heat exhaustion and heat stroke due to the nature of their work.

Though BC produces a diversity of food products, it still imports much of its vegetables, fruits, and nuts.¹⁴¹ In 2017, nearly half of the food consumed in BC was not grown or produced in the province.¹⁴² Seventy percent of fruits and 60% of vegetables imported by BC come from the United States, with the majority coming from California.¹⁴³ In recent years, California has experienced record-breaking wildfires, extreme, unprecedented heat exceeding 54°C and severe drought conditions that have resulted in an emergency drought declaration for 50 of its 58 counties.¹⁴⁴ These climate stressors are making it more difficult for California to maintain agricultural production, jeopardizing domestic food security and BC’s source of many fresh foods.

Climate change has the potential to affect all stages of food production and distribution, with potentially positive and negative implications for BC. Changes in winter weather conditions have resulted in decreased cold-weather damage to crops, as well as improved winter survival for crop-damaging pests. Increased summer temperatures and lower precipitation have resulted in greater irrigation costs, however the long, dry summer months have also extended grazing season and reduced crop-damaging fungal disease.¹⁴¹⁺¹⁴⁷

An increase in adverse weather events such as droughts, flooding, extreme precipitation and heat events, as well as a general decline in glacial mass have resulted in earlier spring run-offs.¹⁴¹ These events have dramatically impacted the length and quality of growing seasons, resulting in variable yields in many regions across the province. While the effect of these changes is felt most strongly in the southern and coastal regions of BC, fluctuations in seasonality are experienced throughout the province.¹⁴¹

Wildfires can also have a detrimental effect on food production by threatening crops, businesses, and infrastructure. BC’s devastating wildfires of 2017 and 2018 scorched over 2.5M hectares of land, causing over $1.2B of damage.¹⁴⁸ In 2021, wildfires in BC burned more than 868,000 hectares—including the tragic loss of the town of Lytton and two of its residents during a week of record high temperatures (peaking at 49.6°C)—with more than 180 evacuation orders and $565M spent on suppression.¹⁴⁹ Wildfires can directly
damage agricultural soils\(^{(150)}\) and smoke from wildfires can damage crops including tainting wine grapes\(^{(151)}\).

Three of BC’s five regional health authorities include coastal ecosystems. Coastal, or marine ecosystems are vitally important for their cultural significance, influence on weather patterns across the province, and contributions to food security. Warming oceanic waters can lead to species die-off, causing cascading impacts up the food web that have social, cultural, and economic ramifications. Harmful algal blooms, which produce a variety of biotoxins that can be harmful and even fatal in both wildlife and humans, are increasing as water temperatures warm\(^{(152)}\). Warmer waters and excessive algal growth lead to an overall decrease in dissolved oxygen content in oceans\(^{(153)}\) creating sub-optimal conditions for many marine species that humans rely on. Rising sea levels also threaten agriculture in BC with some of the province’s most productive farmland in the Fraser River Delta already below sea level\(^{(154)}\).

Agriculture can act as both a source of carbon emissions and a potential carbon sink. Rates of carbon sequestration can vary depending on agricultural practices\(^{(155)}\) and carbon emissions depend on farming practices, food waste, processing, packaging and distribution systems\(^{(156)}\). Fossil fuel infrastructure like oil pipelines can also directly affect food security by putting fragile ecosystems that are sources of traditional foods at risk\(^{(157)}\). BC’s 2020 greenhouse gas emissions inventory showed a 7% increase in overall GHG emissions between 2007 and 2018, with a 171% increase related to on-farm fuel use\(^{(158)}\). In 2020, the BC Food Security Task Force found that “existing food production (in BC) would not be able to meet the dietary needs of forecasted population growth while also meeting the greenhouse gas reduction goals of CleanBC.”\(^{(159)}\).

—Climate change has the potential to affect all stages of food production and distribution with potentially positive, and negative implications for BC.

Food systems, food security and food sovereignty are extremely complex issues that are sensitive to changes in weather and climate and have far-reaching implications for people’s health and wellbeing. Food is not only a source of energy and nutrition; it can also connect us to culture, place, and our community.

**Equity Considerations**

» Agricultural workers are more vulnerable to the health effects of extreme heat. They often lack labour protections and work in precarious, short-term positions that create additional precarious vulnerabilities.

» Traditional and country foods that Indigenous communities rely on may become less abundant or accessible due to drought, wildfire, and possible contamination.

» Food scarcity will affect low-income people most severely, restricting their access to quality and possibly quantity of food.
Knowledge Opportunities

There are numerous and wide-ranging opportunities to build on our understanding of the health impacts we can anticipate under climate change. Like COVID-19, climate change is a risk multiplier, posing direct, indirect, and intersecting threats to human health and exacerbating existing health and social inequities.

Climate hazards such as increased extreme precipitation, drought, heatwaves, floods, wildfires, air pollution, and changes in patterns of vector-borne disease pose serious threats to physical and mental health in BC. Achieving equitable health outcomes for British Columbians will require existing differences in environmental exposure and health vulnerabilities to be understood and addressed in health and climate adaptation planning.

Based on the evidence gathered for this report, there are gaps in current knowledge and practice regarding the role of telemedicine, green infrastructure, and food systems in supporting health, health equity and contributing to climate change mitigation and adaptation. Opportunities to address these knowledge gaps include:

» Improving our understanding of the impact that climate change will have on human and ecological health in BC.

» Mapping climate projections, health impacts and vulnerability across the province to inform coordinated health and equity planning for climate change across health authority boundaries.

» Developing processes that embed health equity in the design and implementation of low carbon, climate mitigation solutions in all sectors.
TELEMEDICINE

» Evaluating the efficacy of telemedicine, its limitations, and benefits for specific populations in the province.

» Developing models that provide a comparable and consistent means of evaluating the net carbon emissions of telemedicine compared to traditional in-person medical visits.

» Developing a BC provincial strategy for telemedicine that will create consistency and promote standardization for all health authorities, while ensuring equity and sustainability are front and centre across both public and private initiatives.

GREEN INFRASTRUCTURE

» Exploring the potential of public urban green spaces for reducing heat exposure, improving air quality, and supporting mental health.

» Developing a better understanding of the health co-benefits of green infrastructure design including the hazards and benefits of flood mitigation strategies, the relative benefits of different plant types and landscape features, and the size, spacing and location of green spaces.

» Evaluating the risks of climate change to green (vegetation) and blue (waterbodies) spaces and infrastructure.

FOOD SECURITY

» Understanding the risks and benefits of climate change to food production in BC including the cascading effects of ecosystem changes on oceanic and terrestrial food webs.

» Understanding the health risks climate change poses to agricultural workers.

» Planning for anticipated disruptions to food production and supply, as well as price instability, to protect those most vulnerable to food scarcity and price increases.

» Diversifying food supply chains (imported and domestic) to minimize disruptions related to climate change.

» Exploring technological, social, and economic innovations that support a resilient, low carbon food system.
Conclusion

Climate change has been called the greatest public health opportunity of the century by the World Health Organization (WHO).

In 2014 the WHO recommended that health be a central pillar of climate debate, that health systems become more resilient to the impacts of climate change while also lowering their carbon footprint, that more robust surveillance and warning systems are developed, and that they focus on solutions that bring health co-benefits through climate mitigation and adaptation. Climate change planning for health is forward thinking and our health and public health systems are structured primarily to be responsive to current and immediate health issues. Climate adaptation planning requires a cross-sectoral, whole of government, all of society approach. Health and public health planners and practitioners cannot solve nor address the challenges of climate change alone. Public health does, however, provide an inclusive, wholistic lens with which to view the possibilities for climate resilience. The integration of health science, social and behavioral sciences, and epidemiology with other disciplines can provide greater insight into the human costs associated with a changing climate.

COVID-19 has helped us to understand some of the complexities of responding to a global public health crisis and highlighted the importance of anticipatory planning. Climate change presents us with opportunities for transformative change and COVID-19 has illustrated the potentially catastrophic consequences of not being well prepared for foreseeable public health risks. Perhaps one of the positive effects of COVID-19 is that it will create additional urgency across all sectors to take more decisive action to mitigate the worst that is possible under climate change.
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