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Planning Resilient Communities and Adapting Rural Health Services in British Columbia

*Responding to climate change and
ecosystem disruption*



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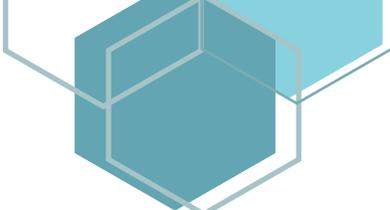


Executive Summary

OVER THE PAST CENTURY, THE IMPACT OF ANTHROPOGENIC ENVIRONMENTAL CHANGE HAS DESTABILIZED THE EARTH'S CLIMATE AND ECOSYSTEMS. Climate science research demonstrates strong evidence of global warming predicted to reach more than 1.5°C above pre-industrial levels by 2030 to 2052. The implications of global warming are rapid rates of sea level rise [1], melting glaciers [2], loss of species diversity [3], along with extreme and unusual weather events [4]. Climate-induced health effects include higher incidences of infectious and vector-borne diseases, increased food and water insecurity, heat- and cold-related morbidity and mortality, increased respiratory illnesses and climate-related psychological distress. Compounding these climate related effects are the emergence of new infections like COVID-19 attributable to human ecosystem disruption. A multitude of institutional, community, and individual-level strategies have been developed to try and prevent and mitigate these unintended effects. Ultimately humankind will need to adapt to these new circumstances.

The purpose of these series of chapters is to identify relevant gaps in the current literature around climate change, mitigation, and adaptation along with exploring innovative ways research can contribute to supporting adaptation strategies for rural health services and healthy rural communities.

Chapter 1 will provide an overview of the background and contextual factors underpinning the complex problems of climate change and ecosystem disruption in rural and remote BC based on a review of the literature supplemented by input from rural people.



Chapter Outlines

Chapter 1: Assessing the impact of climate change on the current situation in British Columbia

Section A: Assessing the current situation on climate change

- An overview of the evidence for climate change in BC its environmental impacts including, temperature rise, extreme weather events, loss of species, increased natural disasters and the decline in sea ice and glaciers.
- Examining vulnerable communities and demographics in rural areas that will be disproportionately impacted by climate change.
- Perception and awareness of climate change and the problems associated with it on the development of prevention, mitigation and adaptation strategies in regions.

Section B: Health Effects of Climate Change

- Identifying COVID-19 as a manifestation of ecosystem disruption.
- This section discusses climate change hazards and its impacts on health determinants and health outcomes in BC.

Chapter 2: Mitigation and Prevention Strategies

- An overview and discussion around how various levels such as institutions, community, and individual-level mitigation and prevention strategies may respond to climate change at a national and provincial level.
- A summary of mitigation strategies and initiatives enacted by health authorities (HA), BC government and rural communities.
- An overview of recommendations on how physicians and other health professionals can contribute to mitigation strategies (e.g., expanding clinicians' knowledge on climate related health effects and diseases and implementing greener clinical practices).
- Global governance and climate mitigation accountability frameworks

Chapter 3: Climate Adaptation Strategies

- Descriptions on various climate change adaptation strategies and decision tools at the national and provincial levels, such as GIS initiatives to identify vulnerable populations, improving education and awareness on the problem and increasing resiliency of communities.
- Discussion on how sustainability will act as a framework that will be tied into economic development to cope with the harmful impacts of climate change.
- Considerations on adaptive measures to cope with climate change that have been implemented (and can potentially be implemented) in rural Canada, including examples of community adaptation measures that have already been implemented.
- Discussion on identifying roles and responsibilities to plan and implement adaptation strategies.



Photo by aaronislulloa

Chapter 4: Rural Health Strategies to Respond to ecosystem disruption in BC

- Building climate resilient communities
- Exploring areas within rural health services that can adapt to climate change:
 - Citizen/Community voice
 - Indigenous ways of knowing
 - Emergency preparedness
 - Telehealth
 - Generalism
 - Enhanced skills/Team based care
- Given previously outlined health and environmental outcomes, provides links to how ecosystem disruption will directly and indirectly impact future health care practices in rural BC.
- Provides introduction, benefits and challenges, current examples of implementation in rural settings, government policies, research, and suggestions for each strategy.



CHAPTER 1

Assessing the impact of climate change on the current situation in British Columbia

Chapter One Highlights

- *The annual average temperature of B.C. has increased by 1.4°C between 1900 and 2013. By 2050, an additional increase may cumulatively reach 2.7°C in B.C. [34].*
- *There is a projected 25% decline in glacier area (a leading cause for rising sea levels in B.C. Coastal communities) within B.C by 2050, relative to 2005 [41].*
- *Disruptions to fishing in Indigenous and rural communities as a result of climate change has been shown to negatively impact the health and well-being of Indigenous communities [1].*
- *Mental and physical health issues are the most consequential health effects of climate change in B.C, based on 2020 survey results from CleanBC.*



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Overview of natural hazards in British Columbia

Province-wide natural hazards related to climate change include warmer temperatures, frequent and severe wildfires, severe storms, increased drought and water shortages, floods and rising sea levels. Due to the geographic diversity of British Columbia, climate impacts differ in each region [5]. The survey results published by CleanBC in March 2020, ranked mental and physical health issues as the most consequential health effects of climate change in B.C [6]. Though climate change will impact all BC communities, it will have disproportionate impacts on rural communities, particularly rural Indigenous [7], elderly [8], and infant and child [9] populations. Geography, peoples' dependence on land and sea for natural resources, culture and livelihood, health systems infrastructure in rural communities, current burden of disease, and social determinants of health creates different risk profiles for non-indigenous, among indigenous and between indigenous groups, exposing them to unique sensitivities to climate change. Although literature indicates greater sensitivities and vulnerability to climate change among indigenous populations, most major climate change assessment reports overlooks reporting on human dimensions of climate change for indigenous people and their capacity to adapt to rapid changes [7].

The geography of British Columbia

British Columbia is Canada's western most province and has huge geographic diversity, with rocky ocean beaches, lush rain forests, mountains, deserts, and plains. With an area of 944,735km², B.C has a landmass roughly the size of France, Germany, and the Netherlands combined [10]. As of 2011, 13% of BC's population resided in a rural area [10]. About 50% of the population of B.C resides in the south. Most of the province is wilderness, interspersed with roads and towns (Figure 1) [10]. BC has many regions that are rich in agricultural production, including the Fraser Valley, which grows fruits and vegetables, the Okanagan Valley that grows wine and produce, and the Peace River Valley, which produces abundant grain crops [10]. Indigenous people have lived in the land we call BC for over 10,000 years. There are 198 distinct First Nations in B.C, with 30 distinct First Nations languages and 60 dialects [11].

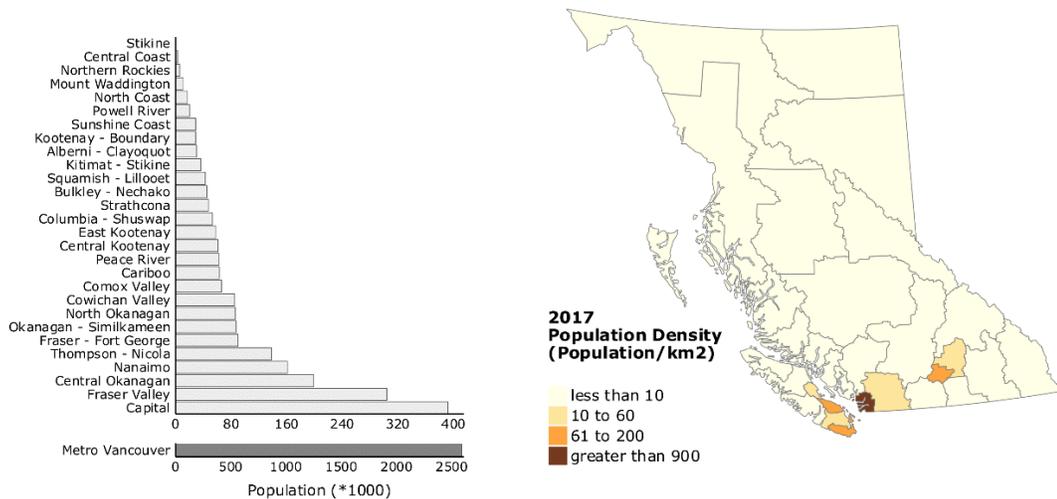


Figure 1: BC Population Size & Density by Regional District (2017). Environmental Reporting BC. Retrieved from: <http://www.env.gov.bc.ca/soe/indicators/sustainability/bc-population.html>

Identifying at-risk populations in rural communities

Though climate change is anticipated to have health consequences for all BC communities, some rural areas may face disproportionately high health impacts as a result of climate change. Rural communities may be more exposed to extreme weather events with lower access to resources that help to protect residents [12]. For example, there is an increased risk of wildfires and floods in parts of Northern and Central BC impacted by the mountain pine beetle [13], which may have significant health implications like respiratory illnesses for people living in those areas. Additionally, residence in a rural community can be a risk factor for heat-related morbidity and mortality, with rural Indigenous populations at an even higher risk [14, 15]. In rural regions where livelihoods are closely tied to natural resources, climate change may contribute to economic decline, social disruption, and population displacement. As social and economic conditions have strong implications for health, such regions are at a greater risk for health challenges as a result of climate change [12].

Indigenous and Northern communities

The health of Indigenous communities is at risk in the face of climate change, as many Indigenous communities have close relationships with and dependence on the natural environment, and additionally face a high burden of poor health due to the historical and on-going impacts of colonialism and socio-economic inequities (Figure 2) [7]. Although rural Indigenous populations demonstrate immense land-based knowledge and capacity to adapt, stressors not related to climate change such as poverty, loss of land, and social and cultural transitions may impede the ability of Indigenous populations

to adapt [7]. Community-based approaches for mitigating the impacts of climate change on Indigenous populations have been identified as critical for fostering climate-resilience among Indigenous populations [26-28].



Figure 2: Nuu-chah-nulth smokehouse from the west coast of Vancouver island. Photograph by: Jacqueline Wind www.jacquelinewindh.com

Elderly populations in rural areas

Older age is a significant risk factor for almost all climate change-related health outcomes, and this is further exacerbated with underlying diseases. Elderly populations living alone or in a nursing home are at greater risk of heat-related mortality [16, 17]. Heat waves and increased humidity are associated with higher all-cause mortality rates in individuals of 65+ years. Respiratory, cardiovascular, and nervous system-related deaths were especially prominent [18,19]. The aging population has increased in rural areas more than urban areas with mental health outcomes much worse in rural areas [20].

Infants and children

Infants and young children are especially vulnerable because of their underdeveloped physiology, greater metabolism and longer lifetime exposure to environmental consequences such as heat, air pollutants, and UV [21]. Infant mortality rates are significantly increased with higher temperatures and projected to further increase with climate change effects [22]. Ozone is a highly reactive particle that damages the lungs. When children are exposed to ozone and other air pollutants at a young age, it can have a long-lasting impact on their respiratory health. This effect is exacerbated with increasing time spent outdoors [23]. Poor air quality is directly related to development of asthma in children [24]. Ground-level ozone and asthma-related hospital visits show strongest association in ages 5-12 years [25]. Similarly, increased life-time accumulation of UV exposure, particularly in children of Northern B.C., heightens their risk of melanoma [21].

Impacts of Climate Change

Extreme and unusual weather events: floods, fires, mudslides

Unpredictable weather patterns within B.C. have been occurring through heatwaves, which increase the frequency and intensity of forest fires [29]. The 2017 and 2018 wildfires had devastating impacts such as respiratory and mental health illnesses, damage to property, displacement of population etc., in B. C (Figure 3) . Although fires were mild in 2019 due to increased precipitation in the summer months, the B.C. Wildfire Service declared nine fires to be highly notable [30].

As of April 9, 2020, B.C Wildfire Services predicted normal fire conditions for the spring wildfire season that will be consistent with the long-term patterns in B.C. [31]. The B.C government has taken measures to reduce unnecessary fire activities, especially in smoke sensitive zones (Figure 4) in the province, as smoke can directly exacerbate the respiratory effects of COVID-19 [32]. If anthropogenic emissions increase, it is likely that the frequency and severity of future forest fires in B.C. will also accelerate. The increase in smoke and heat will have negative impacts on human health [29].

Over the past two years there have been heavy amounts of snowfall in the winter season [33]. It has been predicted that, by 2050, there will be on average a 12% increase in average annual rainfall in B.C. [34]. Additionally, the frequency and severity of floods and mudslides have been increasing over the years. Several evacuations have taken place due to these hazards in B.C. [35]. Precipitation has been projected to increase in intensity and frequency in floodplain and coastal areas, while drier regions such as the interior will face more frequent and severe droughts.



Figure 3. Forest fire from the 2018 Island Lake fire in central BC. Calogeheros, Tracy, 2018. Retrieved from: <https://www.cbc.ca/news/canada/british-columbia/photos-bc-wildfires-2018-1.4789644>.

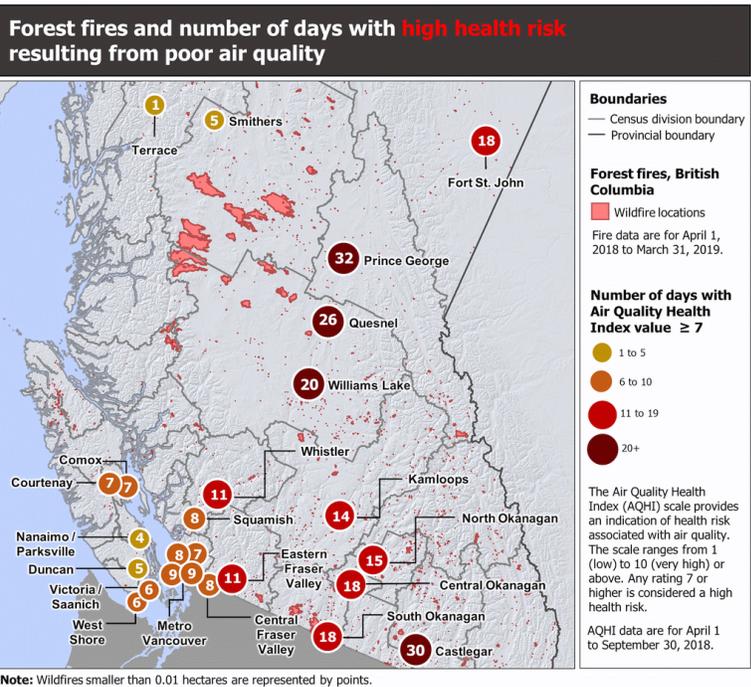


Figure 4. Number of days communities in B.C. suffered from poor air quality due to the 2018 forest fires. Jennie Wang and Katharine Strong, British Columbia's forest fires, 2018 (Government of Canada, Statistics Canada, May 29, 2019), <https://www150.statcan.gc.ca/n1/pub/16-508-x/16-508-x2019002-eng.htm>.

Loss of species

Climate change induces habitat expansion and contraction for certain species, which is responsible for habitat and species loss, displacement of species, and the introduction of undesirable species interactions [36].

Species like the mountain pine beetle have been expanding their range into areas that were previously inhabitable due to temperature limitations in the Boreal forest in Northern Canada [37] and have infected a significant proportion of lodge pole pine trees and Jack Pine tree's [38]. If temperature increase continues at the current rate, it is predicted that this pattern will continue in the coming years, as shown in (figure 5). Loss of species will directly impact community lifestyle and therefore community well-being, as there are certain communities like the Sahtu in Northern B.C. that depend on hunting or fishing practices to sustain their economy, social norms, culture and traditions [39].

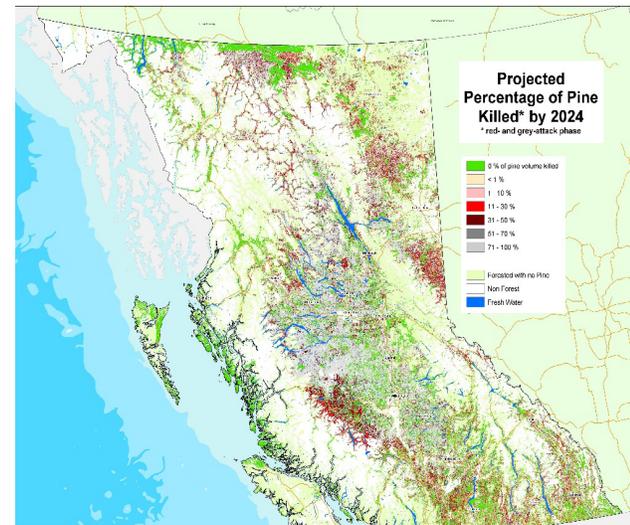
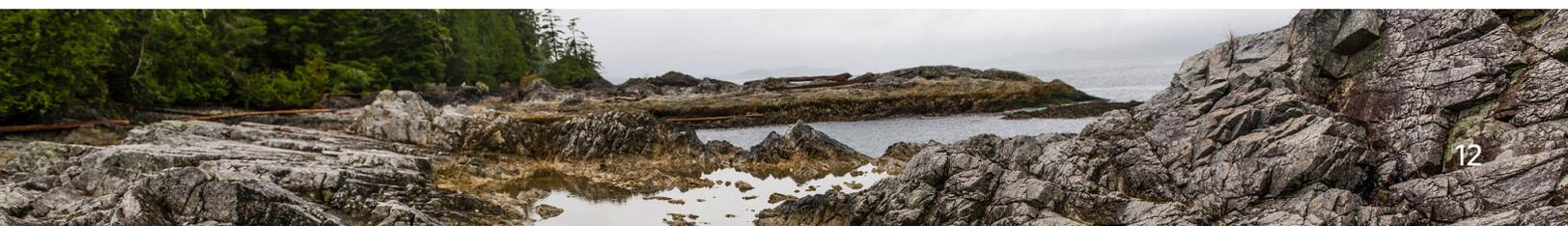


Figure 5: Projected Percentage of Pine Killed by 2024 "Projected Percentage of Pine Killed by 2024." Mountain Pine Beetle Projections. Government of B.C. Accessed June 17, 2020. <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/mountain-pine-beetle/bcmapbv132024kill.pdf>.



Decline in sea ice, glaciers, and ice caps

It is predicted that by the summer of 2050, most Canadian Arctic marine regions will be sea ice-free, and by 2100, most small ice caps and ice shelves will melt away [34]. Winter sea ice areas decreased in eastern Canada by 8% per decade. And glaciers/ice caps are projected to lose 74% to 94% of their volume later in this century [40]. A risk event scenario analysis shows a projected 25% decline in glacier area within B.C. by 2050, relative to 2005 [41]. Sea ice will continue to melt across the Canadian Arctic annually throughout the summer periods, exacerbating sea level rise and result in habitat loss for species that depend on sea ice [40].

Sea level rise

Increased glacier melt is considered a leading cause for rising sea levels in B.C. Coastal communities facing a higher rise in sea level will be more susceptible to natural hazards (e.g., flooding, mudslides) and deal with the loss of several ecosystem services like clean air, food sources etc.(Figure 6) [42]. For example, average sea level rose at a rate of 13.3 centimeters per century at Prince Rupert, 6.6 centimeters per century at Victoria and 3.7 centimeters per century at Vancouver [42]. These communities will face more frequent and severe floods in the coming years creating concerns around housing insecurity [43]. Flooding may disrupt fishing, which could compromise the lifestyle of communities' dependent on it (rural and indigenous communities). For example, the 2014 dam breach in Quesnel lake, resulted in a shift in physical activity, diet, cultural practices, employment opportunities and community income [44].

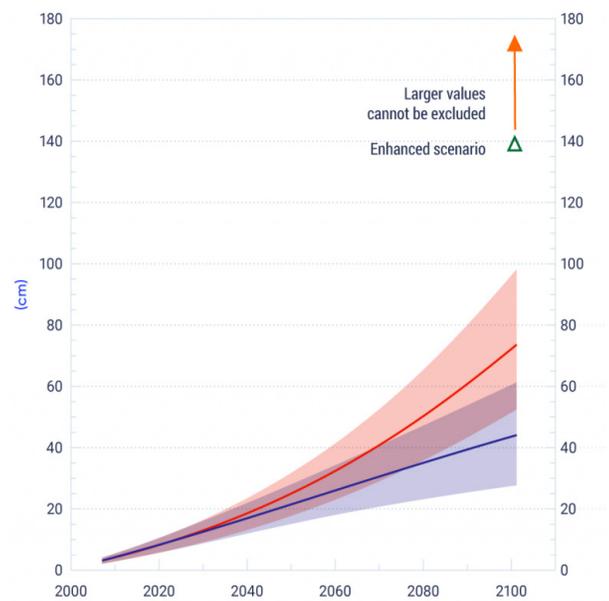


Figure 6: projections of global sea level rise from 2020 to 2100. RCP2.6= low projection, RCP8.5= high projection. Intergovernmental Panel on Climate Change, Figure SPM.9, 2013. Retrieved from: <https://changingclimate.ca/CCCR2019/graphics/>

Public awareness and engagement

Communications intended to engage the public on climate change can be challenging as the timeline is long and marker events are complex. Consequently, responding to these issues is fraught with uncertainty and often seemingly irrelevant at an individual level. Perceptions of the importance of climate change and ecosystem disruption are often diminished as other issues may take priority in day to day society (e.g., health, safety, family, terrorism) [45].

Many communities in the northern hemisphere are yet to experience some of the severe climate-related hazards. Thus, concerns about the impacts of climate change may seem largely theoretical and may not lead to commitment to prevention, mitigation and adaptation activities. Rather than stressing on the negative effects of climate change, researchers are focusing on a 'gain' based model that may produce a more positive attitude towards climate action in communities [46]. The gain-based model is beneficial, as it is solution focused. While communities are made aware about the evidence for climate change and its negative impacts on the community, developing action plans to mitigate/adapt to these impacts is the predominant focus of the model.

For prioritization of mitigation and adaptation strategies to occur, populations will need to accept that climate change will locally impact them and recognize that the sooner they respond to the threat the better for them at an individual, family, and community level. Examining evidence-based findings on climate change and projecting future natural hazards will help prepare mitigation and adaptation strategies and reduce the potential consequent adverse health outcomes. Predicting changes in the Earth's climate system through anticipating the effects of future natural hazards is critical not only for disaster planning and emergency preparedness, but to consider long-term priorities that generate resiliency in various aspects of society such as within communities, ecosystems, and economies.



Health effects of climate change

Rural communities especially those that are socioeconomically disadvantaged will experience disproportionate health impacts due to climate change. These will include:

New emerging and reemerging diseases: COVID-19

The emergence and spread of the COVID-19 pandemic are a result of ecosystem disruption and is a huge threat to rural communities due to an aging demographic, limited resources, and significant barriers to accessing health services. As our climate continues to change as a result of disruptive anthropogenic influence there is an increasing likelihood that the COVID-19 pandemic may become exemplar of a new normal as novel pathogens emerge from melting glaciers and permafrost [47], as well as from interactions with wild animals as humans disrupt their natural habitats [48]. This is a rapidly developing situation and there is currently an evidence gap with respect to how rural communities are impacted by and adapting to COVID-19. We are following the evidence as it emerges and will explore COVID-19 as a case study for how rural communities can adapt to the natural hazards associated with ecosystem disruption.

Zoonotic and vector-borne diseases

Climate change will alter temperature, moisture level and precipitation patterns, transforming the niche of some species due to habitat expansion and contraction in response to these changes. The altered environmental changes may be more conducive to the spread of zoonotic and vector-borne diseases (Figure 7) [49]. Examples of vector-borne diseases that are increasingly impacting Canada include West Nile virus and Lyme disease [50].

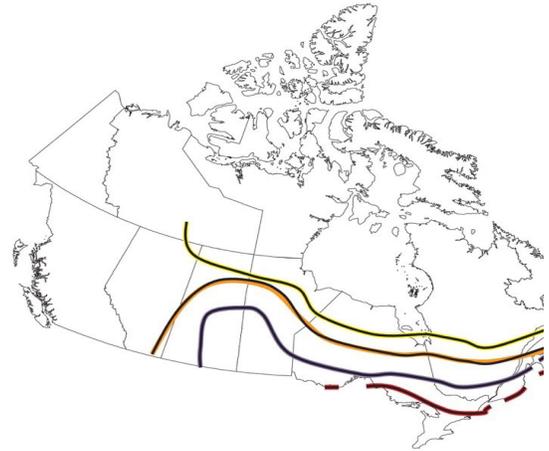


Figure 7: Recorded and predicted changes in *Ixodes scapularis* (deer tick) range as a result of climate change. Greer, A.; Ng, V.; Fisman, D., Figure 2: Upper temperature limits for *Ixodes scapularis*, 2008. Retrieved from: <https://www.cmaj.ca/content/178/6/715>

Mental health in rural areas

There are large disparities in the socio-economic and health status of rural and urban residents of BC [51]. Rural residents in B.C. are disproportionately impacted by the negative impacts of climate change due to socio-economic (lower income, lack of higher education) and environmental vulnerability (environmental destruction, pine infestations etc.). Disruptions to land-based cultural practices as a result of ecosystem disruption has been shown to increase suicide risk in Indigenous communities [52]. Exposure to natural disasters such as floods is correlated with higher levels of anxiety among those affected and panic disorders and phobias may also occur in people affected by natural disasters [51].



Climate related hazards/disasters trigger and exacerbate mental health illnesses such as anxiety, depression, PTSD and acute stress disorder. A study found that forest fires threaten mental health of people living in affected regions [51]. "About 24% of those who applied for disaster assistance after a wildfire in California showed symptoms of PTSD at three-month follow-up". After the 2003 fire in Kelowna, a medical officer identified numerous patients exhibiting PTSD and mental and physical trauma [53].

Figure 8: Centre for Rural and Remote Mental Health in Orange, Australia. Oelke, Nelly, 2019. Retrieved from: <https://rhrnbc.med.ubc.ca/nelly-in-orange-australia-chapter-2/>



Photo by Shane Rounce

There are some global examples of programs addressing mental health and wellbeing impacted by changing and uncertain environmental conditions in rural areas. For example, The Rural Adversity Mental Health Program of Australia has implemented local initiatives to support mental health during extreme drought and forest fires. The *One Book, One Community* initiative is a book club for various communities to gather and share each other's reflections. The meetings are also provided virtually to ensure accessibility and inclusivity. This initiative strives to foster conversations and social connection amongst rural communities [54]. Another example includes the Centre for Rural and Remote Mental Health (CRRMH) (Figure 8) and Men's Community Advisory Committee have launched *You Got This Mate*, which is a website providing mental health resources specifically for rural men in Australia. Although literature investigating how natural disasters affect mental health is very limited, the existing research suggests that solutions must be tailored for susceptible and affected rural communities [53].

Respiratory illnesses

Increases in pollutants such as CO² and fine particulate matters are progressively decreasing air quality. With additional increases in aeroallergens and infectious aerosols, respiratory health becomes a major health concern for all ages. A major cause of deteriorating air quality is anthropogenic emission of greenhouse gases and particulate matter, such as the combustion of bio-fuels, diesel exhaust, and black carbon. Many of these are identified as potent carcinogens [55, 56, 49]. In addition to anthropogenic pollutants, increased temperature accelerates and prolongs pollen season. It also increases dryness of forests, leading to higher frequency and severity of forest fires. Combining the aforementioned causes, climate change leads to negative respiratory health through increased allergies, asthma, chronic obstructive pulmonary disease (COPD), respiratory tract damage, and inflammation.

Food and water quality and safety

Health impacts of changes to food and water quality and access

Rural and Indigenous communities that rely heavily on their natural environment for food and water and may experience food insecurity and anxiety associated with changes to their food supply, depending upon the extent to which their local ecosystem is disrupted [41].

Disruptions to fishing in Indigenous and rural communities as a result of climate change has been shown to negatively impact the health and well-being of Indigenous communities [1]. Water shortages caused by climate related events (droughts, water-borne diseases, human disruption) can increase tension in affected communities. While users with senior water rights continue to use water during a water shortage situation youth cannot reap the same benefits, which may cause conflict within communities [41]. Inequality of access to needed resources may undermine the integrity of a community and contribute to the long standing patterns of urban migration of youth from rural communities [41].

Food-borne and water-borne disease

Climate change may create unfavourable conditions that support the growth and survival of foodborne diseases and create pathways that could increase the risk of contamination of food products through environmental media (i.e. contaminated flood waters inundating agricultural fields). Due to the complexity of the relationship between food, food-borne illness, and changes in temperature and climate, it is difficult to determine which foodborne pathogens will pose the greatest threat, which regions will be the most heavily impacted, and when these areas will be impacted [57]. The food-borne pathogens responsible for many of these illnesses are norovirus, *C. perfringens*, *Campylobacter*, and *Salmonella* [57]. In BC, climate change is likely to create heavier rains in the winter and drier, warmer summers.

An increase in precipitation is associated with an increased emergence of water-borne diseases and increases in temperature also increase the growth of various water-borne, vector-borne, and food-borne pathogens [58]. The most common water-borne disease (WBD) pathogens in Canada are *Giardia*, *Cryptosporidium*, *Campylobacter*, *Shigella* and verotoxigenic *E. coli*. Communities that are dependent on small private water systems that service populations of 5000 or less may be more vulnerable to water-borne disease outbreaks. Changing ocean currents will bring contaminants and water-borne pathogens towards the Northern Pacific. Rising temperatures can similarly change the characteristics of marine ecology. Consequently, communities that rely on oceans and rivers for food and agriculture will face an increased risk of contaminant and pathogen consumption [59]. In Canada, younger children are more vulnerable to infections from food and water contamination [60].

Heat- and cold-related morbidity and mortality

Between 1900 and 2013, records show that the annual average temperature of B.C. has increased by 1.4°C. By 2050, an additional increase may cumulatively reach 2.7°C in B.C. [34]. This is almost double the increase in less than half the duration it took in the last century (Figure 9).

Generally, the highest summertime temperatures and heat-related mortality in B.C. have been observed in the Southern regions, most noticeably in the Southern Interior [61]. Extreme



Photo by Curioso Photography

hot and cold weather correlates with increased rates of heat and cold related mortality in the past few years. Heat-related morbidity and mortality is dependent on multiple factors, such as the frequency, intensity, and duration of heat exposure. Heat and air pollution has a greater synergistic effect on the older population [62]. Men between the ages of 25 and 64 are vulnerable to occupational heat exposure, working outdoors during the hottest times of the day. Increased hospital admissions of men were recorded during extreme heat wave periods in Australia [63]. Although the burden of temperature-associated mortality may shift towards high temperatures in the future, cold temperatures may represent a greater current-day problem in temperate cities [64]. As an adaptation measure to increased heat, the Government of Canada has published guidelines for communities to establish community-specific prevention, alert, and response planning to heat waves [65]. The Guide includes step-by-step toolkits on vulnerability

assessment, relevant stakeholder engagement, alert system development, examples of successful strategies, and more.

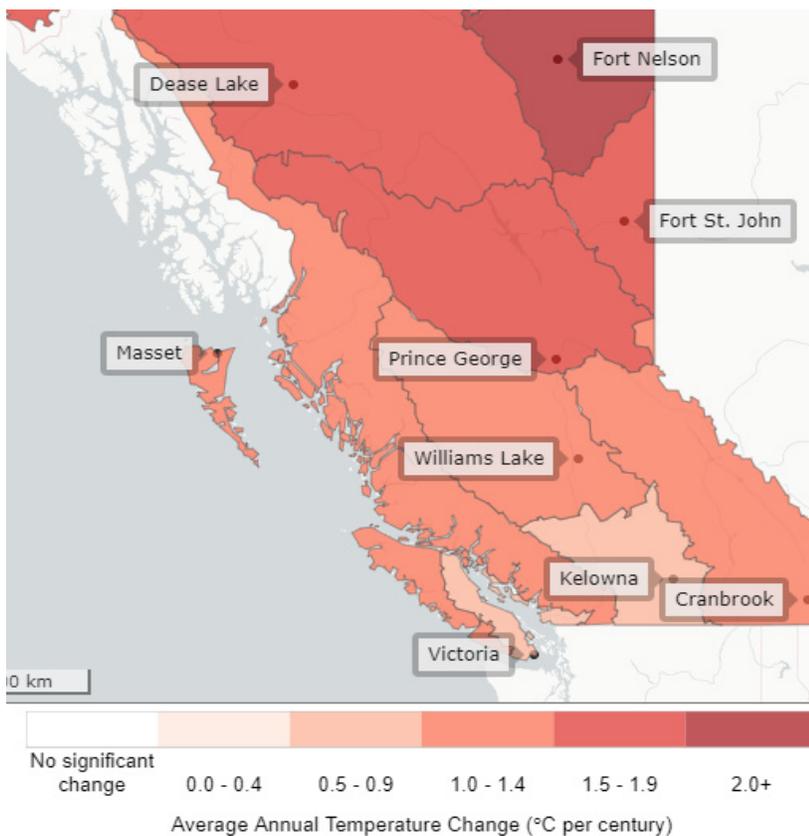


Figure 9: Observed Average Temperature Change in BC (1900-2013). Retrieved from: <http://www.env.gov.bc.ca/soe/indicators/climate-change/temp.html#:~:text=British%20Columbia%20has%20warmed%20an,century%2C%20twice%20the%20global%20average>



Conclusion

There have been substantial effects of climate change on the rural communities of BC. Rural residents in BC, especially those who are a part of elderly, infant and child, Indigenous, and Northern populations, are and will be most affected by climate change due to their socio-economic and environmental vulnerability. More frequent and severe forest fires attributed to climate change have already been observed with increases in air pollutant concentration, in turn contributing to increased lung irritation and more severe cases of respiratory illnesses. COVID-19, a product of ecosystem disruption affects us all in both as a direct risk to our individual health and as indirect effects associated with system wide public health interventions designed to try and keep us safe [66]. Changes to fish and game populations on the land and waters impact rural peoples and Indigenous rural communities. This has had serious health consequences including changes to diet, physical activity, and reduced economic and job security [44]. These examples illustrate current impacts of climate change on rural health and underscore the importance of planning for accessible and sustainable rural health care models in the face of projected climate change.

In our following chapters, we will explore how climate change can be mitigated through initiatives that reduce greenhouse gas emissions, and how communities can adapt to climate change and ecosystem disruption to achieve better health for all.

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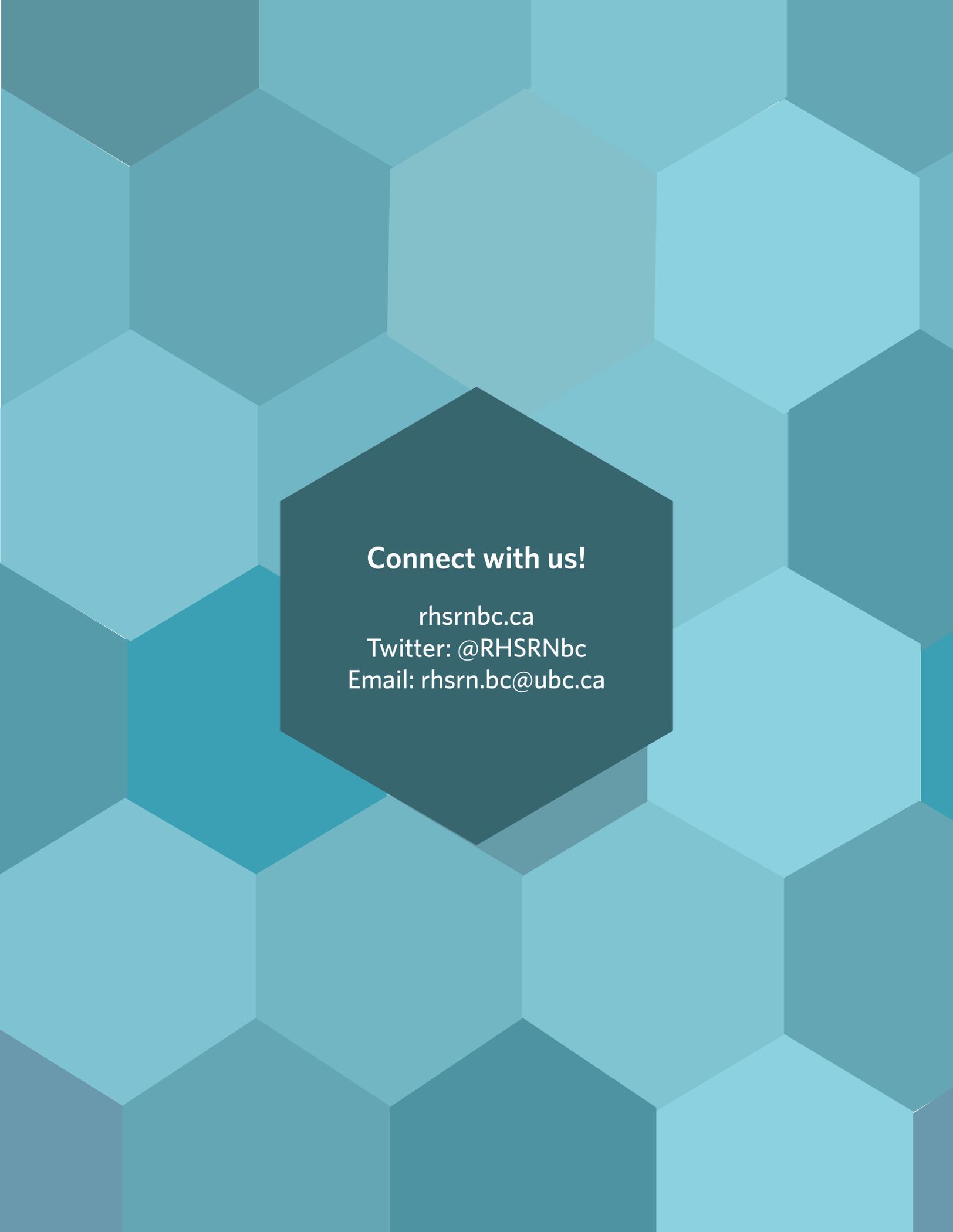
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