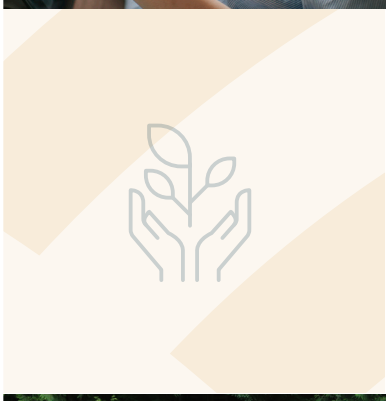


# Climate, Health and COVID-19 in British Columbia

PICS
PACIFIC INSTITUTE
FOR CLIMATE SOLUTIONS

January 2022

## Authors


**Sally Maguet**
Master of Public Health (MPH),
Simon Fraser University

**Sally McBride**
MPH,
Simon Fraser University

**Michael Friesen**
MPH,
Simon Fraser University

**Tim Takaro**
Medical Doctor (MD)/MPH,
Prof. Health Sciences,
Simon Fraser University


## Acknowledgements


**Editorial**
Robyn Meyer,
PICS Communications


## 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 Sḵwx̱wú7mesh (Squamish), Səl̓ílwətaʔ/Selilwitulh (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.

## PICSCanada.ca

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.

University of Victoria · SFU Simon Fraser University Engaging the World · UBC The University of British Columbia · UNBC University of Northern British Columbia

# Table of Contents

# 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.

> *This report focuses on three areas of health and healthcare delivery that have garnered broad public attention over the course of the pandemic to date and are likely to also be affected by climate change*

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)[1][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.

Flooding devastation in the Fraser Valley, BC, November 23, 2021. **Credit:** Province of British Columbia, Flickr.

# Introduction

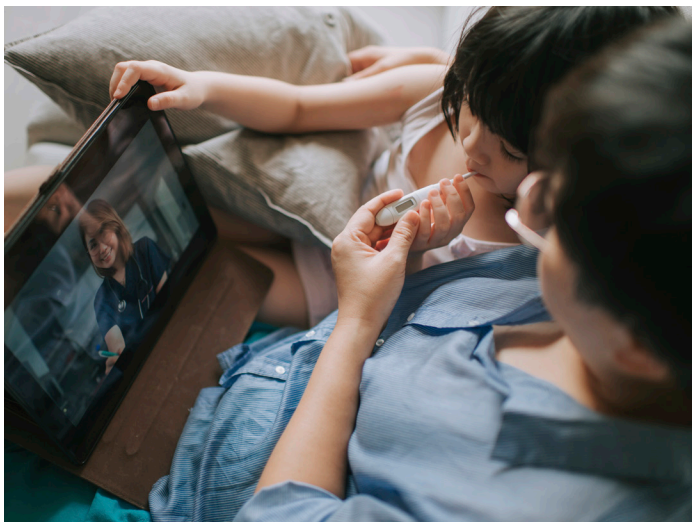
The effects of climate change in British Columbia are already being felt with rising temperatures, extreme wildfire, and flooding conditions, and changing marine and ecological conditions. The direct and indirect impacts of the changing climate on health, are complex and inextricably linked to social, 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].

LEFT: People shopping at a farmers market during the COVID-19 pandemic.

BELOW: Public outdoor space, water park, Port Moody, BC.

BOTTOM: The use of telemedicine to connect patients with health professionals has exploded during the COVID-19 pandemic.



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.

Masks as an introduced public health measure during the COVID-19 pandemic, Vancouver, June, 2020.

# 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].

*– 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.

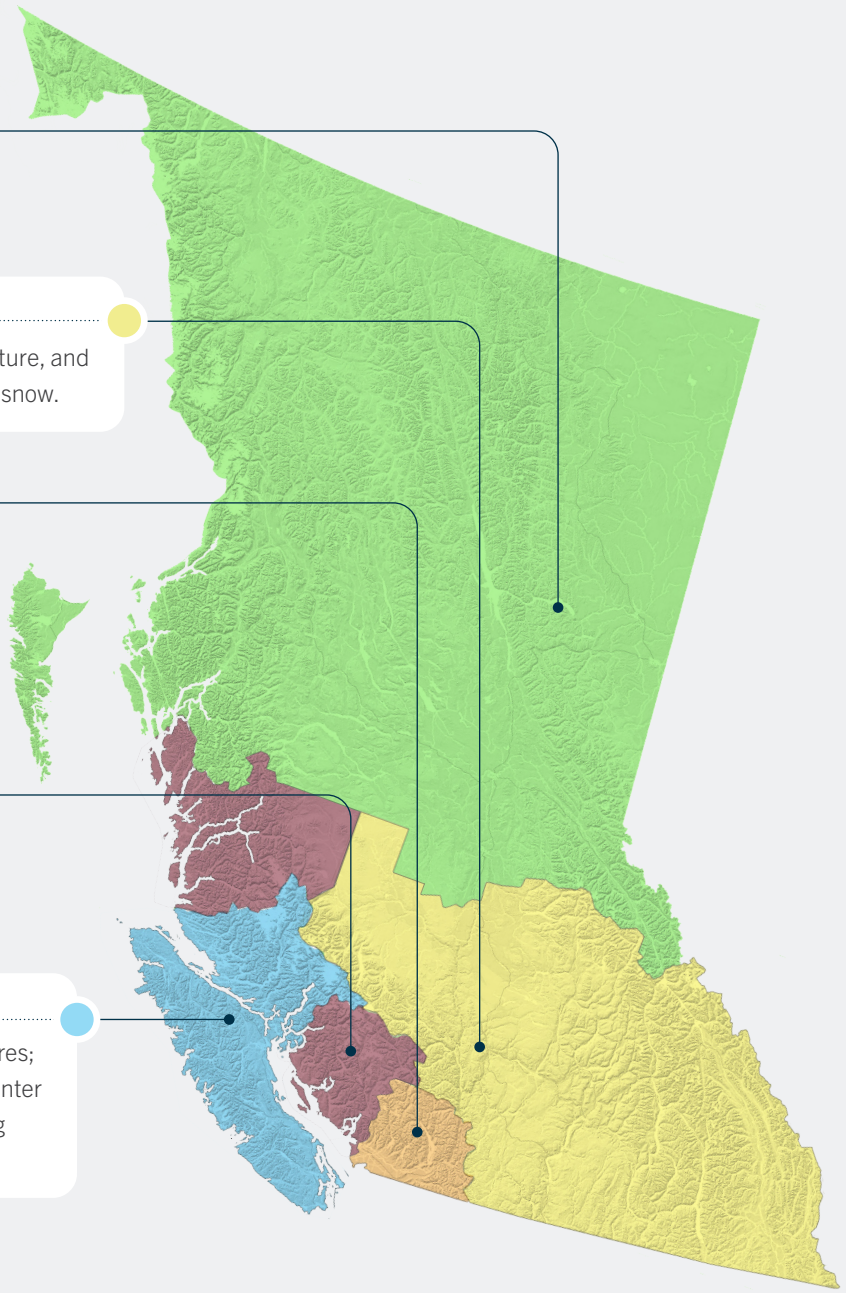
Public health has historically struggled to obtain adequate funding for these critical tasks, punctuated by events like SARS and COVID-19 that cause an increase in public awareness of the value of prevention and subsequently increase temporary funding. Overall, about 95% of the healthcare dollars in 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.

CANADIAN PUBLIC HEALTH ASSOCIATION
ASSOCIATION CANADIENNE DE SANTÉ PUBLIQUE

The Canadian Public Health Association defines public health as an approach to maintaining and improving the health of populations based on the principles of social justice; attention to human rights and equity; evidence-informed policy and practice; and addressing the underlying determinants of health. Such an approach places health promotion, health protection, population health surveillance, and the prevention of death, disease, injury, and disability as the central tenets of all related initiatives[3].

# 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.

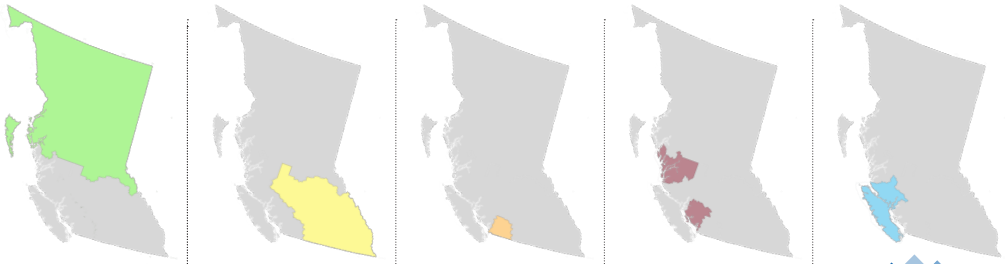
**ISLAND HEALTH**
is expected to see the smallest increase in annual temperatures; the largest decreases in summer precipitation, annual and winter precipitation as snow; and a considerable increase in growing degree days.

* **Fig.1** Regional Health Authorities In BC



PICS

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



| | | northern health | Interior Health | fraserhealth | Vancouver CoastalHealth | island health |
|---|---|---|---|---|---|---|
| Temperature (°C) | ANNUAL | +3.3 °C | +3.2 °C | +2.7 °C | +3.1 °C | +3.0 °C |
| Rain Precipitation (%) | ANNUAL | +10% | +1.2% | +1.6% | -1.4% | +1.8% |
| | SUMMER | +8.8% | -0.46% | -15% | -12% | -10% |
| | WINTER | +8.3% | +0.23% | +3.8% | -1.9% | +1.6% |
| Snow Precipitation (%) | ANNUAL | -25% | -26% | -50% | -50% | -45% |
| | SUMMER | -16% | -17% | -56% | -47% | -42% |
| | WINTER | -36% | -41% | -27% | -57% | -45% |
| Frost-Free Days (Days) | ANNUAL | +40 | +45 | +49 | +52 | +50 |
| Growing Degree Days (GDD)* | ANNUAL | +494 | +566 | +644 | +666 | +586 |
| Cooling Degree Days (CDD) ** | ANNUAL | +39 | +77 | +57 | +115 | +43 |

* **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[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.

> *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[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.

Wildfires threatening vineyard crop.

# 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[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[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[17]. Our experiences with vaccination campaigns over the past two years may offer valuable lessons for future conversations about climate change and climate science.

> *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.


Wildfires affecting Vancouver, August 1, 2021.

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[18].

# 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.*

We are only beginning to understand the long-term effects of the COVID-19 pandemic. The lasting health implications of COVID-19 could include chronic disease[28], continued transmission and the emergence of new variants. The pandemic has had far-reaching mental health impacts due to the disease itself, the public health measures necessary to prevent its transmission, and the strain it has put on health and social systems of care[29][30][31][32]. These have been felt particularly acutely by those providing health and social services[33][34][35].

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].

The intensity and frequency of wildfires are projected to increase due to climate change. **Credit:** Province of British Columbia, Flickr.

# 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 uncertainly of human behaviour[53],[54],[55],[56].

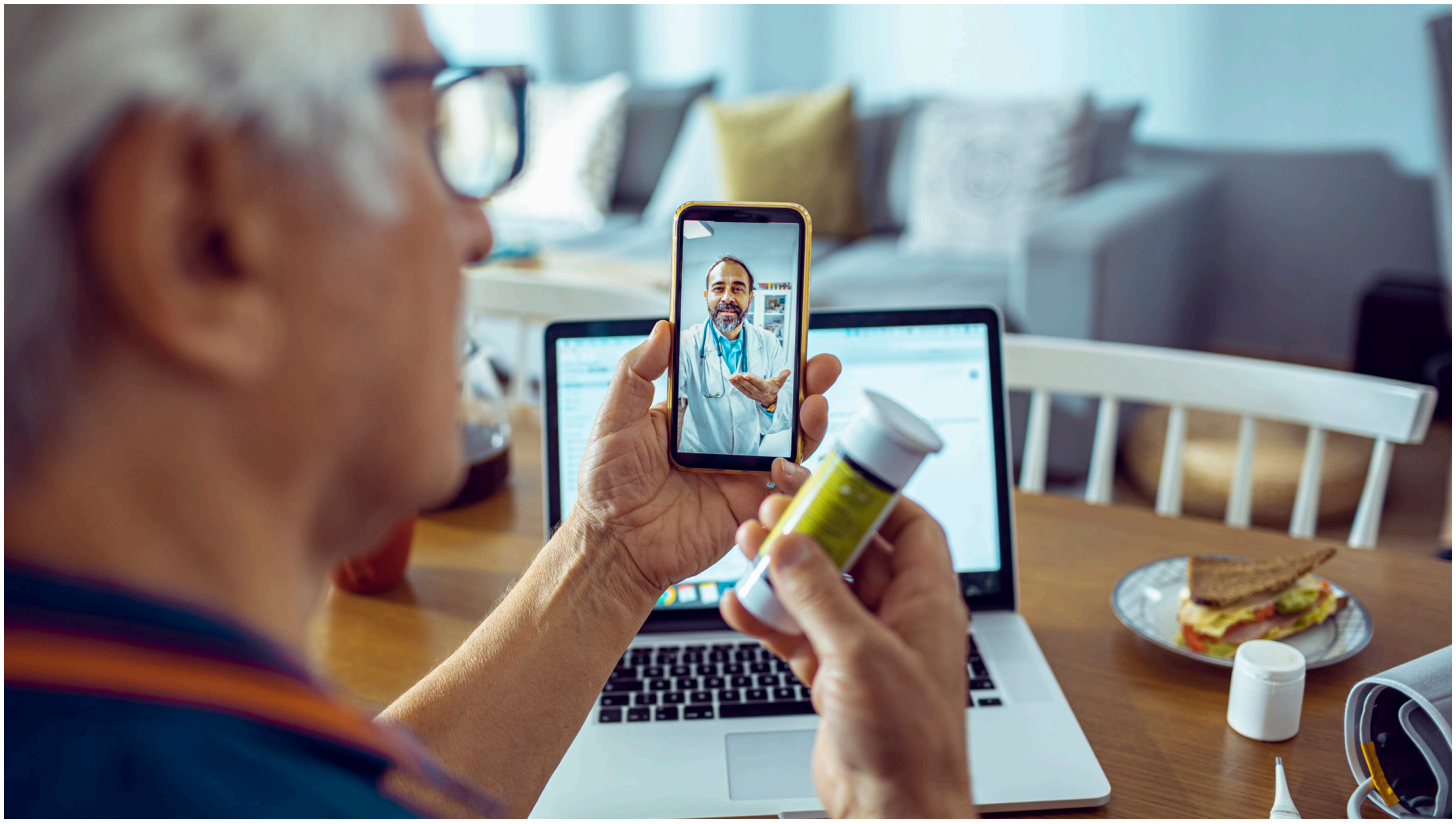
*— The creation of walkable urban neighbourhoods and accessible community gardens are examples of policy decisions that can achieve such co-benefits.*

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.

Community gardens bring co-benefits such as promoting healthy eating, access to outdoor spaces, and connection to the environment.

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].

Medical consultations via the phone or internet are now common practice in Canada due to the COVID-19 pandemic.

*— 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 C02 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

Access to technology, affordable internet services and broadband infrastructure are important for ensuring equity in telehealth.

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.

*— 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].

# Green Infrastructure and Urban Design

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.

*– Spending time in natural environments or greenspaces has been proposed as a nature-based solution that supports positive mental health and well-being.*

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

Como Lake Park provides greenspace for residents in Coquitlam, BC.

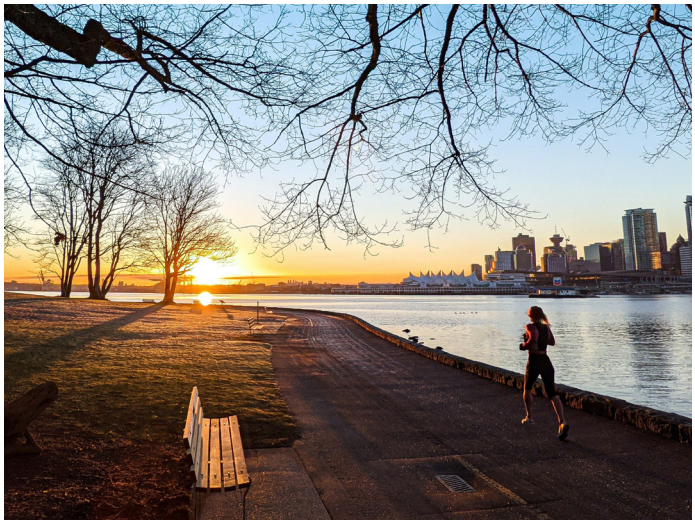
discrimination and educational opportunities[109],[110]. Greenspaces are also not all the same and the health benefits can vary depending on the quantity, quality and biodiversity within them[111],[112],[113].

*— 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[114]. Accessing greenspace buffered some of the negative effects of COVID-19, including on mental health, inactivity and social isolation[115],[116],[117]. Much of the evidence for the benefits of greenspace during the pandemic is qualitative. There have, however been quantitative measures of reduced COVID-19 mortality[118], and reductions in mental health prescriptions due to greenspace exposure[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[119]. Green infrastructure can be used to mitigate damage from flooding[120], cool cities experiencing the urban heat island effect and improve air quality,[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[124],[125]. The plants providing these ecoservices will also experience stresses due to climate change including increased temperatures, seasonal drought conditions[126], and increases in wind speeds and severe weather[127].

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



Vancouver's Stanley Park. **Credit:** Marco Tjokro, Unsplash

anxiety focuses on the perceived negative effects of climate change and worries regarding future safety[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[129].

*— 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[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[11].

## Equity Considerations

- 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[131].
- 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[132],[133],[134].
- 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.
- 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[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[144] and severe drought conditions that have resulted in an emergency drought declaration for 50 of its 58 counties[145]. These climate stressors are making it more difficult for California to maintain agricultural production[146], 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

Wine Vineyards in the south Okanagan near Pentiction, BC.

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 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.

**Credit:** Pursuit Retro, Unsplash

# 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.

Vancouver skyline: **Credit:** Alejandro Luengo, Unsplash

# 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[160].

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.

# References


(1) World Health Organization. Naming the coronavirus disease (COVID-19) and the virus that causes it [Internet]. [cited 2021 Nov 24]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it

(2) Plowright RK, Parrish CR, McCallum H, Hudson PJ, Ko AI, Graham AL, et al. Pathways to zoonotic spillover. Nat Rev Microbiol [Internet]. 2017 Aug [cited 2021 Apr 24];15(8):502–10.

(3) Coroners. Heat-Related Deaths in B.C. - Province of British Columbia [Internet]. Province of British Columbia; [cited 2021 Sep 13]. Available from: https://www2.gov.bc.ca/gov/content/life-events/death/coroners-service/news-and-updates/heat-related

(4) Maguet S. Public Health Responses to Wildfire Smoke Events. National Collaborating Centre for Environmental Health; 2018 Aug [cited 2021 Apr 24]. Available from: https://ncceh.ca/documents/evidence-review/public-health-responses-wildfire-smoke-events

(5) Government of British Columbia. Provincial state of emergency declared | BC Gov News [Internet]. 2021 [cited 2021 Nov 28]. Available from: https://news.gov.bc.ca/releases/2021PSSG0073-002190

(6) CleanBC. Climate Preparedness and Adaptation Strategy: Draft Strategy and Phase 1 Actions for 2021-2022 [Internet]. Government of British Columbia; 2021 [cited 2021 Jun 12]. Available from: https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/cpas_2021.pdf

(7) Diez Roux AV. On the Distinction—or Lack of Distinction—Between Population Health and Public Health. Am J Public Health [Internet]. 2016 Apr [cited 2021 Apr 3];106(4):619–20. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4816152/

(8) Canadian Public Health Association. Public Health: A Conceptual Framework [Internet]. 2017 [cited 2021 Apr 5]. Available from: https://www.cpha.ca/sites/default/files/uploads/policy/ph-framework/phcf_e.pdf

(9) Centre for Disease Control and Prevention. 1918 Pandemic (H1N1 virus) [Internet]. 2020 [cited 2021 Apr 18]. Available from: https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html

(10) Arnett C, Morin J. The Rock Painting/Xela:ls of the Tsleil-Waututh: A Historicized Coast Salish Practice. Ethnohistory [Internet]. 2018 Jan 1 [cited 2021 Apr 18];65(1):101–27. Available from: https://read.dukeupress.edu/ethnohistory/article/65/1/101/133068/The-Rock-PaintingXelals-of-the-TsleilWaututh-A

(11) Canadian Institute for Climate Choices. The Health Costs of Climate Change: How Canada Can Adapt, Prepare, and Save Lives [Internet]. 2021 [cited 2021 Jun 2]. Available from: https://climatechoices.ca/wp-content/uploads/2021/06/ClimateChoices_Health-report_Final_June2021.pdf

(12) Pacific Climate Impacts Consortium. Plan-2-Adapt [Internet]. Available from: https://services.pacificclimate.org/plan2adapt/app/

(13) Demarchi DA. An Introduction to the Ecoregions of British Columbia [Internet]. British Columbia Ministry of Environment; 2011 Mar. Available from: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/broad-ecosystem/an_introduction_to_the_ecoregions_of_british_columbia.pdf

(14) Mahmoudi MH, Najafi MR, Singh H, Schnorbus M. Spatial and temporal changes in climate extremes over northwestern North America: the influence of internal climate variability and external forcing. Clim Change [Internet]. 2021 Mar [cited 2021 Apr 5];165(1–2):14. Available from: http://link.springer.com/10.1007/s10584-021-03037-9

(15) Comfort LK, Kapucu N, Ko K, Menoni S, Siciliano M. Crisis Decision-Making on a Global Scale: Transition from Cognition to Collective Action under Threat of COVID-19. Public Adm Rev [Internet]. 2020 [cited 2021 Jan 4];80(4):616–22.

(16) 16. Lai-Sang Y, Danial Z. Three pre-vaccine responses to Covid-like epidemics. PLoS One [Internet]. 2021 May [cited 2021 Nov 14];16(5):e0251349.

(17) Lockyer B, Islam S, Rahman A, Dickerson J, Pickett K, Sheldon T, et al. Understanding COVID-19 misinformation and vaccine hesitancy in context: Findings from a qualitative study involving citizens in Bradford, UK. Health Expect [Internet]. 2021 [cited 2021 Nov 14];24(4):1158–67.

(18) Belfer E, Ford JD, Maillet M. Representation of Indigenous peoples in climate change reporting. Clim Change [Internet]. 2017 Nov [cited 2020 May 31];145(1–2):57–70. Available from: http://link.springer.com/10.1007/s10584-017-2076-z

(19) Hoogeveen D, Klein K, Brubacher J, Gislason M. Climate Change, Intersectionality, and GBA+ in British Columbia | Summary Report [Internet]. 2021 Mar. Available from: https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/climate_change__gba_in_bc_summary_report.pdf

(20) Stephenson N, Davis M, Flowers P, MacGregor C, Waller E. Mobilising "vulnerability" in the public health response to pandemic influenza. Soc Sci Med [Internet]. 2014 Feb 1 [cited 2021 Apr 18];102:10–7.

(21) National Collaborating Centre for Determinants of Health. Vulnerable populations [Internet]. [cited 2021 Apr 18]. Available from: https://nccdh.ca/glossary/entry/vulnerable-population

(22) Piret J, Boivin G. Pandemics Throughout History. Front Microbiol [Internet]. 2021 Jan 15 [cited 2021 Apr 3];11. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7874133/

(23) Statistics Canada. Leading causes of death, total population, by age group [Internet]. [cited 2021 Apr 3]. (Table: 13-10-0394-01). Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310039401

(24) BC Centre for Disease Control. BC COVID-19 Situation Report Jan 15 2021 [Internet]. Vancouver, BC; 2021 Jan [cited 2021 Sep 10]. Available from: http://www.bccdc.ca/Health-Info-Site/Documents/COVID_sitrep/BC_COVID-19_Situation_Report_Jan_15_2021.pdf

(25) BC Coroners Service. Statistical Reports on Deaths in British Columbia - Province of British Columbia [Internet]. Province of British Columbia; [cited 2021 Sep 12]. Available from: https://www2.gov.bc.ca/gov/content/life-events/death/coroners-service/statistical-reports

(26) Statistics Canada. Adjusted number of deaths, expected number of deaths and estimates of excess mortality, by week [Internet]. 2021 [cited 2021 May 2]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310078401

(27) Statistics Canada. Excess mortality in Canada during the COVID-19 pandemic [Internet]. 2020 [cited 2021 May 2]. Available from: https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00076-eng.htm

(28) Taquet M, Geddes JR, Husain M, Luciano S, Harrison PJ. 6-month neurological and psychiatric outcomes in 236 379 survivors of COVID-19: a retrospective cohort study using electronic health records. Lancet Psychiatry [Internet]. 2021 Apr 6 [cited 2021 Apr 7];0(0). Available from: https://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(21)00084-5/abstract

(29) Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. The Lancet [Internet]. 2020 Mar [cited 2021 Sep 13];395(10227):912–20.

(30) Xiong J, Lipsitz O, Nasri F, Lui LMW, Gill H, Phan L, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. J Affect Disord [Internet]. 2020 Dec 1 [cited 2021 Sep 13];277:55–64. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7413844/

(31) Rossi R, Socci V, Talevi D, Mensi S, Niolu C, Pacitti F, et al. COVID-19 Pandemic and Lockdown Measures Impact on Mental Health Among the General Population in Italy. Front Psychiatry. 2020;11:790.

(32) Clemente-Suárez VJ, Dalamitros AA, Beltran-Velasco AI, Mielgo-Ayuso J, Tornero-Aguilera JF. Social and Psychophysiological Consequences of the COVID-19 Pandemic: An Extensive Literature Review. Front Psychol [Internet]. 2020 Dec 16 [cited 2021 Sep 13];11:580225. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7772398/

(33) Sampaio F, Sequeira C, Teixeira L. Nurses' Mental Health During the Covid-19 Outbreak: A Cross-Sectional Study. J Occup Environ Med [Internet]. 2020 Oct [cited 2021 Sep 13];62(10):783–7. Available from: https://journals.lww.com/10.1097/JOM.0000000000001987

(34) Zhang J, Deng X, Liu H, Xu X, Fang R. Evaluation of the mental health status of community healthcare workers during the COVID-19 outbreak. Medicine (Baltimore) [Internet]. 2021 Feb 12 [cited 2021 Sep 13];100(6).

(35) Debski M, Abdelaziz H, Sanderson J, Wild S, Assaf O, Wiper A. Mental Health Outcomes Among British Healthcare Workers—Lessons from the First Wave of the Covid-19 Pandemic. J Occup Environ Med. 2021 Aug;63(8):e549–55.

(36) Office of the Public Health Officer. Taking the pulse of the population [Internet]. 2019 [cited 2021 May 3]. Available from: https://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/reports-publications/annual-reports/pho-annual-report-2019.pdf

(37) Government of Canada. Gender differences in mental health during the COVID-19 pandemic [Internet]. Public Services and Procurement; July 9, 2020en [cited 2021 May 2]. Available from: http://publications.gc.ca/collections/collection_2020/statcan/45-28/CS45-28-1-2020-44-eng.pdf

(38) Smith A, Peled M. Doing OK?: Checking in on the Mental Health of BC Youth [Internet]. 2021 [cited 2021 Sep 13].

(39) Li X, Vanderloo LM, Maguire JL, Keown-Stoneman CDG, Aglipay M, Anderson LN, et al. Public health preventive measures and child health behaviours during COVID-19: a cohort study. Can J Public Health [Internet]. 2021 Jul 7 [cited 2021 Sep 13]; Available from: https://doi.org/10.17269/s41997-021-00549-w

(40) BC Centre for Disease Control. Overdose Response Indicators [Internet]. 2021 [cited 2021 May 3]. Available from: http://www.bccdc.ca/health-professionals/data-reports/overdose-response-indicators

(41) BC Centre for Disease Control. BC COVID-19 SPEAK Survey [Internet]. 2020 [cited 2021 Sep 15]. Available from: https://public.tableau.com/app/profile/bccdc/viz/BCCOVID-19SPEAKSurvey/BCCOVID-19SPEAKresults

(42) Shopsowitz KE, Lim C, Shih AW, Fishbane N, Berry BR, Bigham M, et al. Impacts of COVID-19 and elective surgery cancellations on platelet supply and utilization in the Canadian Province of British Columbia. Vox Sang [Internet]. [cited 2021 Sep 13].

(43) Simon MJK, Regan WD. COVID-19 pandemic effects on orthopaedic surgeons in British Columbia. J Orthop Surg [Internet]. 2021 Feb 26 [cited 2021 Sep 13];16(1):161. Available from: https://doi.org/10.1186/s13018-021-02283-y

(44) Canadian Centre on Substance Use and Addiction. Impacts of the COVID-19 Pandemic on People Who Use Substances: What We Heard. [Internet]. 2020 [cited 2021 Sep 14]. Available from: https://www.ccsa.ca/sites/default/files/2020-07/CCSA-COVID-19-Impacts-on-People-Who-Use-Substances-Report-2020-en.pdf

(45) Children First Canada. Raising Canada Report 2020 [Internet]. 2021 [cited 2021 Sep 14]. Available from: https://childrenfirstcanada.org/wp-content/uploads/2021/07/Raising-Canada-Report_Final_corrected-footnote.pdf

(46) BC Representative for Children and Youth. Left Out: Children and youth with special needs in the pandemic [Internet]. 2020 Dec [cited 2021 Sep 14]. Available from: https://rcybc.ca/wp-content/uploads/2020/12/CYSN_Report.pdf

(47) Gilmour JY, Polsky H. Food insecurity and mental health during the COVID-19 pandemic [Internet]. Statistics Canada; 2020 Dec. Available from: https://www150.statcan.gc.ca/n1/en/pub/82-003-x/2020012/article/00001-eng.pdf?st=HuWdF1Qg

(48) National Research Council. Environmental Epidemiology: Volume 1: Public Health and Hazardous Wastes. [Internet]. Environmental Epidemiology: Volume 1: Public Health and Hazardous Wastes. National Academies Press (US); 1991 [cited 2021 Sep 13]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK234293/

(49) Buse CG, Oestreicher JS, Ellis NR, Patrick R, Brisbois B, Jenkins AP, et al. Public health guide to field developments linking ecosystems, environments and health in the Anthropocene. J Epidemiol Community Health [Internet]. 2018 May [cited 2020 May 31];72(5):420–5.

(50) Gibb R, Redding DW, Chin KQ, Donnelly CA, Blackburn TM, Newbold T, et al. Zoonotic host diversity increases in human-dominated ecosystems. Nature [Internet]. 2020 Aug [cited 2021 Apr 24];584(7821):398–402.

(51) Nunez S, Arets E, Alkemade R, Verwer C, Leemans R. Assessing the impacts of climate change on biodiversity: is below 2 °C enough? Clim Change [Internet]. 2019 Jun 1 [cited 2021 Apr 24];154(3):351–65. Available from: https://doi.org/10.1007/s10584-019-02420-x

(52) Beyer RM, Manica A, Mora C. Shifts in global bat diversity suggest a possible role of climate change in the emergence of SARS-CoV-1 and SARS-CoV-2. Sci Total Environ [Internet]. 2021 Jan 26 [cited 2021 Feb 10];145413.

(53) Ogden NH. Climate change and vector-borne diseases of public health significance. FEMS Microbiol Lett [Internet]. 2017 Oct 16 [cited 2020 Jun 1];364(19). Available from: http://academic.oup.com/femsle/article/364/19/fnx186/4107775

(54) El-Sayed A, Kamel M. Climatic changes and their role in emergence and re-emergence of diseases. Environ Sci Pollut Res Int. 2020 Jun;27(18):22336–52.

(55) Khan SU, Ogden NH, Fazil AA, Gachon PH, Dueymes GU, Greer AL, et al. Current and Projected Distributions of Aedes aegypti and Ae. albopictus in Canada and the U.S. Environ Health Perspect [Internet]. 2020 May 22 [cited 2020 Jun 1]; Available from: https://ehp.niehs.nih.gov/doi/10.1289/EHP5899

(56) Sonenshine DE. Range Expansion of Tick Disease Vectors in North America: Implications for Spread of Tick-Borne Disease. Int J Environ Res Public Health [Internet]. 2018 Mar [cited 2020 May 31];15(3):478. Available from: https://www.mdpi.com/1660-4601/15/3/478

(57) Shaw C, Hales S, Howden-Chapman P, Edwards R. Health co-benefits of climate change mitigation policies in the transport sector. Nat Clim Change [Internet]. 2014 Jun [cited 2021 Apr 24];4(6):427–33.

(58) Food Empowerment Project. Food Deserts [Internet]. [cited 2021 May 2]. Available from: https://foodispower.org/access-health/food-deserts/

(59) Bascaramurty D. Racialized Canadians have some of the highest rates of COVID-19 infections in the country. Who can allay their doubts about taking the vaccine? [cited 2021 May 2]; Available from: https://www.theglobeandmail.com/canada/article-racialized-canadians-need-the-covid-19-vaccine-more-urgently-than-most/

(60) Fanel S. Advocates say COVID-19 "vaccine desert" leaves racialized communities behind in rollout [Internet]. Toronto. 2021 [cited 2021 May 2]. Available from: https://toronto.ctvnews.ca/advocates-say-covid-19-vaccine-desert-leaves-racialized-communities-behind-in-rollout-1.5357999?cache=sazhusyrecmk

(61) Statistics Canada. COVID-19 mortality rates in Canada's ethno-cultural neighbourhoods [Internet]. Government of Canada; 2020 Oct [cited 2021 May 2]. Available from: https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00079-eng.htm

(62) Mutambudzi M, Niedzwiedz C, Macdonald EB, Leyland A, Mair F, Anderson J, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. Occup Environ Med [Internet]. 2021 May 1 [cited 2021 May 2];78(5):307–14. Available from: https://oem.bmj.com/content/78/5/307

(63) Ahmad K, Erqou S, Shah N, Nazir U, Morrison AR, Choudhary G, et al. Association of poor housing conditions with COVID-19 incidence and mortality across US counties. PLOS ONE [Internet]. 2020 Nov 2 [cited 2021 May 2];15(11):e0241327. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0241327

(64) Crooks K, Casey D, Ward JS. First Nations peoples leading the way in COVID-19 pandemic planning, response and management. Med J Aust [Internet]. 2020 [cited 2021 May 2];213(4):151-152.e1.

(65) World Health Organization. WHO guideline: recommendations on digital interventions for health system strengthening [Internet]. Geneva: World Health Organization; 2019 [cited 2021 Sep 15]. Available from: https://apps.who.int/iris/handle/10665/311941

(66) McKinsey and Company. Virtual health: A look at the next frontier of care delivery [Internet]. 2020 [cited 2021 Sep 14]. Available from: https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/virtual-health-a-look-at-the-next-frontier-of-care-delivery

(67) Spelten ER, Hardman RN, Pike KE, Yuen EYN, Wilson C. Best practice in the implementation of telehealth-based supportive cancer care: Using research evidence and discipline-based guidance. Patient Educ Couns [Internet]. 2021 Nov 1 [cited 2021 Oct 22];104(11):2682–99.

(68) Monaghesh E, Hajizadeh A. The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. BMC Public Health [Internet]. 2020 Aug 1 [cited 2021 Oct 22];20:1193. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7395209/

(69) Fung A, Irvine M, Ayub A, Ziabakhsh S, Amed S, Hursh BE. Evaluation of telephone and virtual visits for routine pediatric diabetes care during the COVID-19 pandemic. J Clin Transl Endocrinol [Internet]. 2020 Dec 1 [cited 2021 Oct 22];22:100238.

(70) Wang EY, Zafar JE, Lawrence CM, Gavin LF, Mishra S, Boateng A, et al. Environmental emissions reduction of a preoperative evaluation center utilizing telehealth screening and standardized preoperative testing guidelines. Resour Conserv Recycl [Internet]. 2021 Aug 1 [cited 2021 Oct 22];171:105652.

(71) Webster P. Virtual health care in the era of COVID-19. The Lancet [Internet]. 2020 Apr 11 [cited 2021 Sep 14];395(10231):1180–1. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30818-7/fulltext.

(72) Provincial Health Services Authority. British Columbia hits one million virtual video visits [Internet]. [cited 2021 Oct 22]. Available from: http://www.phsa.ca/about/news-stories/news-releases/2021-news/british-columbia-hits-one-million-virtual-video-visits

(73) Harris MTH, Peterkin A, Bach P, Englander H, Lapidus E, Rolley T, et al. Adapting inpatient addiction medicine consult services during the COVID-19 pandemic. Addict Sci Clin Pract [Internet]. 2021 Feb 24 [cited 2021 Sep 14];16(1):13. Available from: https://doi.org/10.1186/s13722-021-00221-1

(74) Cadili L, DeGirolamo K, McKevitt E, Brown CJ, Prabhakar C, Pao J-S, et al. COVID-19 and breast cancer at a Regional Breast Centre: our flexible approach during the pandemic. Breast Cancer Res Treat [Internet]. 2021 Apr 1 [cited 2021 Sep 14];186(2):519–25. Available from: https://doi.org/10.1007/s10549-020-06008-3

(75) Pierce R, Stevermer J. Disparities in use of telehealth at the onset of the COVID-19 public health emergency. J Telemed Telecare [Internet]. 2020 Oct 21 [cited 2021 Oct 22].

(76) Canadian Public Health Association. The Lancet Countdown on Health and Climate Change Policy brief for Canada [Internet]. 2019 Nov [cited 2021 Sep 14]. Available from: https://policybase.cma.ca/documents/Policypdf/PD20-06.pdf

(77) Dacones I, Cave C, Furie GL, Ogden CA, Slutzman JE. Patient transport greenhouse gas emissions from outpatient care at an integrated health care system in the Northwestern United States, 2015–2020. J Clim Change Health [Internet]. 2021 Aug 1 [cited 2021 Oct 22];3:100024.

(78) Whetten J, Montoya J, Yonas H. ACCESS to Better Health and Clear Skies: Telemedicine and Greenhouse Gas Reduction. Telemed E-Health [Internet]. 2019 Oct 1 [cited 2021 Oct 22];25(10):960–5. Available from: https://www.liebertpub.com/doi/abs/10.1089/tmj.2018.0172

(79) Filfilan A, Anract J, Chartier-Kastler E, Parra J, Vaessen C, de La Taille A, et al. Positive environmental impact of remote teleconsultation in urology during the COVID-19 pandemic in a highly populated area. Prog En Urol [Internet]. 2021 Aug 26 [cited 2021 Oct 22].

(80) Paquette S, Lin JC. Outpatient Telemedicine Program in Vascular Surgery Reduces Patient Travel Time, Cost, and Environmental Pollutant Emissions. Ann Vasc Surg [Internet]. 2019 Aug 1 [cited 2021 Oct 22];59:167–72.

(81) Andrew N, Barraclough KA, Long K, Fazio TN, Holt S, Kanhutu K, et al. Telehealth model of care for routine follow up of renal transplant recipients in a tertiary centre: A case study. J Telemed Telecare. 2020 May;26(4):232–8.

(82) Salas RN, Maibach E, Pencheon D, Watts N, Frumkin H. A pathway to net zero emissions for healthcare. BMJ [Internet]. 2020 Oct 1 [cited 2021 Oct 22];371:m3785.

(83) Purohit A, Smith J, Hibble A. Does telemedicine reduce the carbon footprint of healthcare? A systematic review. Future Heal J [Internet]. 2021 Mar 1 [cited 2021 Sep 14];8(1):e85–91. Available from: https://www.rcpjournals.org/content/futurehosp/8/1/e85

(84) Holmner A, Ebi KL, Lazuardi L, Nilsson M. Carbon footprint of telemedicine solutions--unexplored opportunity for reducing carbon emissions in the health sector. PloS One. 2014;9(9):e105040.

(85) Vidal-Alaball J, Franch-Parella J, Lopez Seguí F, Garcia Cuyàs F, Mendioroz Peña J. Impact of a Telemedicine Program on the Reduction in the Emission of Atmospheric Pollutants and Journeys by Road. Int J Environ Res Public Health. 2019 Nov 8;16(22):E4366.

(86) Masino C, Rubinstein E, Lem L, Purdy B, Rossos PG. The impact of telemedicine on greenhouse gas emissions at an academic health science center in Canada. Telemed J E-Health Off J Am Telemed Assoc. 2010 Nov;16(9):973–6.

(87) Jong M, Mendez I, Jong R. Enhancing access to care in northern rural communities via telehealth. Int J Circumpolar Health [Internet]. 2019 Jan 28 [cited 2021 Oct 22];78(2):1554174. Available from: https://doi.org/10.1080/22423982.2018.1554174

(88) Dawson KG, Jin A, Summerskill M, Swann D. Mobile Diabetes Telemedicine Clinics for Aboriginal First Nation People With Reported Diabetes in British Columbia. Can J Diabetes [Internet]. 2021 Feb 1 [cited 2021 Oct 22];45(1):89–95.

(89) Rush KL, Seaton C, Li E, Oelke ND, Pesut B. Rural use of health service and telemedicine during COVID-19: The role of access and eHealth literacy. Health Informatics J [Internet]. 2021 Apr 1 [cited 2021 Oct 22];27(2):14604582211020064.

(90) Snoswell CL, Chelberg G, De Guzman KR, Haydon HH, Thomas EE, Caffery LJ, et al. The clinical effectiveness of telehealth: A systematic review of meta-analyses from 2010 to 2019. J Telemed Telecare [Internet]. 2021 Jun 29 [cited 2021 Oct 22];1357633X211022907.

(91) Romanchych E, Desai R, Bartha C, Carson N, Korenblum M, Monga S. Healthcare providers' perceptions of virtual- care with children's mental health in a pandemic: A hospital and community perspective. Early Interv Psychiatry. 2021 Jul 26.

(92) Lima TRC de M, Santos LM, Muniz MCH, Araújo BCL, Santos MA dos, de Oliveira AA, et al. Telehealth in audiology: an integrative review. Rev Assoc Médica Bras [Internet]. 2021 Aug 27 [cited 2021 Oct 22];67:454–61. Available from: http://www.scielo.br/j/ramb/a/rBBFgrnG8ZfS8QcNfqyckVS/?lang=en

(93) Palmer KR, Tanner M, Davies-Tuck M, Rindt A, Papacostas K, Giles ML, et al. Widespread implementation of a low-cost telehealth service in the delivery of antenatal care during the COVID-19 pandemic: an interrupted time-series analysis. The Lancet [Internet]. 2021 Jul [cited 2021 Jul 2];398(10294):41–52.

(94) Masterton W, Carver H, Parkes T, Park K. Greenspace interventions for mental health in clinical and non-clinical populations: What works, for whom, and in what circumstances? Health Place [Internet]. 2020 Jul [cited 2021 May 3];64:102338.

(95) Hartig T, Mitchell R, de Vries S, Frumkin H. Nature and Health. Annu Rev Public Health [Internet]. 2014 Mar 18 [cited 2021 Sep 14];35(1):207–28. Available from: https://www.annualreviews.org/doi/10.1146/annurev-publhealth-032013-182443

(96) Torres M, Julvez J, Casas M, Guxens M, Lertxundi L, Anabitarte A, et al. Residential Surrounding Greenspace and Mental Health in Three Spanish Areas. Environ Epidemiol [Internet]. 2019 Oct [cited 2021 Sep 9];3:399. Available from: https://journals.lww.com/environepidem/Fulltext/2019/10001/Residential_Surrounding_Greenspace_and_Mental.1217.aspx

(97) Fletcher DH, Likongwe PJ, Chiotha SS, Nduwayezu G, Mallick D, Uddin Md. N, et al. Using demand mapping to assess the benefits of urban green and blue space in cities from four continents. Sci Total Environ [Internet]. 2021 Sep 1 [cited 2021 Sep 10];785:147238. Available from: https://www.sciencedirect.com/science/article/pii/S0048969721023093

(98) Collins RM, Spake R, Brown KA, Ogutu BO, Smith D, Eigenbrod F. A systematic map of research exploring the effect of greenspace on mental health. Landsc Urban Plan [Internet]. 2020 Sep 1 [cited 2021 Sep 9];201:103823.

(99) Rufo JC, Paciência I, Ribeiro AI. Green Environments and Allergic Diseases in Children: a Scoping Review. Curr Epidemiol Rep [Internet]. 2019 Dec [cited 2021 Sep 14];6(4):442–8. Available from: http://link.springer.com/10.1007/s40471-019-00218-0

(100) Roberts M, Irvine KN, McVittie A. Associations between greenspace and mental health prescription rates in urban areas. Urban For Urban Green [Internet]. 2021 Sep 1 [cited 2021 Sep 9];64:127301.

(101) Reyes-Riveros R, Altamirano A, De La Barrera F, Rozas-Vásquez D, Vieli L, Meli P. Linking public urban green spaces and human well-being: A systematic review. Urban For Urban Green [Internet]. 2021 Jun 1 [cited 2021 Sep 9];61:127105.

(102) Luo Y-N, Huang W-Z, Liu X-X, Markevych I, Bloom MS, Zhao T, et al. Greenspace with overweight and obesity: A systematic review and meta-analysis of epidemiological studies up to 2020. Obes Rev [Internet]. 2020 [cited 2021 Sep 14];21(11):e13078.

(103) Bozkurt M. Metropolitan children's physical fitness: The relationship between overweight and obesity prevalence, socioeconomic status, urban green space access, and physical activity. Urban For Urban Green [Internet]. 2021 Sep 1 [cited 2021 Sep 9];64:127272.

(104) Twohig-Bennett C, Jones A. The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environ Res [Internet]. 2018 Oct 1 [cited 2021 Sep 14];166:628–37.

(105) Younan D, Tuvblad C, Li L, Wu J, Lurmann F, Franklin M, et al. Environmental Determinants of Aggression in Adolescents: Role of Urban Neighborhood Greenspace. J Am Acad Child Adolesc Psychiatry [Internet]. 2016 Jul [cited 2021 Sep 14];55(7):591–601.

(106) Shepley M, Sachs N, Sadatsafavi H, Fournier C, Peditto K. The Impact of Green Space on Violent Crime in Urban Environments: An Evidence Synthesis. Int J Environ Res Public Health [Internet]. 2019 Dec 14 [cited 2021 Sep 14];16(24):5119. Available from: https://www.mdpi.com/1660-4601/16/24/5119

(107) Yu H, Zhou Y, Wang R, Qian Z, Knibbs LD, Jalaludin B, et al. Associations between trees and grass presence with childhood asthma prevalence using deep learning image segmentation and a novel green view index. Environ Pollut [Internet]. 2021 Oct [cited 2021 Sep 14];286:117582.

(108) Medeiros-Sousa AR, Fernandes A, Ceretti-Junior W, Wilke ABB, Link to external site this link will open in a new window, Marrelli MT. Mosquitoes in urban green spaces: using an island biogeographic approach to identify drivers of species richness and composition. Sci Rep Nat Publ Group [Internet]. 2017 Dec [cited 2021 Sep 14];7:1–11.

(109) Ng A, Gergel SE, Eskelson BNI. Inequality and allergenic cover of urban greenspaces surrounding public elementary schools in Vancouver, British Columbia, Canada. Ecosyst People [Internet]. 2021 Jan 1 [cited 2021 Sep 14];17(1):178–90. Available from: https://www.tandfonline.com/doi/full/10.1080/26395916.2021.1903557

(110) Razani N, Long D, Hessler D, Rutherford GW, Gottlieb LM. Screening for Park Access during a Primary Care Social Determinants Screen. Int J Environ Res Public Health [Internet]. 2020 Apr 17 [cited 2021 Sep 14];17(8):2777. Available from: https://www.mdpi.com/1660-4601/17/8/2777

(111) Kim D, Ahn Y. The Contribution of Neighborhood Tree and Greenspace to Asthma Emergency Room Visits: An Application of Advanced Spatial Data in Los Angeles County. Int J Env Res Public Health. 2021;12.

(112) Wood E, Harsant A, Dallimer M, Cronin de Chavez A, McEachan RRC, Hassall C. Not All Green Space Is Created Equal: Biodiversity Predicts Psychological Restorative Benefits From Urban Green Space. Front Psychol [Internet]. 2018 [cited 2021 Sep 14];9:2320. Available from: https://www.frontiersin.org/article/10.3389/fpsyg.2018.02320

(113) Lockaby G, Noori N, Morse W, Zipperer W, Kalin L, Governo R, et al. Climatic, ecological, and socioeconomic factors associated with West Nile virus incidence in Atlanta, Georgia, U.S.A. J Vector Ecol [Internet]. 2016 [cited 2021 Sep 14];41(2):232–43.

(114) Robinson JM, Brindley P, Cameron R, MacCarthy D, Jorgensen A. Nature's Role in Supporting Health during the COVID-19 Pandemic: A Geospatial and Socioecological Study. Int J Environ Res Public Health [Internet]. 2021 Jan [cited 2021 Sep 14];18(5):2227. Available from: https://www.mdpi.com/1660-4601/18/5/2227

(115) Wortzel JD, Wiebe DJ, DiDomenico GE, Visoki E, South E, Tam V, et al. Association Between Urban Greenspace and Mental Wellbeing During the COVID-19 Pandemic in a U.S. Cohort. Front Sustain Cities [Internet]. 2021 [cited 2021 Sep 14];3:56. Available from: https://www.frontiersin.org/article/10.3389/frsc.2021.686159

(116) Berdejo-Espinola V, Suárez-Castro AF, Amano T, Fielding KS, Oh RRY, Fuller RA. Urban green space use during a time of stress: A case study during the COVID-19 pandemic in Brisbane, Australia. People Nat [Internet]. 2021 [cited 2021 Sep 14];3(3):597–609.

(117) Grima N, Corcoran W, Hill-James C, Langton B, Sommer H, Fisher B. The importance of urban natural areas and urban ecosystem services during the COVID-19 pandemic. PLoS One [Internet]. 2020 Dec [cited 2021 Sep 14];15(12):e0243344.

(118) Russette H. Greenspace exposure and COVID-19 mortality in the United States: January–July 2020. Environ Res. 2021;7.

(119) Bikomeye J, Rublee C, Beyer K. Positive Externalities of Climate Change Mitigation and Adaptation for Human Health: A Review and Conceptual Framework for Public Health Research. Int J Environ Res Public Health [Internet]. 2021 [cited 2021 Sep 10];18(5):2481.

(120) O'Donnell E, Thorne C, Ahilan S, Arthur S, Birkinshaw S, Butler D, et al. The blue-green path to urban flood resilience. Blue-Green Syst [Internet]. 2019 Dec 2 [cited 2021 Sep 14];2(1):28–45. Available from: https://doi.org/10.2166/bgs.2019.199

(121) Knight T, Price S, Bowler D, Hookway A, King S, Konno K, et al. How effective is 'greening' of urban areas in reducing human exposure to ground-level ozone concentrations, UV exposure and the 'urban heat island effect'? An updated systematic review. Environ Evid [Internet]. 2021 Jun 5 [cited 2021 Sep 14];10(1):12. Available from: https://doi.org/10.1186/s13750-021-00226-y

(122) Abulibdeh A. Analysis of urban heat island characteristics and mitigation strategies for eight arid and semi-arid gulf region cities. Environ Earth Sci. 2021;80(7):259–259.

(123) Lei Y, Duan Y, He D, Zhang X, Chen L, Li Y, et al. Effects of Urban Greenspace Patterns on Particulate Matter Pollution in Metropolitan Zhengzhou in Henan, China. Atmosphere [Internet]. 2018 [cited 2021 Sep 14];9(5):199.

(124) Russo A, Escobedo FJ, Timilsina N, Schmitt AO, Varela S, Zerbe S. Assessing urban tree carbon storage and sequestration in Bolzano, Italy. Int J Biodivers Sci Ecosyst Serv Manag [Internet]. 2014 Jan 2 [cited 2021 Sep 14];10(1):54–70. Available from: https://doi.org/10.1080/21513732.2013.873822

(125) Wang Y, Chang Q, Li X. Promoting sustainable carbon sequestration of plants in urban greenspace by planting design: A case study in parks of Beijing. Urban For Urban Green [Internet]. 2021 Sep 1 [cited 2021 Sep 9];64:127291.

(126) Zhang Z, Paschalis A, Mijic A. Planning London's green spaces in an integrated water management approach to enhance future resilience in urban stormwater control. J Hydrol [Internet]. 2021 Jun [cited 2021 Sep 14];497.

(127) Cheng CS, Lopes E, Fu C, Huang Z. Possible Impacts of Climate Change on Wind Gusts under Downscaled Future Climate Conditions: Updated for Canada. J Clim [Internet]. 2014 [cited 2020 Jul 20];27(3):1255–70.

(128) Usher K, Durkin J, Bhullar N. Eco-anxiety: How thinking about climate change-related environmental decline is affecting our mental health. Int J Ment Health Nurs [Internet]. 2019 [cited 2021 May 3];28(6):1233–4.

(129) Comtesse H, Ertl V, Hengst SMC, Rosner R, Smid GE. Ecological Grief as a Response to Environmental Change: A Mental Health Risk or Functional Response? Int J Environ Res Public Health [Internet]. 2021 Jan 16 [cited 2021 May 3];18(2):734. Available from: https://www.mdpi.com/1660-4601/18/2/734

(130) Albrecht G, Sartore G-M, Connor L, Higginbotham N, Freeman S, Kelly B, et al. Solastalgia: The Distress Caused by Environmental Change. Australas Psychiatry [Internet]. 2007 Feb 1 [cited 2021 May 3];15(1_suppl):S95–8.

(131) Public Services and Procurement Canada. Access and use of parks and green spaces: The potential impact of COVID-19 on Canadian households [Internet]. Government of Canada; 2020 Jun [cited 2021 May 2]. Available from: http://publications.gc.ca/collections/collection_2020/statcan/45-28/CS45-28-1-2020-28-eng.pdf

(132) Astell-Burt T, Feng X. Time for 'Green' during COVID-19? Inequities in Green and Blue Space Access, Visitation and Felt Benefits. Int J Environ Res Public Health [Internet]. 2021 Mar 9 [cited 2021 Sep 14];18(5):2757. Available from: https://www.mdpi.com/1660-4601/18/5/2757

(133) Heo S, Desai MU, Lowe SR, Bell ML. Impact of Changed Use of Greenspace during COVID-19 Pandemic on Depression and Anxiety. Int J Environ Res Public Health [Internet]. 2021 May 29 [cited 2021 Sep 14];18(11):5842. Available from: https://www.mdpi.com/1660-4601/18/11/5842

(134) Pearson AL, Horton T, Pfeiffer KA, Buxton R, Gardiner J, Liu W, et al. Contact With Nature as a Mental Health Buffer for Lower Income Communities During the COVID-19 Pandemic. Front Sustain Cities [Internet]. 2021 [cited 2021 Sep 14];3:86. Available from: https://www.frontiersin.org/article/10.3389/frsc.2021.688473

(135) Bikomeye JC, Namin S, Anyanwu C, Rublee CS, Ferschinger J, Leinbach K, et al. Resilience and Equity in a Time of Crises: Investing in Public Urban Greenspace Is Now More Essential Than Ever in the US and Beyond. Int J Environ Res Public Health [Internet]. 2021 Aug 9 [cited 2021 Sep 14];18(16):8420. Available from: https://www.mdpi.com/1660-4601/18/16/8420

(136) Frank LD, Wali B. Treating two pandemics for the price of one: Chronic and infectious disease impacts of the built and natural environment. Sustain Cities Soc [Internet]. 2021 Oct 1 [cited 2021 Sep 14];73:103089.

(137) Government of British Columbia. Agriculture Food and Beverage in British Columbia [Internet]. Trade and Invest British Columbia. [cited 2021 Sep 15]. Available from: https://www.britishcolumbia.ca/buy/goods-and-services/agrifood/

(138) MNP LLP. Study of the BC Agriculture Sector 2020 [Internet]. C Agriculture Council; 2020 Sep p. 99. Available from: https://bcac.ca/wp-content/uploads/2020/10/Economic-Impact-Study-of-the-BC-Agriculture-Sector.pdf

(139) Statistics Canada. COVID-19 Disruptions and agriculture: Temporary foreign workers [Internet]. Government of Canada; 2020 Apr [cited 2021 Sep 15]. Available from: https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00002-eng.htm

(140) Landry V, Semsar-Kazerooni K, Tjong J, Alj A, Darnley A, Lipp R, et al. The systemized exploitation of temporary migrant agricultural workers in Canada: Exacerbation of health vulnerabilities during the COVID-19 pandemic and recommendations for the future. J Migr Health [Internet]. 2021 [cited 2021 Sep 15];3:100035.

(141) Ostry A, Miewald C, Beveridge R. Climate Change and Food Security in British Columbia [Internet]. 2011. Available from: https://pics.uvic.ca/sites/default/files/uploads/publications/Food%20Security_2011.pdf

(142) Growing Forward 2. 2017 BC Agrifood and Seafood Export Highlights [Internet]. Government of British Columbia, Government of Canada; 2017 [cited 2021 May 3]. Available from: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/market-analysis-and-trade-statistics/2017_bc_agrifood_and_seafood_export_highlights.pdf

(143) BC Centre for Disease Control. A Sustainable Harvest: Weathering the Impact of Climate Change on BC's Food Supply [Internet]. Provincial Health Services Authority; p. 4. Available from: http://www.bccdc.ca/pop-public-health/Documents/foodforthought_summary_climatechange.pdf

(144) Masters J. Death Valley, California, breaks the all-time world heat record for the second year in a row [Internet]. Yale Climate Connections. 2021 [cited 2021 Sep 15]. Available from: http://yaleclimateconnections.org/2021/07/death-valley-california-breaks-the-all-time-world-heat-record-for-the-second-year-in-a-row/

(145) California Water Service. Latest Drought News [Internet]. Conservation. [cited 2021 Sep 15]. Available from: https://www.calwater.com/conservation/drought/

(146) Parker LE, McElrone AJ, Ostoja SM, Forrestel EJ. Extreme heat effects on perennial crops and strategies for sustaining future production. Plant Sci [Internet]. 2020 Jun [cited 2021 Sep 15];295:110397.

(147) Provincial Health Services Authority. Food for Thought The Issues and Challenges of Food Security [Internet]. 2010 [cited 2021 May 3]. Available from: http://www.bccdc.ca/pop-public-health/Documents/foodforthought_issueschallengesoffoodsecurity.pdf

(148) BC Wildfire Service. Wildfire Averages - Province of British Columbia [Internet]. Province of British Columbia; [cited 2021 May 3]. Available from: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-statistics/wildfire-averages

(149) BC Wildfire Service. Wildfire Season Summary - Province of British Columbia [Internet]. Province of British Columbia; [cited 2021 Nov 14]. Available from: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary

(150) Neary DG, Ryan KC, DeBano LF. Wildland fire in ecosystems: effects of fire on soils and water [Internet]. Ft. Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station; 2005 [cited 2021 May 3] p. RMRS-GTR-42-V4. Report No.: RMRS-GTR-42-V4. Available from: https://www.fs.usda.gov/treesearch/pubs/20912

(151) Williams L. Understanding Smoke Taint in Wine. Wine Spectator [Internet]. [cited 2021 May 3]; Available from: https://www.winespectator.com/articles/understanding-smoke-taint-in-wine

(152) NOAA. Scientists link toxic algal blooms along U.S. West Coast to warm waters in the Pacific [Internet]. Climate.gov. Available from: https://www.climate.gov/news-features/event-tracker/scientists-link-toxic-algal-blooms-along-us-west-coast-warm-waters

(153) IUCN. Ocean deoxygenation [Internet]. 2019 [cited 2020 Oct 13]. Available from: https://www.iucn.org/sites/dev/files/ocean_deoxygenation_issues_brief_-_final.pdf

(154) B.C. Ministry of Agriculture and Lands. BC Food Self Reliance Report [Internet]. [cited 2021 May 3]. Available from: https://foodsecurecanada.org/sites/foodsecurecanada.org/files/BCFoodSelfReliance_Report.pdf

(155) Bai X, Huang Y, Ren W, Coyne M, Jacinthe P-A, Tao B, et al. Responses of soil carbon sequestration to climate- smart agriculture practices: A meta- analysis. Glob Change Biol [Internet]. 2019 Apr 19 [cited 2021 Sep 15];25(8):2591–606.

(156) Niles MT, Ahuja R, Barker T, Esquivel J, Gutterman S, Heller MC, et al. Climate change mitigation beyond agriculture: a review of food system opportunities and implications. Renew Agric Food Syst [Internet]. 2018 Jun [cited 2021 Sep 15];33(3):297–308.

(157) Jonasson ME, Spiegel SJ, Thomas S, Yassi A, Wittman H, Takaro T, et al. Oil pipelines and food sovereignty: threat to health equity for Indigenous communities. J Public Health Policy [Internet]. 2019 Dec [cited 2021 May 20];40(4):504–17. Available from: http://link.springer.com/10.1057/s41271-019-00186-1

(158) Ministry of Environment and Climate Change Strategy. Provincial greenhouse gas emissions inventory - Province of British Columbia [Internet]. Government of British Columbia; 2020 [cited 2021 Apr 11]. Available from: https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory

(159) B.C. Food Security Task Force. The Future of BC's Food System [Internet]. Government of British Columbia; 2020 [cited 2021 Sep 15]. Available from: https://engage.gov.bc.ca/app/uploads/sites/121/2020/01/FSTF-Report-2020-The-Future-of-Food.pdf

(160) World Health Organization. Operational Framework for Building Climate Resilient Health Systems [Internet]. 2015. Available from: https://apps.who.int/iris/bitstream/handle/10665/189951/9789241565073_eng.pdf?sequence=1

PICS
PACIFIC INSTITUTE
FOR CLIMATE SOLUTIONS

Connect with us online to stay up to date: