Determining Knowledge, Understanding, Perception and Attitudes Towards Climate Change-related Health Risks by Public Health Actors in Ontario to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies

by

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A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Master of Science

in

Public Health and Health Systems

Waterloo, Ontario, Canada, 2021

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

While majority of Canadians believe that climate change has the potential to harm them, many have a limited understanding of the associated health risks. Public health actors play an important role in communicating these risks alongside mitigation and adaptation strategies to the public. However, public health actors' knowledge, understanding, perception and attitudes surrounding this issue across Ontario is not well known. As such, this study aims to address the following research questions: **(1) "**How does knowledge, understanding, perception and attitudes towards climate change-related health risks differ amongst public health sector actors in Ontario?" **(2) "**What mitigation, adaptation and risk communication strategies are public health units implementing or proposing for climate change-related health risks, and to what degree are they locally contextualized?". Semi-structured interviews of Ontario public health actors (n=17) were conducted over six weeks. NVivo 12 was used for a combination of deductive and inductive thematic analyses; the former informed by theory of mental models (Westbrook, 2016, pp. 563-579). This study identified beliefs held by Ontario public health actors surrounding climate-related health risks, alongside motivators associated with increased engagement in environmental health work. Secondary findings elucidated emerging opportunities for key policy changes to address organizational and behavioural barriers towards the implementation of effective climate mitigation, adaptation, and effective risk communication strategies in the Ontario public health sector.

Acknowledgements

I'd like to thank my supervisor, Dr. Martin Cooke, for always providing opportunities for critical inquiry, for challenging me to be the best researcher I can be, for supporting me throughout this research and for allowing me the freedom to be creative and independent in the choosing this research topic. I want to thank Dr. Samantha Meyer, for being an amazing role model, mentor, and support system over the past almost two years as both my research assistantship supervisor and committee member. I appreciate your ability to lead with empathy and your drive to always guide research in the direction of greatest meaning, intent, and impact (it makes working with you incredibly fun!). I want to thank Dr. Susan Elliott, who is also a member of my committee, for teaching me how to conduct *good* qualitative research and for being someone whose work in the field I admire. With your guidance I realized that there was so much *more* to qualitative, and that it is our duty as researchers to do all that we can to ensure high quality research. It's also imperative I acknowledge the never-ending support, input and friendship of my fellow researcher, Kayla Benjamin throughout this work and our whole-time completing MSc's at University of Waterloo. I don't think I would've been able to do all this without you! Thanks for being the best "grad wife" ever. I can't wait to watch you succeed in everything you do.

I'd like to thank my family. My mom is my best friend and my role model – the ultimate smart, beautiful and kind person. I don't have the words to express how much she always celebrates me, as a child, woman, and academic for all the milestones I've achieved, and those acts of love have been a driving force for all my successes. To me, my dad is an intellectual legend— someone who reminds me to ask hard questions and think critically. He also taught me to celebrate all my losses. My brother challenges me in the best way as he truly ignites the necessary growth that I need to be the best version of myself. He also keeps me humble with his unbound potential and creativity. I want to thank my Dadu, Dadi, Nanu and Nani for all their love and support. Recently, my Nanu passed away, and I wish he could have read this thesis, as he'd been advocating for environmental health issues for decades. To the loves of my life: Potato & Luigi, thank you times infinity for cuddles, supportive looks during good cries, companionship when its most needed (basically always), nose boops and lovingly putting your paws on my leg. I promise new toys and high value treats forever. I also wouldn't have made it through this degree amidst a pandemic without the support of my 4 other foster puppies: Billy, Seiya, Archie and Greg.

I'd also like to thank each of my friends for being there for me, and for always listening to me talk endlessly on all my little tangents. You create space for me, and as a person who doesn't always want to recognize the space that we each deserve to take up in this world, you remind me often. Finally, my fellow climate justice activists – you inspire me every day to keep working in this space and remind me that a better future is possible with us at the helm, steering the way through the uncertain (rising) seas.

Dedication

This one's dedicated partly to future me, for when I am thinking, "does any of this even matter?" and I am feeling the crushing blow of eco-anxiety. The day I moved to what is currently Vancouver, B.C., the province broke the all-time record for hottest day recorded in Canadian history, at 47.9°C. That fateful Monday, three hours away from me, the town of Lytton was decimated to rubble in 15 minutes after being engulfed in flames. I saw pictures of people losing absolutely everything, and puppies with scorched paws being rescued. My friends and I were suffering in the unrelenting heat, as having an A/C in your home is not commonplace here due to there not being a need historically. However, we found it hard to complain once we acknowledged that those without shelter, water, food and access to cooling options of some sort, were faring much worse. Soon after, the Vancouver coroner reported that 719 people died sudden deaths that day, a number noted to be significantly exacerbated by the heat waves, indicating the province (and more specifically, public health)'s lack of preparedness in managing this emerging, yet urgent threat-to-life. Experiencing something like that, the reality of the climate crisis truly hits you like bricks. It only reiterated to me that this work *is* important, and necessary. In saying that, I also acknowledge that many of us still move through this world under the constructs of predominantly white, cis, capitalist patriarchal colonial structures that have in large part been the driving forces for the havoc humans have reaped upon our bountiful planet. To quote Audre Lorde, "the master's tools will never dismantle the master's house", so I commit to this work being one of the *many* things I hope to do to address the climate crisis, a harmful symptom of extractive, diseased systems.

This work is also partly dedicated to Mother Earth. Before writing this, I grounded my bare feet on the grass of the ancestral, unceded territory of the xʷməθkʷəy̓əm people whose land I'm grateful to live upon at present. I smelled the summer breeze and let it fill me with emotion, thanked the trees and drank chai— hoping some of that peace I felt would transcend to my ancestors to let them know that the world they wished for us all will manifest in due time and that their efforts were not for nothing.

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Chapter 1: Introduction

The goals of this thesis were to investigate the knowledge, understanding, perceptions and attitudes of Ontario public health sector actors regarding the health impacts and risks associated with climate change. The purpose of this was to elucidate its impact on the planning and implementation of mitigation and adaptation plans, and to identify opportunities to improve risk communication. This section provides a high-level brief background and provides the statement of problem. Chapter 2: Literature Review will provide more context and state the specific aims.

1.1 Statement of Problem

As stated in the 2019 Lancet Countdown report (Watts et al., 2019, pp. 1836-1878), if left unaddressed, climate change will negatively impact the health of people now, and for generations to come. Public health sector actors hold positions of power that inform policies and actions for the health and wellbeing of the population. As such, these individuals play a critical role in shaping Canada's response to climate change through their agencies' climate mitigation and adaptation strategies. Although public health structures differ across provinces in Canada, in Ontario there are 35 public health units which are both provincially and locally funded to protect and promote the health of the community in their local jurisdiction (Levison et al., 2018). All of the units are also mandated by the updated 2018 Public Health Standards to "assess the health vulnerability of their community, monitor health impacts, and engage partners to develop and promote strategies that reduce the health impacts of climate change" (Minister of Health and Long-Term Care, 2018). Given that they are aware of the

locally contextualized health status of their local populations, including the leading causes of death and the demographic characteristics of the population, they are also in a position to determine which subpopulations are more vulnerable to the effects of climate change (Levison et al., 2018; Mendez, 2015, pp. 637-663). With this knowledge, they can create plans to aid in increasing the adaptive capacity of the communities, in order to contribute to their resilience in the face of this crisis (Levison et al., 2018). However, the degree to which public health units are effectively and impactfully engaging in this work, particularly following the updated mandate, is not known.

Public health actors are often also tasked with providing evidence in effective ways to communicate and mitigate the health risks associated with climate change (Frumkin & McMichael, 2008, pp. 403-410). These communications are critical tools that can be used to increase the public's intrinsic motivation for climate action and minimize the value-action gap (Linden, 2014). Interestingly, Mildenberger et al. (2018) found that 83% of Ontarians believed that the Earth is getting warmer, but only 45% believed it would harm them personally; this is congruent with previous research that found that many individuals perceived climate change-related impacts as distant and detached from themselves (Cardwell & Elliott, 2013). This underlines an ongoing need to further investigate the production and use of health messaging surrounding this topic (Mildenberger et al., 2018).

Importantly, effective risk communication for climate change-related health impacts is also critical in sparking the necessary health-protective behaviour changes in our population. According to studies published by researchers at Health Canada, populations that are at the highest risk of disproportionately facing the negative effects of climate change include infants and children, women, seniors, individuals with underlying health conditions, homeless and low-income individuals, individuals living off the land and rely heavily on natural resources, individuals living alone, and Indigenous, northern, coastal and rural communities (Berry, Clarke, Fleury, & Parker, 2014, pp. 191-232; Pinto, Penney, Ligeti, Gower, & Mee, 2010). They also state that exposure to forest fires, floods, natural disasters and storms, coupled with a vulnerable health state such as a chronic condition, pregnancy or co-morbidities, can contribute to increased health risks (Berry et al., 2014, pp. 191-232). Therefore, climate-related health risks vary in prevalence and severity by population subgroups, but also, importantly, intersect and overlap to increase risk for individuals belonging to more than one category. This highlights the urgency to ensure effective communication strategies are employed by public health actors to minimize the health risks associated with our changing environment, particularly for structurally vulnerable populations.

Chapter 2: Literature Review

This section provides an overview of climate change causes and impacts in a Canadian context and elaborates on the critical role of the public health sector in climate change mitigation and adaptation work. It also provides a detailed look at the governance structures within Canada responsible for addressing the health impacts of climate change, from the Federal level down to the local level. There is an overview of the roles and responsibilities for public health actors situated within this study's research setting of Ontario, Canada, as well as insights from past research in this field of work. Finally, the theoretical orientation is provided, and the specific aims of the study are outlined.

2.1 Understanding the Climate Crisis

Over the past 150 years, there has been a dramatic rise in average global temperature that has been in large part due to the release of greenhouse gas (GHG) emissions from industrial processes (NASA, 2020). These gases (such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and water vapour) are composed of molecules that have the ability to trap solar energy from the Sun that would normally be reflected back into space (the "greenhouse effect") (IPCC, 2018; NASA, 2020). Other factors contributing to the greenhouse effect include soot (black carbon), which has two-thirds the impact of most-abundant GHG carbon dioxide, alongside water vapour (Hansen, 2008; Tollefson, 2013). This greenhouse effect has been determined to be the driving force behind rising temperatures, and therefore anthropogenic climate change (IPCC, 2018; NASA, 2020). Per

current estimates, warming of two degrees Celsius above pre-industrial times is expected to occur around 2050 if we continue with "business as usual" with our fossil fuel use; and this warming brings a host of devastating adverse health risks with it (Ebi et al., 2018).

Climate change can be broadly defined as persistent, long-term changes in the average weather of a geographic location (United Nations Framework Convention on Climate Change, 2011). Globally, the geophysical effects of climate change include extreme weather conditions (heat waves and cold weather advisories), changes in annual average rainfall, droughts, melting of sea ice, permafrost and glaciers, rising sea levels, increased frequency and intensity of wildfires and other natural disasters (IPCC, 2018). It is important to note however, that while global average temperatures are rising (IPCC, 2018), local temperatures and weather conditions vary all across the world; this is why climate change "looks different" in different locales. This is due to a multitude of factors, with the most important natural factors being: distance from the sea, ocean currents, direction of winds, topography of the area, distance from the equator and the El Niño phenomenon (UK Environmental Change Network, N.d.). For example, one marked difference across different regions will be precipitation. Rising temperatures will intensify our hydrological cycle, meaning some areas will get more rain, and some will face drought-like conditions (National Oceanic and Atmospheric Administration (U.S. Department of Commerce), N.d.).

2.1.1 Climate Change in a Canadian Context

According to the 2019 Canada's *Changing Climate* report published by the Government of Canada (Cohen et al., 2019, pp. 424–443), Canada's average temperatures increased by 1.7°C from 1948 to 2016, which is double the global average. In the same period, our Northern regions' temperatures increased by 2.3°C, triple the global rate. The report also highlighted the regional differences across Canada which can be summarized as follows: the Arctic regions will face loss of permafrost and sea ice, alongside increased precipitation; the West Coast will encounter increased frequency and severity of droughts in the summer, and increased amounts of snow in the winter due to glacier retreat; the Prairies will be subject to warmer winters and increased severity and duration of droughts; the Atlantic regions will face more erosion of the coast, and increased frequency of intense storms; and Quebec/Ontario will face earlier ice breakup, less snow and more storms and heavy rain (Cohen et al., 2019, pp. 424–443).

These regional changes are directly tied to our current relationship with non-renewable energy sources, whose use leads to a great degree of greenhouse gas (GHG) emissions. In 2018, the majority of Canada's emissions were produced by oil and gas (27.3%) and transportation (24.3%), and only five provinces emit 91% of the country's total GHG emissions; namely, Alberta, Ontario, Quebec, Saskatchewan and British Columbia, respectively (Environment and Climate Change Canada, 2019). It is interesting to note that, despite scientific consensus on anthropogenic climate change, only 60% of Canadians and

the same percentage of Ontarians feel that the Earth is getting warmer partly or mostly due to human activity (Mildenberger et al., 2018).

2.1.2 Health-related Risks of Climate Change in Canada

Alongside with the geophysical changes mentioned, the effects on human health are expansive and urgent. Scientists predict a rise in vector-, water- and food-borne diseases, increase in pests and pathogens with changing biomes, introduction of new infectious diseases and re-emergence of pre-eradicated ones, worsening and lengthening of allergy seasons, and a threat to food security (Berry et al., 2014, pp. 191-232; Watts et al., 2019, pp. 1836-1878). Cardiovascular diseases and issues with kidney function are implicated as well, as extreme heat events exacerbate dehydration alongside increasing risks associated with other pre-existing and chronic conditions (Watts et al., 2019, pp. 1836-1878). Heat stress alone is a pressing issue, as highlighted by the 90 deaths due to the heatwave in July 2018 in Quebec (Woods, 2018). Previous research has concluded that indirect impacts include negative effects on public health resource allocation due to population displacement as a result of wildfires, floods and storms, civil conflict perpetuating environmental racism-based inequities, infrastructure damages affecting the economy, interruptions in health services, agricultural practices which impact food security and nutritional health as well as mental health (Berry et al., 2014, pp. 191-232; Frumkin, Hess, Luber, Malilay, & McGeehin, 2008, pp. 435-445).

Mental health, in fact, has already been measured to be negatively impacted by climate and environmental changes, with studies confirming elevated rates of pre-and-post traumatic stress disorder (Agyapong et al., 2018, p. 345), depression, anxiety suicidal ideation, suicide attempts and death by suicide (Cunsolo & Ellis, 2018, pp. 275-281). Interviews in a 2014 study on long-term exposure to smoke and fire in the subarctic area surrounding Yellowknife found residents expressing themes of isolation, fear, loss of connection to the land, lack of physical activities and a sense of ecological grief (Dodd et al., 2018, pp. 327-337). Eco-grief, was first defined in a 2018 paper as, "the grief felt in relation to experienced or anticipated ecological losses"; the authors claim it will become more common as the environment and climate continue to change (Cunsolo & Ellis, 2018, pp. 275-281).

Another important component to note is that greenhouse gas emissions are not only contributing to anthropogenic climate change but also are the root cause of an immense amount of air pollution that also provides a host of negative health impacts. Air pollution has been shown to directly impact the prevalence of respiratory illnesses (such as asthma and lung cancer), cardiovascular disease (heart attack and ischemic heart disease) and stroke (Berry et al., 2014, pp. 191-232; Health Canada, 2019). In fact, Health Canada estimates that 35 million acute respiratory symptom days, 2.69 million asthma symptom days and 8,000 emergency room visits can be attributed to air pollution yearly, which amounts to an economic impact total of $114 billion annually (Health Canada, 2019). As such, it has been identified as one of the "most important risk factors for premature mortality and non-fatal

health outcomes" (p. 4) and has been estimated to be responsible for 14,600 premature deaths per year nationally, with 6,700 of them being in Ontario (Health Canada, 2019).

2.1.3 Mitigation Versus Adaptation

To best address the climate crisis, the Intergovernmental Panel for Climate Change (IPCC) recommends that all countries continue to "up-scale and accelerate multi-level and cross-sectoral" mitigation and adaptation measures (IPCC, 2018). Notably, the IPCC also mentions in their landmark 2018 report (p.5), that both efforts are needed in conjunction to battle the crisis ahead.

In the context of public health, climate change mitigation efforts are when health sector actors work directly with the energy and environment sectors to reduce emissions (Frumkin et al., 2008, pp. 435-445). Consequently, climate adaptation efforts are where public health sector actors are tasked with health system preparedness in the form of health impact and vulnerability assessments, as well as risk communication and knowledge translation to policymakers and the public, infrastructure planning and risk management strategies (Frumkin & McMichael, 2008, pp. 403-410). While this may initially feel somewhat removed from public health, it is important to remember that there are health co-benefits from these preparations, given the large impact on the health and economic wellbeing of the population (Frumkin & McMichael, 2008, pp. 403-410; Younger, Morrow-Almeida, Vindigni, & Dannenberg, 2008, pp. 517-526).

For example, in the *Ontario Climate Change and Health Vulnerability And Adaptation Assessment Guidelines* (Ebi, Anderson, Berry, Paterson, & Yusa, 2016), the authors highlight an article by Sandink and MacLeod (2009) that outlines differences between mitigation and adaption initiatives in Toronto. Mitigation initiatives, it offers, are sustainable transportation, energy efficiency, renewable energy, and building code changes, to name a few. Adaptation initiatives, on the other hand, include programs to reduce flood risk, increasing smog alerts, help for vulnerable populations during severe weather events, and countering invasive species. They also point out that there is room for overlap, with initiatives such as tree planning, local food production and water conservation, that help in both domains (Ebi et al., 2016). However, as Health Canada outlines in their chapter on *Human Health in Canada in a Changing Climate*, barriers to adaption exist in Canada and one such important barrier is incomplete knowledge of health risks and limited awareness of best adaptation practices to protect health (Berry et al., 2014, pp. 191-232).

2.2 Responsibilities of Federal, Provincial and Local Authorities

In addition to knowledge gaps, at present there is insufficient coordination between the adaptation initiatives undertaken by provinces and territories across Canada. Nationally, the Federal government has outlined commitments surrounding "generating and sharing information, building adaptive capacity and mainstreaming adaptation policies" (Austin et al., 2015, pp. 623-651) in their 2011 Federal Adaptation Policy Framework (Ford, Smith, & Berrang-Ford, 2011). More recently, they have committed to the Pan-Canadian Framework on Clean Growth and Climate Change (Environment and Climate Change Canada, 2016),

and this outlines that they will be responsible for developing and maintaining industry emissions and fuels standards, working to innovate and create clean energy jobs and technology, implementing carbon-pricing alongside improving the energy efficiency of buildings, reducing the emissions from the transportation sector by investing in zero-emissions vehicles, public transit and a clean fuel standard and increasing land and marine conservation efforts. Importantly, they commit to helping provinces and territories "translate scientific information and Traditional Knowledge into action by establishing a Canadian centre for climate services and by building regional capacity and adaptation expertise" in an effort to support adaption and build climate resiliency (Environment and Climate Change Canada, 2016, p. 7). Consequently, at a provincial level, the Ontario government is responsible for air quality, implementing emissions-reductions programming, maintaining vehicle emissions testing, better land use planning to promote active and public transport, and funding municipal efforts to reduce emissions, among a few others (Austin et al., 2015, pp. 623-651).

Locally, from a municipal perspective, the adaptive measures vary substantially between municipalities with many municipalities working with their region's public health unit and other relevant departments to create climate action strategies (Coningsby & Behan, 2019). Importantly, there a great need to focus on efforts at this local scale because identifying health threats, creating adaptive measures and assessing for vulnerability amongst sub-groups happens at this level (Frumkin et al., 2008, pp. 435-445). In the context of local public health,

there are 35 health units distributed across Ontario that work either under a municipality or regional government, or independently to ensure the health and wellbeing of the people living within their health region. According to Cardwell & Elliot (2013), a locally-oriented public health frame "would be useful to link climate change risks to local health impacts" (Cardwell & Elliott, 2013, p. 10). This would aid in contextualizing the issue as a "current and local threat", which is most conducive towards eliciting mitigative and adaptive changes in that local population (Cardwell & Elliott, 2013, p. 10). To this effect, Ontario public health units are well-positioned to address the needs of people living within their health regions. They have the ability to impact climate-sensitive health outcomes as they can provide valuable insight into both the vulnerability of communities and the most fitting adaptation strategies (Paterson et al., 2012, p. 452).

Despite this however, the introduction of climate change into Ontario public health unit programming and education responsibilities is quite novel, as compared to in health-adjacent sectors, such as urban planning, emergency management, water and utilities, conservation and social work (Paterson et al., 2012, p. 452). It was only in 2018 that the Ministry of Health updated the Ontario Public Health Standards to include climate change as being within the functions and responsibilities of public health units in Ontario (Minister of Health and Long-Term Care, 2018). As such, further research upon the impact of this mandate upon the Ontario public health units' activities is required, as no studies have yet elaborated upon if this was an effective means to enhance the sector's response to climate change.

2.3 Implementation of Climate Adaptation and Mitigation Strategies

There have been several findings from previous research in this field that have helped in informing this study. According to a 2009 report by researchers at Health Canada (Berry, Clarke, Pajot, Hutton, & Verret, 2009), a key area needing further assessment is public health actor and policymaker knowledge, attitudes, and behaviours with respect to climate change. To this effect, a 2019 study found that the prerequisites for enhancing effectiveness of climate adaptation and mitigation strategies includes policy makers' and health sector actors' understanding of the links between climate change and health, caring about the issue, having the capacity of influence policies and programming, and possessing the political will to commit to resources on this issue (Ebi et al., 2019). Moreover, in the context of Ontario's public health sector, a 2018 vulnerability assessment concluded that health units needed to better understand climate literature, models and that there needs to be increased mentorship from experts to support evaluations (Levison et al., 2018). The researchers state that this would require public health actors to develop and regularly implement a "climate lens" or "climate-in-all-policies" approach, which would aid in ensuring that climate-related adaptation is integrated in all relevant programming and policies (Levison et al., 2018). This would mean, for example, considering the intersecting impacts of climate change on issues such as chronic diseases, food and water security, accessibility to housing, and other social determinants of health beyond just the impacts of heat waves and pollution which are most commonly associated with climate change (Berry et al., 2009). This approach would require an understanding of not only the social determinants of health, but also knowledge on the

causes and impacts of climate change (Chowdhury, Haque, & Driedger, 2012, pp. 149-168). Altogether, much of the literature in this field has identified that more research is needed on the role that public health actors' knowledge, understanding, perception and attitudes on climate change plays towards influencing the implementation and prioritization of climate action strategies in the public health sector.

2.3.1 Theory of Mental Models

This study used the Theory of Mental Models (TMM) to inform the approach taken to investigate public health actors' knowledge, understanding, perception and attitudes on climate change. TMM is a broad socio-cognitive theory that recognizes role of "social context, personal situation, and affective influences" (Westbrook, 2006) in shaping one's worldview which informs how they "infer relationships, predict outcomes, understand the systems they encounter, determine a course of action, control that action, and experience events "by proxy"" (Johnson-Laird, 1983). This theory is useful because it helps to identify aspects of individuals' worldviews that influence their decision-making. In this study, this approach also helps to illuminate values, motivations and beliefs that are common amongst those that do see recognize the urgency and importance of climate change work versus those that do not, and it offers insight into why this might be. The theory can be adapted to a methodological approach used to elucidate the knowledge structures present, determine what the understanding of an issue is by a person or group and determine how they perceive risks (Morgan, Fischoff, Bostrom, & Atman, 2002). Since individuals of the same background are more likely to share common goals and social influences that inform their sense-making and

logical reasoning processes, for studies with a homogenous study population, it is possible to create a mental model representative of the entire sample to draw conclusions about it (Westbrook, 2006).

A further motivation for choosing this theory stems from its use in prior public health and climate change research. Notably, TMM has been used to perform assessments for the effectiveness of risk communication strategies (Morgan et al., 2002). To do so, one first creates an expert model using literature to set the baseline of knowledge for an "expert model" (Morgan et al., 2002). Then, one conducts semi-structured interviews with experts to elicit their knowledge, understanding, beliefs and perceptions about risk associated with the topic in focus (Morgan et al., 2002). Following that, through the use of surveys and/or focus groups with a target audience, researchers can create a "public model" (Morgan et al., 2002). When researchers compare the two models, they are able to determine differences in perception between the final "expert model" versus the model held by their target audience (Wong-Parodi & Bruine de Bruin, 2017, pp. 1369-1386). This approach was used in a 2012 paper by Chowdhury and colleagues to look into public health authorities' knowledge, beliefs and understanding of heat waves in Manitoba, and compare them to Manitobans' understanding to determine knowledge gaps and areas for improvement of messaging (Chowdhury et al., 2012, pp. 149-168).

In this research thesis, only the expert model was elucidated because the focus was solely upon determining which factors were most strongly associated with increased perceived risk and prioritization of climate change-related work amongst the study population of individuals employed within the Ontario public health sector.

2.4 Risk Communication

In terms of risk communication, Frumkin and McMichael (2008) state that knowledge translation gaps may exist due to political and economic conflicts of interests and failure of science to "meet [the] evidence needs of local policy-making contexts" (Frumkin & McMichael, 2008, pp. 403-410). However, more research on public and policymaker knowledge, attitudes, and behaviours with respect to climate change is needed to inform how to improve the effectiveness risk communication on this topic with the general population (Frumkin et al., 2008, pp. 435-445).

2.5 Organizational and Behavioural Barriers

Beyond the influence of individual public health actors' knowledge, understanding, attitudes and beliefs, there are structural and systemic barriers hindering meaningful progress for climate change-related health work in the public health sector as well. In a study where Paterson and colleagues (2012) interviewed both Ontario public health and health-adjacent sector authorities, they found that key enablers for supporting adaptation efforts included, "political will, inter-agency coordination and local leadership", particularly support from non-public health municipal actors such as the city councillors. By contrast, barriers noted by

public health sector actors included the difficulty in communicating and establishing a link between climate change and health, alongside short-term funding and political terms inhibited sustainable actions (Paterson et al., 2012, p. 452).

2.6 Specific Aims

The specific aims of this research are:

1. to understand knowledge, understanding, perception and attitudes of public health actors regarding climate change and environmental degradation, with a focus on the health impacts;
2. to document ongoing, anticipated, and proposed mitigation and adaptation actions taken by Ontario's public health units to mitigate the health risks of climate change as well as factors impacting the prioritization of this work within that setting; and
3. to investigate who is involved in the process of developing and implementing risk communication strategies for climate-related health risks, what these communications look like, current challenges that limit the effectiveness of these communications, and the extent to which they are framed in a locally contextualized manner.

Secondary Aims included further elaborating upon the organizational and behavioural barriers towards meaningful climate action in the Ontario public health sector. It was anticipated that this would mean differentiating between the roles and responsibilities of local, provincial, federal and non-governmental public health actors who are involved in local environmental governance and climate change-related risk communication. It was also

anticipated that this study's findings would capture the challenges they encounter that hinder their ability to facilitate effective health promotion campaigns on climate change-related health risks. Finally, it was anticipated that this study would provide insight on current strategies being used to address climate change at the local level and help in mapping out the various leverage points which may inform better policies and practices to further meaningful climate action both in and beyond Ontario.

Chapter 3: Methods

This section provides an overview of the ontological, epistemological and theoretical orientations of this research and outlines all the processes, decisions and techniques used to elicit data, from recruitment to data analysis. It also describes the ways in which we endeavored to maintain qualitative rigour throughout the study.

3.1 Research Time Frame, Setting and Design

This study was proposed in December 2020, with recruitment, data collection and analysis beginning in March 2021 and continuing till June 2021. Unfortunately, this coincided with the vaccine rollout period of the COVID-19 pandemic which, given the dire public health implications, had a significant impact upon this study's research design. The initial research design included using purposive sampling, with the intention of recruiting employees from each of the Ontario public health units to elucidate their mental models in the context of climate change and to discern their units' climate change mitigation, adaptation and risk communication strategies. However, the COVID-19 pandemic had a large impact upon that sample strategy as most public health sector actors were redeployed to focus on the COVID-19 vaccination rollout and were unable to participate, including much of senior leadership. Moreover, those that were not specializing in climate change-related work, who would be important towards ensuring a representative sample for the study population's mental model, as well as those working at resource-scarce and/or under-staffed units located in "hot spot" regions with high COVID-19 caseloads were also especially unable to participate in this

study. As such, the study was re-designed early on to use a grounded constructivist approach to instead iteratively recruit participants who could be considered “key informants”. Consequently, individuals in this study were recruited regardless of their current employment at a health unit, as long as they could provide insights on the study’s three primary Aims broadly as well as the Secondary Aims.

3.1.1 Modified Constructivist Grounded Theory Approach

This study’s general research design adopted methodological tools from constructivist grounded theory. Grounded theory research studies actions and meanings and shows how they are connected, with the goal of understanding the research participants’ experiences and perspectives (Charmaz & Thornberg, 2020, pp. 1-23). Therefore, this methodological approach is well aligned with the researcher’s intention of centring of the experiences and perspectives of the key informants and using narrative style thematic analysis to explain the observed phenomena in the context of the public health sector. Broadly, research designs using constructivist grounded theory include the forming of the research questions, theoretical sampling, data collection, initial coding, focused coding and categorization, theory building and then the writing up of the findings (Miles, Huberman, & Saldana, 2020). Importantly, theoretical sampling is when choices of participants and interactions are driven by the researcher’s early analyses through the development of initial codes and ideas (Charmaz & Thornberg, 2020, pp. 1-23). This iterative process encourages the recruitment of individuals to support or disconfirm findings as one generates theory (Charmaz, 2006).

While this research did not initially set out to generate a theory, through this iterative process, a conceptual framework summarizing the power, knowledge and responsibilities, as well as direct and in-direct leverage points for progressing climate action within the public health sector was generated (Appendix E). This conceptual framework also served to summarize the boundaries of the field in relation to what constituted a "key informant" in the Ontario public health sector within the context of this study (Appendix E). Per the recommendations of Miles and Colleagues' (2020), this conceptual framework was developed beginning when data collection began through open-ended, semi-structured interviews. The first two participants in the study were former public health unit employees who now worked in the climate change and public health advocacy space and in the federal level at Health Canada, respectively. The third participant was a current public health unit employee recruited, and these three interviews provided great insight to form the foundation of the conceptual framework, which continued to be updated until data collection ended. Alongside these efforts, memo-writing and constant comparisons between the data being collected contributed to the development and revisions of the coding system (Miles et al., 2020). Moreover, increased knowledge of the field prompted changes to the questions asked to the participants in the open-ended, semi-structured interviews (Charmaz & Thornberg, 2020, pp. 1-23). These processes are all tools derived from constructivist grounded theory and they contribute to the quality of the research and increase the trustworthiness of the research design, and findings (Charmaz & Thornberg, 2020, pp. 1-23).

3.1.2 Study Population

Health units (Figure 3.1) had been identified in the *Ontario Climate Change and Health Vulnerability And Adaptation Assessment Guidelines'* recommendations for whom to include as stakeholders at the local level, in vulnerability assessments in Ontario, as they have an impact on climate-sensitive health outcomes (Ebi et al., 2016). However, once the study population was broadened to consist of "key informants", it was inclusive of people with experience working in the public health sector in Ontario generally. This encompassed employees at any of the 35 local Ontario public health units, as well as individuals working within the public health sector federally, provincially or municipally through the government, or at non-governmental agencies such as Canadian Public Health Agency, Ontario Public Health Agency as well as environmental health and climate change advocacy groups. Many participants coincidentally had past or present experiences working at health units, however. As such, in the Results chapter there is a summary of the representation of health units across the sample, from participants who could speak to health unit activities from their professional experiences.

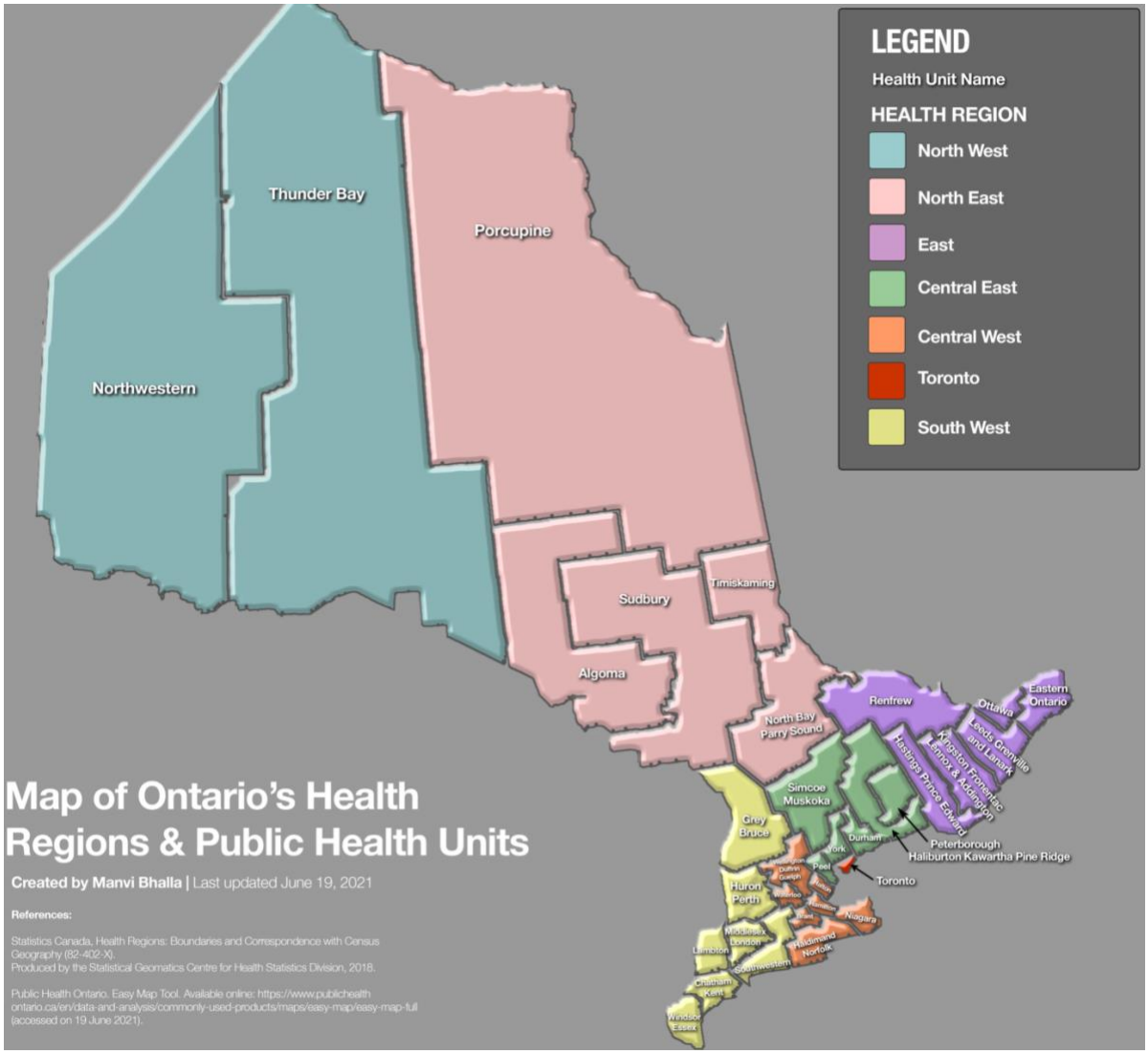

Figure 3.1: Map of Ontario's Health Regions and Public Health Units

3.1.3 Research Setting and Recruitment

Initially, for the purposes of purposive sampling, each health unit was sent recruitment materials (list in Appendix D) using their online web-form, public email addresses, and through professional networking. To formalize the boundaries of the sub-regions in Ontario,

the researcher referred to the various ways that the Ontario government divides Ontario in the context of public health units and the jurisdictions they oversee. In 2006, the Ontario Government mandated that the public health units coordinate their efforts within 14 local health integration networks (LHINs). As such, the public health units are distributed under these 14 regions on the Government of Canada's website (see Appendix D). As of 2019, the 14 LHINs were further condensed down to five transitional regions (see Appendix F). The goal was to have representation from each of the five LHINs (from the 2019 distribution).

However, many public health units were overwhelmed with communications concerning the pandemic during this time period, and many outright declined to participate till the following year. With the transition to a more grounded approach influenced by the reality of the pandemic, the recruitment based on distribution across Ontario was relaxed. Several known professional networks to individuals working at environmental health agencies such as the Ontario Public Health Association, Canadian Association of Physicians for the Environment and the Environmental Noxiousness, Racial Inequities & Community Health (ENRICH) Project, alongside those with academic institutional affiliations. These people were utilized to maximize response from prospective study participants. Incidentally, the key informants were well distributed amongst each of the five health regions, as shown in the Results chapter. This helped to reflect different experiences across the various geographies of Ontario. The anticipated number of interviews with key informants was 15 to 20, with recruitment continuing until saturation of themes was reached; this occurred at 17 interviews.

3.2 Qualitative Data Collection

Following ethics approval, the semi-structured interviews were scheduled directly into the primary researcher's calendar via calendly.com by prospective participants, after written consent was provided. Semi-structured interviews were chosen to be the data collection tool because they were recommended for both the mental models approach (Wong-Parodi & Bruine de Bruin, 2017, pp. 1369-1386) and are frequently used in constructivist grounded theory-informed research as well (Miles et al., 2020). If written consent was not provided prior to the interview, verbal consent was obtained prior to the commencement of the formal interview at the scheduled interview time. Interviews were conducted using Zoom, WebEx, or Microsoft Teams, per the preference of the interviewee and recorded with participant permission. The interviews were between 45 to 95 minutes, with an average interview time of approximately one hour.

3.2.1 Interview Guide

The interview guide (Appendix J) was informed in part by the Theory of Mental Models (Westbrook, 2016, pp. 563-579), in order to elicit insights regarding participants' knowledge, understanding, perceptions and attitudes with respect to climate change. The questions added for this purpose were informed by a literature review on the definition, causes and impacts of climate change. The responses to these questions can be analyzed for frequencies of mentions and commonalities/ differences, with more complex analyses looking at patterns within frequencies as well as content and accuracy of statements to derive deeper meaning. (Morgan et al., 2002).

Additional questions were also added to the interview guide regarding prioritization of climate action in health units/ progress on adaptation and mitigation strategies (Aim Two) as well as questions to discern information about risk communication materials (Aim Three) and broader, open-ended questions were included to elucidate more upon the barriers and enablers for climate action work within the public health sector (Secondary Aims). These open-ended questions were often adjusted throughout the interview process as informed by ongoing concurrent data analysis, field notes/ analytic memos, and new participant interview data (Miles et al., 2020). Demographic information including self-identified age, gender identity, educational background, professional experiences, immigration status, and race/ethnicity were also collected in the interviews. The demographic data being collected has significance because there has been discourse in the climate change community about the importance of increased diversity and representation in environmental governance, as a means of better informing mitigation and adaptation actions (Jones, 2020; Poitevien, 2020).

3.2.2 Field Notes and Analytic Memos

At key decision-making points, either during or immediately following each interview, field notes were taken, which were processed during the data collection and analysis stages to solidify key insights and to later aid in conceptualizing "core concept" themes (Miles et al., 2020). The contents of these field notes often included observations such as words/ concepts that were repeated frequently and/or that which the interviewee put additional emphasis upon, the attitude of interviewee throughout the interview in both verbal communication and emotional expression as well as thoughts informing future research directions (Birks,

Chapman, & Francis, 2008, pp. 68-75). For example, decisions were made regarding probing questions and further customization of the survey instrument (interview guide) based on increased knowledge of the field, both on the public health sector in Ontario broadly and of climate-health policies/mandates through the first five interviews. Different professional backgrounds recruited based on theoretical sampling also brought in novel perspectives and this led to a number of new questions revolving around the organizational structure of the public health unit in relation to the regional government. This aspect was not originally an area of focus to the researcher prior to the commencement of this study, as it is not frequently discussed in past literature as being important towards progressive climate action in the sector, however this line of questioning was found to resonate with all of the participants; many often even remarked, "good question". There was also an increased focus on individuals with specialized knowledge and people in positions of power to identify key leverage points for systemic change, as well as sources of funding, accountability and conflicts of interest in the context of barriers and enablers.

Journal-style entries were also commonly made throughout the study to maintain reflexivity in interpretations as well as "methodological self-consciousness" to ensure decisions made were considerate of personal worldviews and biases (Birks et al., 2008, pp. 68-75). Additional more casually formatted notes were gathered in a dedicated notebook with topic and date headers to reflect knowledge gained about the field through interviews and through conducting concurrent literature/document reviews (Miles et al., 2020). These were fruitful in

providing the necessary background knowledge to understand terminology, organizational structure and political frameworks that were frequently referenced by key participants in interviews. An example of this would include documenting the differences in the responsibilities of varying senior leadership positions (e.g., managers vs. directors vs. Medical Officers of Health) as well as employees of different divisions (e.g., epidemiologists versus health promoters) within public health units; each of these individuals also had a specific area of focus and this was often referred to as one's "portfolio". In consequent interviews, the correct terminology was used, and it was found to help elicit more detailed and impactful responses from interview participants.

During the data analysis, field notes reviewed, cleaned up and re-organized, and processed field notes were considered analytic memos (Gale, Heath, Cameron, Rashid, & Redwood, 2013). These were very helpful during the latter part of the analysis to find connections between recurring patterns amongst themes and sub-themes and to develop policy recommendations from such observations.

3.3 Data Analysis

Interviews were transcribed verbatim using the audio recordings, anonymized to remove any identifying info, and upon completion of analysis, the audio recordings were deleted. The transcripts were analyzed using combined deductive and inductive thematic analysis. Thematic analysis is used identify and elaborate key findings in a manner which summarizes "variations and regularities" in the results (Green & Thorogood, 2018, pp. 249-283).

Thematic analysis (Braun & Clarke, 2006, pp. 77-101) was chosen for this study because it was deemed the most appropriate to capture the full richness of the data (Green & Thorogood, 2018, pp. 249-283) both from the perspectives of the constructivist grounded theory approach (Braun & Clarke, 2006, pp. 77-101) and for practical applications of the theory of mental models (Morgan et al., 2002). The qualitative analysis tool, NVivo 12, alongside Microsoft Word and Microsoft Excel (Ose, 2016, pp. 147-162) were used throughout the analysis process.

3.3.1 Initial Coding

First cycle, initial line-by-line coding consisted of inductive thematic coding of the first three transcripts to distil common themes (Miles et al., 2020). These themes were binned into one of the deductive categories informed by the three aims of this study (sense-making, behaviour and risk communication), or were grouped with similar themes into inductively-generated categories to be further elaborated upon in second cycle, focused coding (Miles et al., 2020). It was anticipated that there would be data points for the deductive categories, particularly sense-making, because questions informed by the theory of mental models were included in the interview guide to elicit responses for this purpose.

3.3.2 Inter-rater and Intra-rater Analyses

After the initial coding was complete and a preliminary coding scheme was developed, the researcher shared this codebook and coding instructions with an experienced qualitative researcher, who acted as a second coder for this study. Key benefits of doing inter-and intra-

rater analyses are noted to be that they improve the "systematicity, communicability, and transparency of the coding process" (O'Connor & Joffe, 2020) while also promoting reflexivity and thereby increasing the trustworthiness of the research.

The coding instructions (Appendix M) were discussed until both coders had the same understanding of the process. Following this, they both coded randomly chosen, clean (as in un-coded) transcripts which comprised roughly 10% of data (2 of 17 transcripts is 11.8%). These decisions were informed by the acceptable standard in qualitative methodology literature (O'Connor & Joffe, 2020), as well as in the context of mental models-informed work, which recommends that two or more people should follow same written coding instructions to independently code a matching set of transcripts and compare them (Morgan et al., 2002). If the resulting comparison between two coders is the same approximately two-thirds of the time, it will likely yield reproducible results (Morgan et al., 2002).

Consequently, to calculate the amount of agreement between the two coders, the following formula by Miles and Huberman (1994) was used: *(# of agreements)/ (# of agreements + # of disagreements) x 100%* . Similarities and differences between the two coders were measured to the sub-theme level; to be considered a similarity, it had to be the same theme and sub-theme on the same (general) quote. Additional or ambiguous coding was marked for discussion and led to generation of new categories, re-categorizations or clarifications about classification, so discussed tags were not included in the calculation. Differences were also

discussed, and changes were recommended if relevant. The full inter-rater reliability analysis including all discussions, changes made, and calculations of the percent agreement between the two coders is available in Appendix N. Miles and Huberman (1994) recommend that an acceptable standard is 80% agreement. The overall inter-coder reliability was calculated to be 83.4%, which met and exceeded this standard.

A similar process to the one above was completed to determine the intra-rater reliability (Miles & Huberman, 1994). For this, the primary researcher coded a transcript using the preliminary coding scheme, and then coded the same transcript again one week later. Using the same formula, an intra-rater reliability score of 86.4% was determined. After the codebook had been fully revised, the primary researcher began the second cycle, focused coding, and coded the remainder of the data.

3.3.3 Focused Coding - Deductive

Corresponding to the three specific aims of this study, the Aim one questions in the interview guide are centred around determining the social context, personal experiences, affective influences and knowledge structures (Westbrook, 2016, pp. 563-579) of public health actors. The Aim Two questions are centred around identifying underlying assumptions (i.e., values/attitudes/beliefs) that inform their behaviours and decision-making with implications upon the prioritization of climate change-related work in the public health sector. Finally, the Aim three questions were centred around comparing the need, production, and use of risk communication materials. The major deductive categories created to correspond to these

aims in the codebook were “sense-making”, “behaviour”, and “risk communication” (see full codebook in Appendix O). The deductive analysis was supported by emotion, value, and evaluation coding with descriptive or in-vivo sub-codes (for Aims one to three respectively) (Miles et al., 2020).

3.3.4 Focused Coding - Inductive

The inductive analysis relied on conceptual coding for any “emerging” themes which were common amongst the interviews. These inductively determined themes often provided insights into the Secondary Aims of this study, surrounding organizational, institutional and behavioural barriers and enablers for climate action within the public health sector.

3.4 Research Credibility

3.4.1 Ethics

Ethics approval was obtained from the University of Waterloo’s Research Ethics Board prior to commencement of the research activities (Appendix L). Ethics documents included four (4) recruitment posters that broadly characterized the different types of people who would be considered key informants for this study based on a review of relevant literature (Appendix B), recruitment email templates (Appendix C), a list of public health units in Ontario with their official websites (Appendix D), a letter of information for prospective study participants (Appendix G), consent forms (Appendix H and I), the semi-structured interview guide (Appendix J) and the statement of appreciation for study participants following their interviews (Appendix K).

3.4.1.1 Maintaining Anonymity and Confidentiality

Anonymity and confidentiality were maintained to the best of the research team's abilities by storing audio recordings, field notes and transcripts on locked device, removing identifying information from transcripts immediately after transcription, providing opportunity for key informants to remove themselves from the study up to two weeks after their interview, and ensuring anonymity in reporting of results, including using univariate tables to report participant sample characteristics.

3.4.2 Rigour

Field notes and analytic memos (Birks et al., 2008, pp. 68-75) were used to inform data collection for the duration of the study. In particular, the development of the conceptual framework (see Appendix E) and subsequent adjustments to the semi-structured interview guide were made throughout the concurrent recruitment, interview, and preliminary data analyses processes to ensure emerging concepts were flexibly investigated. As aforementioned, inter- and intra-rater reliability scores were calculated and met the recommended criteria. Reflexive field notes were extensively used and documented throughout this work and trustworthiness of sample was demonstrated through the use of theoretical sampling (Charmaz & Thornberg, 2020, pp. 1-23) until saturation. This was achieved when by no new properties or characteristics of the categories (outlined in the conceptual framework) were found with subsequent participants (Charmaz & Thornberg, 2020, pp. 1-23; Miles et al., 2020). Beyond these measures, Braun and Clarke (2019, pp. 1-2)'s checklist for editors and reviewers of manuscripts was referenced to assess quality of

thematic analysis. Braun and Clarke popularized thematic analysis through their work (Braun & Clarke, 2006, pp. 77-101), and have significantly contributed to the literature on quality assurance techniques for this analytic technique (Braun & Clarke, 2019, pp. 589-597). In addition to this checklist, Miles and colleagues' (2020) chapter on rigor in qualitative data analyses was also referenced and their reference chart was used to ensure additional considerations for quality of research were embedded into the research design and analytic techniques (pp. 289).

3.4.3 Reflexivity

I believe anthropogenic climate change, according to both western institutional and Traditional Knowledge, is impacting our way of life and our viability as a species. Thus, the climate crisis *is* a public health crisis now and in years to come. Moreover, when I work in both academic spaces and the voluntary sector, I use an intersectional lens (Crenshaw, 1989) to acknowledge and address the health inequities experienced by oppressed, underserved and/or structurally vulnerable communities. To me, to advocate for climate action means to address societal inequities determining health outcomes alongside mitigation and adaptation efforts. This is referred to as climate justice; an approach which underlines that those who already face disproportionately higher health risks due to a variety of systemic factors are the ones who face the gravest negative impacts associated with the climate crisis (Watts et al., 2019, pp. 1836-1878). Overall, in my worldview, climate justice is both personally meaningful due to my positionality (see Appendix A) and is critical public health work. However, throughout this study, I acknowledged where my academic viewpoints and

personal beliefs influenced the research. During data collection and analysis, I purposefully kept my opinions and perspectives to myself and practiced active listening to ensure that the participants' opinions and worldviews could be most accurately and efficiently captured (Wong-Parodi & Bruine de Bruin, 2017, pp. 1369-1386).

Chapter 4: Results

The results section presents the study sample, and then organizes the findings into five sub-sections titled to reflect the overall category that the themes and sub-themes were organized into. The first deductive category, "Sense-making" is directly informed by the theory of mental models which provides insights into how knowledge, understanding and perception interact to influence one's viewpoint of an issue (Aim one: to discern knowledge and understanding gaps); this also bears some impact upon the consequent decision-making and prioritization of climate change in public health work, reflected in the second deductive category, "Behaviour" (Aim Two: proposed and/or ongoing local mitigative and adaptive efforts). The third and final deductive category, "Risk Communication" summarizes the findings associated with communication materials produced from a public health perspective on the topic of climate-related health risks (Aim Three: need, use and production of risk communication strategies). Categories four and five discuss inductively determined themes that speak to organizational and institutional barriers and enablers towards effective implementation of climate action strategies across the Ontario Public Health Sector (Secondary Aims: organizational and behavioural barriers). For a select number of results, frequencies for themes are presented in this chapter; however, a comprehensive frequency table corresponding to the results to the sub-sub theme level is available in Appendix P.

4.1 Overview of Study Sample

This research interviewed a total of 17 public health actors. For anonymity purposes, the number of staff (present or former) associated with specific public health units that participated cannot be identified, so the regions within which unit(s) that these key informants worked, or previously have worked at, are represented in percent form in Table 4.1. Individuals were often asked to elaborate extensively on their professional experiences during the interview to discern their roles/ responsibilities and affiliations within the public health sector. If individuals had experience working at more than one health unit, each of the health units they could confidently speak to are included here and counted as represented. Individuals from Federal and Provincial Public Health Agencies, as well as those with relevant environmental health agencies, organizations, and advocacy group affiliations were also represented in the sample. All but one participant also had experience working directly at a public health unit, but all had experience working with public health units. Notably, all of the 2019 LHINs were represented in the sample.

Table 4.1. Health Regions in Ontario Represented in Sample

LHINs (2019)	% Represented	LHINs (2006)	% Represented	Public Health Units in these Regions
West	31.3%	Erie St. Clair	0.00%	Chatham-Kent Health Unit
				Lambton Health Unit
				Windsor-Essex County Health Unit
		South West	20.0%	Middlesex-London Health Unit
				Grey Bruce Health Unit
				Haldimand-Norfolk Health Unit

				Southwestern Public Health
				Huron Perth Health Unit
		Waterloo Wellington	33.3%	Wellington-Dufferin-Guelph Health Unit
				Grey Bruce Health Unit
				Region of Waterloo, Public Health
		Hamilton Niagara Haldimand Brant	20.0%	Brant County Health Unit
				Hamilton Public Health Services
				Halton Region Health Department
				Haldimand-Norfolk Health Unit
				Niagara Region Public Health Department
Central	77.7%	Central West	50.0%	Wellington-Dufferin-Guelph Health Unit
				Toronto Public Health
		Mississauga Halton	66.7%	Peel Public Health
				Halton Region Health Department
				Toronto Public Health
		North Simcoe Muskoka	50.0%	Simcoe Muskoka District Health Unit
				Grey Bruce Health Unit
		Central	100.0%	York Region Public Health Services
				Toronto Public Health
Toronto	100.0%	Toronto Central	100.0%	Toronto Public Health
East	50.0%	Central East	50.0%	Peterborough Public Health
				Haliburton, Kawartha, Pine Ridge District Health Unit
				Toronto Public Health
				Durham Region Health Department
		South East	50.0%	Hastings and Prince Edward Counties Health Unit
				Leeds, Grenville and Lanark District Health Unit
				Kingston, Frontenac and Lennox & Addington Health Unit
				Haliburton, Kawartha, Pine Ridge District Health Unit

		Champlain	50.0%	Leeds, Grenville and Lanark District Health Unit
				Eastern Ontario Health Unit
				Ottawa Public Health
				Renfrew County and District Health Unit
North	100.0%	North East	100.0%	Northwestern Health Unit
				Timiskaming Health Unit
				North Bay Parry Sound District Health Unit
				Algoma Public Health Unit
				Sudbury and District Health Unit
				Porcupine Health Unit
		North West	100.0%	Northwestern Health Unit
				Thunder Bay District Health Unit

LHINs' 2006 regional distributions are used only as a point of reference for a more detailed commentary on the representation offered within the sample. From the 2006 configuration, only one region had no participants represented in this sample, Erie St. Clair, as visualized in Figure 4.1. Notably, Northern Ontario was well represented in this work, perhaps in-part, speaking to the degree to which Northern Ontario public health units were impacted by the burden of the COVID-19 pandemic at the time, as compared to regions in central Ontario who consistently had higher COVID-19 caseloads.

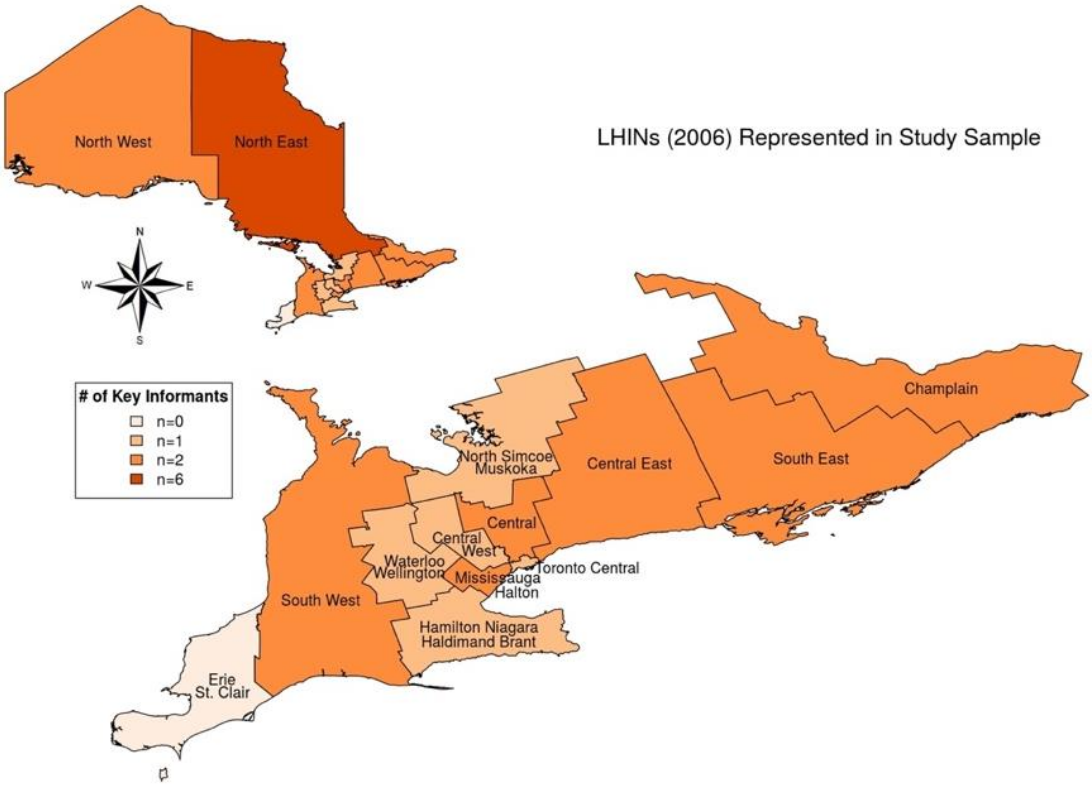

Figure 4.1. Local Health Integration Networks (LHINs) (as of the 2006 divisions of regions), represented in this study, including number of participants representing each region.

Additional demographic information about the participants is summarized in Table 4.2. Notably, there was only one non-white participant, only one new immigrant and one individual under 30 years of age. All participants had post-secondary education.

Table 4.2. Study Sample Characteristics (n=17).

Characteristic	**# of Participants (% of Sample)**
Age	

Mean: 47.8; **Median:** 47; **Mode:** 57	
Under 30	1 (5.9%)
31-35	1 (5.9%)
36-40	3 (17.6%)
41-45	1 (5.9%)
46-50	4 (23.5%)
51-55	2 (11.8%)
56-60	3 (17.6%)
61-65	2 (11.8%)
Gender Identity Most people referred to their sex instead of their gender when answering so "female" was interpreted as "woman" and "male" was "man" in this context.	
Woman	9 (52.9%)
Man	8 (47.1%)
Non-binary/ Third gender	0 (0.00%)
Race/ Ethnicity These are self-identifications. Many white individuals referred to themselves as "Canadians" and "Caucasian" to allude to white/ European descent.	
White	16 (94.1%)
Non-White (identified as South Asian)	1 (5.9%)
Immigration Status	
Born in Canada	14 (82.4%)
Canadian citizen, immigration unknown	2 (11.8%)
Immigrated to Canada in past 30 years	1 (5.9%)
Educational Background Individuals often had more than one degree and sometimes more than one of the same degree types. Lists indicate majors/ foci.	
Bachelor's degree	17 (100.0%)
Environmental Studies, Biomedical Science, Health Promotion, Kinesiology, Applied Science, Psychology, Women's Studies, Political Science, Business Management, Science, Chemistry, Microbiology, Intercultural Education/ Sociology, Oceanography	
Master's degree	11 (64.7%)
Health Science, International Development, Business Administration, Rural Extension Studies, Public Health, International Communications, Environmental Studies, Political Science, Epidemiology	
Doctorate degree	2 (11.8%)
Political Science	
Professional Degrees	1 (5.9%)
Medical Doctor	
Certifications and Programs	5 (29.4%)
Environmental Management, Public Health Inspector, Public Health/Preventative Medicine	
Key Informant Type Some individuals counted for more than one, given many have held multiple roles in different agencies/ institutions over their careers. Health Unit Staff includes employees not in senior level leadership positions (manager, director, Medical Officer and/or Board of Health), and includes Project Officers, Health Inspectors, Policy Analysts, Epidemiologists and Health Promoters.	

Ontario Health Unit	16 (94.1%)
Staff	15 (88.2%)
Manager	5 (29.4%)
Director	2 (11.8%)
Medical Officer of Health	1 (5.9%)
Federal Health Authority	2 (11.8%)
Health Agency (e.g., CPHA, OPHA)	3 (17.6%)
Health Advocacy Group/Organization	2 (11.8%)

4.2 Aim 1: Sense-making

Sense-making is a major category because it is the core concept behind the Theory of Mental Models; it broadly means the way about which we assign meaning to concepts. To fulfill this aim, interview guide questions informed by Theory of Mental Models approach and literature were used to elicit information surround the deductive themes of knowledge, understanding and perception. Public health actor attitudes were addressed in Aim 2: Behavior as its themes aligned better with the beliefs and values discerned through this work.

4.2.1 Knowledge

In this study, knowledge is defined as any information held about the topics being discussed from any acquisition source, including experiences and formal education.

4.2.1.1 Specialized knowledge of Public Health Actors

Individuals were asked how they would define climate, if there were differences between climate change and global warming and if they thought climate change poses big health risk where they live. They were also asked about factors they thought that have the ability to

impact the health of individuals and of a community. The results are summarized in Table 4.3.

Table 4.3: Knowledge, Understanding and Perceptions of Climate Change Held by Public Health Actors.

Causes	**# of Participants**
Caused by warming of Earth/ global warming due to greenhouse gas emissions inducing weather pattern changes and causing more extreme weather	7
Atmospheric process where greenhouse gases in increasing concentrations in the atmosphere increasingly retain heat leading to increased temperatures	3
General pattern of changing climate (i.e., variable weather not just global warming) exacerbated by greenhouse gas emissions which causes extreme weather	2
Direct result of the release of greenhouse gases from human activities since the Industrial Revolution/ at an accelerating rate in recent decades, which has led to the general warming of our planet	3
Multiple factors come into play to cause extreme temperature events and extreme weather, including pollution and the way we live right now	2
Shift that is happening in our lifetime to the weather patterns seasonally each year	3
Human emissions-induced climate change accelerates the natural ecological cycle and increases severity/ risk	3
Couldn't provide a definition	2
Impacts	**# of Participants**
Erratic weather patterns	3
Global impact on human life	2
Going to impact everything on Earth and touches every aspect of life	2
Slow insidious changes	2
Impact differs depending on region	5
List of health impacts	4
Shorter/ warmer winters	2
More bacteria being able to survive in our environment	1
Impacts above and beyond what we would expect from just natural emission sources	3
Differences between climate change and global warming	**# of Participants**
Potentially/ yes and no/ maybe	3

Climate change is part of global warming	2
Global warming is a factor in climate change	3
Global warming is the average global temperature increase	5
Global warming is an antiquated term which has been replaced by climate change	4
Global warming is used to downplay the seriousness of climate change because it sounds less threatening	2

Participants were also asked more broadly about factors they perceive to have the ability to impact the health of individuals and of a community; despite specifying that it did not have to be related to climate change, most individuals mentioned environmental health impacts. All participants mentioned the social determinants of health, and most mentioned income as being influential in determining health outcomes and access to health services. Many respondents identified that socioeconomic status (SES) also impacts people's capacity to engage in climate change. One health unit employee elaborated that they believed individuals of lower SES had more pressing things going on than climate change.

> There's a lot of people who are living day to day, you know, focused on like food and shelter. And you may be dealing with more like pressing, immediate problems, and that climate change is just not, not on the radar.

A summary of the findings associated with these questions is presented in Table 4.4.

Table 4.4: Factors mentioned by participants that can impact health of Ontarians.

Climate change-related	**Other factors**
• Heat waves/ extreme heat events • Flooding • Violence (physical/ sexual assault) • Emergency room visits • Ice storms/ freezing rain • Increases in ticks/ Lyme disease • Food insecurity	• Diet • Political judicial system • Land use planning • Community leadership • Physical activity • Active transportation/ public transit • Genetics

• Safe drinking water/blue-green algae • Extreme precipitation storms • Droughts/ low crop yield • Freeze thaw with rain and ice (poor walking conditions) • Extreme windstorm/ tornados • Environmental degradation/ pollution (air and soil quality)	• Noise • Behaviour and lifestyle choices • Social connectivity/ supports • Federal/ provincial policies access to services
Social determinants of health	**Vulnerable populations**
• Safe consumption sites • Affordable housing • Employment • Early childhood experiences • Access to healthcare services • Education • Systemic issues, including racism • Social supports available • Food security • Income/ socioeconomic status	• Low-income people • Homeless people • People with asthma • People with COPD • Elderly • People with mobility challenges • Substance users, including opioids • Pre-existing chronic conditions • Rural residents

Beyond the questions that were added to explicitly elicit knowledge structures, additional discourse over impacts led to the conceptualization of an inductive sub-theme that individuals with interdisciplinary academic backgrounds seemed to have an enhanced ability to make intersectional connections between climate change and health outcomes. For example, a participant with a women's studies-focused undergraduate degree said that one can find connections between the impacts of climate change and "any health topic" and then proceeded to present an example of the impact of climate change on the prevalence of STIs.

> We need, we need to look at it broader, like you know, even just using like, like sexually transmitted and blood borne infections, for example, like, you can have an extreme weather event that displaces people. And that's going to change, like STI levels and rates and people who maybe would typically be very good with prevention practices, like if their whole life is upset, then that can change things or access to the healthcare.

Similarly, a few individuals drew connections between the implications of built environment on health outcomes, particularly in regions with urban sprawl where citizens have to rely on single passenger vehicles to travel around. A Medical Officer of Health identified how much they enjoyed their own childhood playing outdoors, and further added that increasing active transport opportunities has health co-benefits for the population.

> Driving [poses] an issue with regards to [the] inability to be physically active. Time tied up commuting, there's a lot of commuting that happens here, a lot of commuting to the GTA, automobile collision, mortality and injury. It would be higher here [in a more rural region] than in downtown Toronto where 40% of people walk to work or take transport. The minority in downtown Toronto actually drive to work. You've got child health, well-being, obesity as an issue back when everybody's in the suburbs. So, it's you know, that impedes free active childhood, right? People try to make up for it with organized sports, but organized sports have never really been shown to make up for just a free and active childhood.

Finally, an aspect of knowledge that was asked about that had a varied response amongst the sample was on the topic of Traditional Knowledge (TK). Many of the interviewees said that they did not know a lot about TK personally or often, did not answer the question but would mention that they knew it was something that their Indigenous community stakeholders had knowledge of. For example, when asked if they were familiar with Traditional Knowledge; in a North American context, this more explicitly refers to Tradition Indigenous Knowledge. One participant said, “I don't think so”, and another participant, when asked to generally describe what TK is said, “I, I know what they are, I'm not familiar with the contents of them”, while mistakenly referring to TK in the plural illustrating their unfamiliarity with the concepts. Participants often also alluded that TK was incorporated into their strategies when they sought consultations *after* strategies or communications had already been developed.

4.2.1.2 Knowledge Gaps Identified by Public Health Actors

In terms of knowledge gaps, many public health actors said that it was difficult to even know what was considered a knowledge gap in some ways, because there are large data gaps in this area of work, so it is hard to see the big picture at this point. However, two key aspects that emerged were related to mental health and to the locally oriented impacts of climate change. For mental health, an individual who has published on this topic reflected that, "some of the biggest public health threats are the impacts to our mental health [as a result of climate change] that affect us differently over our lifetimes, and often are not as talked about." Another interviewee who was involved in research on the health impacts of climate change in Canada, and had been a part of the Federal government's report on the same topic mentioned that "there's some big sort of question marks or maybe concerns with things like mental health and eco anxiety… I think, and we don't have very good data on that." Moreover, they also mentioned that vulnerability assessments are critical for filling locally oriented data gaps, so public health authorities can know where to focus actions.

> I think one of the biggest things that we should and could do is every health authority in Canada or whatever level should do their assessment and should do one every five or six years, because it provides the basic information about who's vulnerable. You know, what are the risks? What are the projections as much as they can get in terms of that information? And it helps them adapt, right and plan their adaptation measures. So, that does require more resources, it requires more resources at all levels. Right now [the Federal government] provides funding, through the HealthADAPT project directly to the local health authorities and the provincial and territorial authorities to do that work.

4.2.2 Understanding

In this study, understanding was conceptualized as taking the realization of the causes of climate change and the information known about it towards the development of concepts to address it. To this effect, two key areas were identified that were captured across a majority of the sample.

4.2.2.1 The Impacts of Climate Change Differ Based on Local Context

Many participants were aware of the populations who were to be most disproportionately impacted by climate change. Many also were familiar with the impacts of local geography upon how changes in the climate present themselves. One participant who has experience working in four different health units over the span of their career in public health, outlined the major groups and perspectives that were widely reflected across the sample.

> There's kind of the four different groups that I'm aware of… Older populations, very young children, and people with chronic diseases are more sensitive to extreme heat, air pollution, etc. So, you've got them, that's kind of a physiological sensitivity. But you've got low income populations who are absolutely— they don't have the resources to prepare themselves for climate change. So, they may not be able to afford air conditioners, or special roofing that protects them from wildfires or the precautions that are needed to protect them from flooding… So low income, both in terms of from kind of a financial perspective, but also in terms of we know that low income populations are more vulnerable to health impacts already simply because of their social disadvantages. And so, they already tend to have a higher risk of chronic diseases, etc. so low income populations, and I know within low income populations, that we are probably talking about racialized populations. But that's not been well documented in Canada, except in a few situations with COVID… And then you've got Indigenous people in the far north in particular, like I think anybody in the far north, but Indigenous populations that rely on the land for traditional food sources, who are seeing populations of animals changing, and who are having access to these populations, affected by melting permafrost and unstable ice road.

4.2.2.2 Lessons learned from COVID-19

All participants in the sample lamented the impacts of COVID-19 on the health of the population, but most also mentioned that there were opportunities to learn from this experience in the context of public health sector preparedness for climate change (summarized in Table 4.5). One participant, who has experience in working both in public health units and in the advocacy sector on climate change-related health work remarked that, "one of the good things come out of COVID is that we are actually starting to look at, who are these people in these low-income neighborhoods?... [because] they are more heavily impacted."

Table 4.5: Lessons Learned from COVID-19 Pandemic Helpful for Climate Crisis.

Highlighted existing vulnerabilities
• Mental health impacts associated with adapting to new situations • Fatigue in following public health directives • Demonstrated need for housing • Communications with structurally vulnerable, marginalized or underserved populations
Demonstrated opportunities to improve public health work
• Government *can* re-allocate resources to prioritize public health work • Economic concerns can take a backseat when population health is on the line • Leveraging COVID-19 for a Just Recovery since public health has everyone's attention • Connecting with community leaders/ organizations to improve strategic priorities

An interesting sub-theme that emerged from a niche number of participants was that the recovery from the pandemic could be leveraged for a "just recovery". A "just recovery", or

"just green recovery", is terminology often used in policy advocacy work to refer to the idea that there is no "back to normal" following COVID-19 (Canadian Public Health Agency (CPHA), Ontario Public Health Agency (OPHA), & Canadian Health Association for Sustainability and Equity (CHASE), 2021). In the future, with all that we know about the impact of global health crises, this approach underlines that we should continue to centre equity alongside emissions-mitigation and adaptation efforts to build up community resiliency, in lieu of returning to our "business as usual" way of life. One participant, a Medical Officer of Health, remarked, that we should look critically at the opportunities coming out of the pandemic that she thought could be leveraged for a green and just recovery. Input from this individual in this context is particularly relevant given that during the COVID-19 pandemic, senior leadership in public health units have often been on the news and have become public figures responsible for the health of constituents in their health regions, with respect to COVID-19 case numbers, outbreaks and vaccination efforts.

> Public health now has everybody's attention, [whereas] for most of the time, nobody even knows who exist or what we do. During a crisis like this, we become front and center. So, we've, for time, we've got their attention… And now that everybody knows that crises aren't just hypothetical, they are real… So other crises will be real… like climate change

4.2.3 Perception

In this study, perception was defined as a process by which the participants acquired information about the world, often through their experiences. Participants' experiences were elicited by asking if they had noticed changes in their environment and what their perceptions were on how family, friends, co-workers and members of their community view climate

change. Further, they were asked about if they had noticed differences in the perceptions of climate change across different genders, races/ethnicities and ages.

4.2.3.1 Personal Experiences

Everyone in the sample identified that they had noticed changes to their immediate environments as a result of climate change. However, two emerging patterns beyond the scope of that question related to how (1) when people felt the impact of the changes in their environment on a personal level, they felt more inclined to act on the issue of climate change, and (2) sometimes, the changes in the environment, or the progress made as a result of increased awareness had been positive. For example, a health unit program director noted that they managed the vector borne disease program, so they are, "probably the only person that is doing a happy dance in September, October when the first frost comes" because that's the official end to the program for the year.

4.2.3.2 Community's Perception of Climate Change and Health

Many public health actors reported that they knew people who had some degree of climate change denial or minimalism, and they often provided reasons for why they thought this was the case. Many participants lamented that climate change is often seen as too big and complex for the general population to be able conceptualize the risk associated with it. One participant, who has past experience at a health unit but is now working in one of the non-governmental health agencies on this work, stated that climate change is too big to "wrap your head around".

> There's so many different ways, it can impact health, right? It can be, you know, oh, like, maybe you lose your job because of, I don't know, like shutting down a plant or a hurricane destroyed your, and then there's less access to money. And then you know, like, you can have those like, very indirect consequences to your health or more direct like you were bitten by a mosquito that gives you West Nile virus. So, yeah, I think it's too big for a lot of people to really, like fully understand.

Another participant, who had the most years of experience working in the public health sector from this sample, noted that much of the general population of Southern Ontario does not see climate change as threat to health.

> I know we've done surveys about this, but even just more recently, talking to people, I don't think they see it affecting them. Personally, I think they believe that it's affecting others currently. And that it may affect their families in the future, but I don't think they're seeing it being an effect today. No.

One respondent in senior leadership within a health unit reasoned that this may be because people might feel that the situation is out of our control, so it is a defense mechanism to be denying the urgency of addressing it.

> I think you'll run into quite a few attitudinal defense mechanisms for people because the whole thing is very daunting, right? Challenging to people… Threatening to people. And, you know, people don't react well to something that is very threatening that they feel they have no control over. And, and so they might seek to bury it in their minds or deny it as well. Certainly, you get some denial as well happening. And there are many ways to deny climate change as an issue you, you can agree that it exists, but disagree that we're causing it or disagree that we can do something about it or you know, there are many ways that it can be put aside. Or they can simply be distracted with day to day living.

Moreover, a health unit director commented that people tend to question if certain extreme weather events are truly due to climate change.

> I think we've had enough climate events that even if people don't believe that climate change is caused by human activities. We've seen enough floods and ice storms and various events that people can see these extreme weather events. If they know whether they're climate change related or not? That's up for debate, but they can see the impact of extreme weather events, and the potential for their health. So, we don't get pushback from that perspective.

> The pushback would come as to whether that extreme weather event is indicative of climate change, or whether it was human caused.

Finally, two participants expressed frustration at other countries' lack of response to climate change because they felt that it causes people to feel that any action is futile. Even though both respondents believed in climate change, and believed it was important to address, they said that it does not help that those other countries are not doing their part.

> I mean, even just seeing last week with the climate change talks that the US held, internationally, we're hearing, we're hearing like China, Russia is like huge countries are basically like, they're not committing to further measures. And, and there is that argument too that for the last 100 years, a lot of these big countries have benefited from fossil fuels. And so why should they? You know, like, have their economies hit by taking these reductions now. So, it's just- it's so complex.

4.2.3.3 Perceived Differences Between Demographics

When asked if they had noticed any differences in risk perception between people of different races or ethnicities within their life or health region, the only pattern that emerged was that there seemed to be a greater awareness amongst Indigenous peoples. One respondent, who was involved in the *Make It Better* campaign organized by the Ontario Public Health Association, provided an illustrative story about their experience in working with an Indigenous Elder to create communication materials. They described how the Elder addressed climate change through storytelling and reflected a deep knowledge of both impacts the land and all of its peoples.

> I would say, Indigenous groups they see, so the ones that I've spoken to, they see the impact now, because they have such a strong connection with nature. And their Elders are talking to them about what climate was like, what their community was, like, two or three generations previous. So, I think they're seeing that change because their elders are talking to them about it and sharing it.

Another participant who works in a Northern Ontario health unit described how they felt that Indigenous peoples are “so much more in tune and so much more aware of even minute environmental changes” due to their connection to the land.

> What we're hearing in some of my work is these personal experiences- that *people* have lived on the land for 60 years. And have seen these changes and experienced how this— whether or not we're thinking about like warming temperatures and the impact on ice stability and ice roads and access to services, food, recreation— and how that's being impacted. It's, it's, it's wild. So, I think the way that climate change is experienced isn't equitable.

Beyond Indigenous peoples, participants also frequently mentioned that there was a general pattern of increased climate denial or apathy associated with increased age. One participant who leads an environmental health advocacy NGO, with former experience in health units, said that their father's generation does not “buy it” and are “not too engaged” because they are “not going to be around”. They go on to state that we have “a generation that's kind of in total denial”. Similarly, another participant who works at a non-governmental public health agency remarked that this prompt made her immediately think of her grandmother, who is 90 years old, and the participant said, “she just doesn't care cause- she's like… it's not my problem, it's not going to affect me, like, I'm going to be dead, before these impacts hit. And which is, you know, it can be a bit of a selfish way of thinking about it.” From a more research-oriented perspective, a federal policy analyst said that they know for a fact that younger people are more concerned.

> Younger people, you know, children and youth are talking about this a lot more than I did in my in my, you know, childhood or, or as a youth. I feel like that is a demographic that is acutely concerned about the issues.

In terms of gender, another individual working with experience in climate change-related health research and policy work passionately noted that they believed women perceived the risks associated with climate change more.

> I think, I think women tend to be like— I've just looked at some research and… and those who are in the field, particularly in climate change and mental health [*laughs]* it's like mainly a female dominated area. And climate change and health in general, there's more, it seems to be that there are more women who have been, or people who identify as women, I should say, who are more are kind of abreast of the… the issues.

4.2.3.4 Rural Individuals' Concerns About Climate Change

Participants who could speak to the experience of Northern Ontarians said that they believed people often thought that rural residents, of which Northern Ontario has many, are climate deniers, but their experiences with the communities reflect differently. A project officer located in Northern Ontario described how they conducted a study to look at how people in Thunder Bay perceive climate change and the impacts. They said that the study found that people do recognize that climate change is happening, which they remarked was "surprising" because it was contrary to the stereotypical "rural northern mentality" which expects people from these regions to be climate minimalists and denialists.

> You want to think about right wing conservative, more like, people, generally like Albertans, in a sense… I'm not trying to stereotype here… when I met Americans who say, "climate change is a hoax, and I don't believe in that… why should we have to do anything about it when China is the one causing the problems?" kind of like… those rhetorics? And I think a lot of people feel that that's the way that rural and Northern Ontario people think about the issue, but the study really showed that climate change isn't perceived that way… people recognize that climate change is a problem. And the impacts are being felt, to some degree.

The Manager of a health unit reflected that this same rhetoric is in some ways true from his experience living and working in Northern Ontario, due to the "blue collar mindset" that is prevalent in his health region.

> I don't know if there's greater climate denial. But again, you're dealing with the semi blue collar town… It's "well what are we going to do? We're small potatoes."

Interesting, from a Southern Ontario perspective, the Director of a health unit noted that rural individuals who make their livelihoods out of agriculture were indeed concerned about climate change; she stated, "The northern part of [city 30 minutes outside of Toronto] is quite rural, and certainly the farm community. The agricultural folks are quite concerned about it."

4.3 Aim 2: Behaviour

In this study, behaviour was defined as how individuals have acted in response to climate change, and how their values and attitudes informed this. The Theory of Mental Models postulates that the sense-making process is inclusive of ones lived experiences, personal values and affective emotions, so some questions were incorporated to the interview guide to elicit responses which reflected the participants' attitude and values, however many of the findings shown below are a combination of deductive and inductively generated themes.

4.3.1 Values

A value in this study refers to the importance participants attribute to any person, thing or idea; in the context of this research topic, it is values associated with climate change and the importance to implement mitigation, adaptation and risk communication strategies. To preface this section, it is important to note that there was an interesting finding (alluded to in six interviews) reflecting the notion that some people working in the health sector do not recognize climate change as being part of their "portfolios", meaning the area of work they

are responsible for. Outside of interview data, I noticed this same pattern during my recruitment efforts for participants because in at least three email responses from health unit staff (to whom I had emailed my study's recruitment information via the health unit's general inbox) stated that climate change was not being an urgent enough issue to divert staff and resources towards discussing during this time. I also received four emails from Medical Officers of Health of different health units remarking the same; two of these emails had the added comment that this work was "not a part of their portfolio". Overall, this made it clear to me that public health actors, particularly those in higher levels of management, who did find time to participate in this study were individuals who already demonstrated a vested interest in this topic and who did see it as a priority despite the present-day public health situation surrounding COVID-19. This sentiment is reflected in many of the responses below.

4.3.1.1 Influences on Decision-Making

When prompted with the question, "which aspects of climate change concern you the most?", the biggest patterns observed amongst responses included intergenerational concerns and changes to our "normal" way of life. One 57-year-old participant reflected, "by the time I'm 80, what is my climate going to look like? What's that circumstance going to look like for my daughter?"

> Within climate change- because it's so slowly changing… I think that there's a different framework that we have to be thinking of it as sort of a legacy context, rather than an immediate, um- impact sort of context.

Another participant, aged 62, also remarked, that they, "feel like I could be leaving my children and grandchildren with a with a horrible future. And so, for me, that's the big one.

My son who's 30 will say, you know, you guys really dropped the ball, you left us this problem. And I think its kind of unfair." Moreover, a 58-year-old participant went beyond stating his concern for the future of humanity, to describing climate change as a "mass species extinction" event.

> I am most concerned for the, the future of humanity, within my lifetime, but even more so beyond my lifetime, so as I get older, I become more concerned about the generations to come, that I will see some of those [changes] but my sons in their 20s will see much more of it. And their children will see much more of it. Very concerned about our ability to live in a sustainable and prosperous way, as a species in the future. When the stability of the ecosystem that we depend on becomes undermined, I don't believe that anything is certain, I don't believe that glorious, good future at all is certain. I think it's up to us to do what we can to make it much more likely. I don't take it for granted at all. I think that the possibility of great turmoil and hardship, and even massive decline of our species is entirely possible. And really, it's it we can't take our present prosperity as something that's going to continue on into the future for granted at all.

Additional responses are summarized in Table 4.6.

Table 4.6: Aspects of climate change that concern public health actors the most.

Concerns Expressed	**# of Participants**
Politicization of climate change preventing actions	8
Lack of urgency/ not acting on gravity of the situation till it is too late	5
Intergenerational impacts for children	5
Health inequities worsening	4
Mental health impact	4
Existence of the planet	3
Future of humanity/ mass species extinction event	3
Sea levels/ coastal cities drowning	2
Combination of events leads us to exceed our adaptive capacity	1

4.3.1.2 Centring of Equity-informed Approaches

Many of the respondents noted that there had been a greater focus on equity in the past few years across sector. One tangible example of this was when a Medical Officer of Health

described how his unit was prioritizing training for health unit staff to ensure cultural safety in their work with Indigenous communities.

> Two years ago, I think it was, we pulled into our strategic plan, the- the priority of engagement with our Indigenous populations, and to going on a journey as an agency to become much more knowledgeable and informed about our Indigenous reality. And so that's been in our strategic plan. Strategic Plan, by the way was put on hold with the pandemic, we, we just put it on hold and dealt with the pandemic. So, I have to come back to it but we, we had made awareness raising and knowledge and skill development among our staff and our board a priority and had required all of our staff to undergo a web-based orientation process and we'd had some Indigenous educators come and attend for our staff education days and that type of thing, of which our board members were going to make it a priority for our board to undergo this kind of training as well. But we just haven't been able to keep any of it up with the pandemic.

However, more broadly many participants, when prompted to comment on diversity in the workplace, mentioned that there was still insufficient representation of historically underrepresented groups such as women, gender diverse people and racialized people. The same Medical Officer of Health noted that there was some gender diversity and some younger individuals in their work setting now, but generally that there needs to be a continued effort to increase representation across different groups.

> I don't think [the health unit's employees] are representative. Neither the staff nor the board are representative of the general population. Certainly, they're skewed heavily to older male and older male, white, basically, there are some women, there are no people of color. No Indigenous population representatives that we hope to have for First Nations communities in [our region]. We have maybe 20,000 people who are off reserve who have an Indigenous background in the population… We don't have any control over the board, [as] that's determined by the municipalities that appoint the representatives or the province who appoints so we don't have control over that— And then among staff… [in] senior management we've got an equal gender blend. In fact, there's a predominance of women among staff, including in leadership. Overall, there more women than men in the agency and there are more women than men in leadership positions. And, of course, among staff, there can be very young people down into teens or 20s. Right? So, we have a good range of people. [As a Medical Officer of Health], a number of years ago, we did a kind of a deep demographic survey of our staff and compared it with the general population. And it was extremely skewed in terms of women, and highly educated, right, so much more women and highly educated compared with the general population in [our region in Ontario], it's much

> higher in much higher income, right? And there is right some racial diversity but still heavily skewed to education.

Another white woman noted that there was insufficient representation of racialized people generally, outside of some urban regions with higher new immigrant populations.

> I have to say Toronto, the staff like in [their health unit], the staffing is incredibly diverse. I think as a region- as a city as a whole. I don't know if you could say that in [health unit 30 minutes away, more suburban region with higher SES and less diverse demographic], not so much. That may have changed. [Health unit staff and generally individuals working in the climate change/ health space] are not ethnically diverse as a rule, like I think, [both] in the environmental movement, and the public health people.

Across many of the interviewees who were asked about this, there was generally a consensus that racialized and Indigenous people were not embedded within the staff in their health units, non-governmental agencies and advocacy organizations, but were instead frequently consulted as community stakeholders.

> If I had to give us a score of like, a plus or a fail, I think we would probably be like, six? So somewhere, somewhere average? Because we did, we did have input from our Indigenous engagement team, and women, but other than that, and men, but other than that, we didn't have any other perspectives or contributors from traditionally underrepresented groups.

Finally, despite including it in the question prompt, no participants acknowledged neurodiverse or disabled peoples within their criteria of diversity in the workplace.

Beyond diversity, another area of interest was Traditional Knowledge. It seemed that Traditional Knowledge was often incorporated as an afterthought, not embedded throughout the design of strategies and communications, despite recognizing value. One 31-year-old white woman noted,

> Reflecting on my career to date. That's something that hasn't really been incorporated as much, but I know it can have a great benefit when we take western knowledge and Traditional Knowledge… And like us the strength of both and yeah, like, I think there's like that, yeah, there's real value in using that knowledge and like bringing that in, and not just overvaluing Western knowledge over other systems. So, something that's great, I'm all for,

> but maybe selling it- we don't have the capacity or background or like support to, to really like to do it.

Interestingly, the only non-white participant said that they had a fair understanding of TK and had knowledge of specific actions being taken by their health unit to engage directly with stakeholders at various critical points in the development of their strategies to try to include it. However, they too, felt that more could be done to improve the degree to which underrepresented groups are involved in the design of strategies and communications. To this effect, on more than one occasion it was mentioned that health units often relied on health equity teams, or community stakeholders if they didn't have the resources for a health equity team/ employee, to look retroactively at strategies, reports and communications for feedback. Commonly, there was an emphasis to specifically engage Indigenous communities and committees were often organized for stakeholder consultations to create opportunities to garner direct input them. One health promoter noted,

> Our health promoter in our health equity team looked over the entire report to ensure that I was, you know, phrasing everything sensitively related to health equity, and our Indigenous engagement team also took a look at the report and said, and like looked at a section that we have on Indigenous ways of knowing and climate action.

4.3.1.3 Prioritization of Climate Action Strategies in Health Unit

One of the most prominent themes that emerged from this work surrounded the role of leadership in making critical decisions to further climate action work in this sector. The most influential leverage point was identified to be the health unit's Medical Officer of Health; one health unit manager put it as, "the [Medical Officer of Health], or the commissioner for the department is more engaged with [city] counsellors… So, if they were to advocate, they're probably the best. Like, within, like, the internal structure or senior management here." They

also elaborated that if this individual prioritizes climate change related health work, then this would be the most impactful towards ensuring the climate change ranks in the list of health concerns that the unit is working to address for their region. All of the participants that were prompted with this line of questioning agreed with that sentiment, with one Northern Ontario health unit manager remarked, "is it the top priority of the health unit? Depends on the day. Our medical officer of health… does agree that climate change is an important aspect. So, it's hard to say, you know, I can't just say… It's, you know, depending on what we're dealing with, at the time, it is higher or lower." A former Southern Ontario health unit manager went for far as to say that differences in the progress of health units is influenced by individual "climate champions" in senior leadership. She provided the following example,

> There's another reason why you might see a difference when you talk to some medical officers of health. Like if you talk to [name of health region], Dr. [censored], the medical officer of health, [they're Ontario's] biggest champion for addressing climate change. And that's why [their health unit] was one of the first health units to complete their vulnerability assessment. There are other health units to say, you know, *that's not our mandate*, you know, we'll do this the minimum, which is maybe just, you know, look at what others have done and just kind of maybe do a very short report or something like that.

Consequently, one project officer in a health unit expressed that a "climate in all policies approach" is used more when senior leadership sets the standard for that practice. This is a motivator for those in the health unit who might not otherwise know to do or feel comfortable doing due to the politicization of climate change.

> I think it depends on the leadership, but also depends on the personality and people's willingness to engage and to push people a little bit because it's, it's something- climate change can be out of people's comfort zones for sharing.

Examples of "climate in all policies" were mentioned by two participants; a climate policy specialist with experience working in numerous health units, and the director of a health unit.

> There were all the things they were doing on climate change; people don't necessarily see them as being climate policies! Like even the carbon taxes, you know, people, you know, the fight against carbon taxes. So, I feel like, we have a real role to do in terms of making the health benefits of climate policies kind of available, and educate public health, like, that's what I've been trying to say to public health people, you are already working on things that are good for the climate, you just don't realize it. And so, you know, recognize that when you're fighting for active transportation and public transit, and that you're not only you're improving, you know, human health, but you're actually improving climate change, so recognize it and help people to understand that, that there's multiple benefits associated with these investments.

> We have a large South Asian population, a lot of new immigrants to Canada and in doing our health assessment problem, or health assessment studies, the issue of diabetes came forward and you're probably wondering, "what does diabetes have to do with climate change?" But when we started looking at the underlying factors to why our population had such a high incidence of diabetes, it really came down to the fact that in many ways, we've engineered physical activity out of our day to day lives. We're very car dependent. Our built form lends itself to that. And so, when we started to tackle diabetes and the built form issue, again, many of the underlying factors come into climate change, car dependency, sprawl, long distances between places, energy reliant systems. And so again, we could tackle several health problems at once… And so, we've done a tremendous amount of work on built form, moving towards more compact, more energy, friendly, more pedestrian, active transportation friendly communities, which is a win across the board. So, it's sometimes stepping back and addressing one problem can give you a win in a different, different area.

Participants also often discussed that when leadership (e.g., Medical Officer of Health) doesn't prioritize climate change related health work or does not believe it is in their portfolio, climate change is often siloed to be only one person or department's job, hindering interdepartmental/ meaningful progress.

> [My Medical Officer of Health] is aware of climate change. [They're] an advocate for climate change. But [they] could be a bigger advocate for climate change. Like, for example, when we did our strategic plan about, I don't know, a year and a half ago, I really wanted to bring the whole climate change piece into our strategic plan and take that as a, you know, as a contributing factor to the programs and services that we provide here at the health unit. [They] weren't quite prepared to do that. So. although I think [they] believe in climate change, [they] don't view it as like, a top priority. And I think if [they] did, it would be… we could, it might be an easier sell to smaller communities.

Medical Officers of Health are accountable to, and work with, the Board of Health); Each health unit has their own Board of Health and is governed by it. An interesting finding that stemmed from one interview was that despite being in charge of health unit activities, Board

of Health members do not need any specific qualifications to be elected. Rather, they are often local leadership with non-health backgrounds.

> They merely have to be appointed. So, to be appointed as a representative from the municipalities, they have to be… they're almost always elected officials. So, in that regard, they've had to be qualified to, by, by way of election, right. Whereas the provincial appointees merely have to apply to the province and the province uses whatever means they use to select people. For the Board of Health- a number of years ago, we did have a governance review, where the recommendations about types of criteria types of qualifications [that] would be helpful to have on the board. And we brought that to the board for their consideration of whether they would ratify it, noting that there's, there's no way you could impose it or enforce it. But you could potentially make it known to the appointing bodies, that these are the kinds of backgrounds we're looking for. And is it was an interesting discussion. And they took great exception to the idea that anything other than the requirement that they be elected by their people, would be necessary. So, it never got approved.

That was surprising to hear given that the Board of Health has oversight over a health unit's activities. One epidemiologist described their role as being the "[the Medical Officer of Health]'s governance agent".

> So, [the Medical Officer of Health as informed by the health unit staff] would be saying to them, "this is what we're planning to do, and here's what we're doing". And then [the Board of Health] would say, "Yes, we think that's a great idea". I think they'd rarely say no… but so they're not really the agent of change, per se, but they would be the governing agent to say "yes, where you're going is the right way… we also want you to do this new thing". So, they're kind of our boss per se.

Furthermore, the Board of Health plays a role in approvals for strategic priorities and for connecting with community stakeholders including municipality. One participant in senior leadership described how their Board of Health helped make climate change a strategic priority which led their unit to being among the first to conduct a vulnerability assessment.

> I take very seriously the governance role of the Board of Health and take to them for their input and ultimately approval, anything that's major and new and strategic, ideally, within our strategic plan, and that they lead in the creation. It's the hands-on work as staff, but we always take things to the board, get their discussion, get their input, capture their input. And certainly, we did that with climate change… So, it's absolutely critical to have a good relationship with your board… to use your board in that way. And then to get their approval, and to get their input into how to go about it too, because they're all prominent people in the

> community; municipal politicians who have connections in their communities can really advise on who you could be working with, and what are some opportunities there. So, to me, it's very, very important that you get the board support framed as a strategic priority.

Finally, in terms of the overall progress that health units are making towards the implementation of climate mitigation and adaptation strategies, many noted larger, urban, well-resourced health units were miles ahead, and have been for years, as compared to smaller units. One individual who has worked with many of the health units through their role in the Federal government noted that, "they're just dealing with everything all the time" so a big problem with climate change for health units is that they are "just starting to get into it- so not like Toronto [who] has been working on climate change and health for 20 years- right, and they're doing like, fantastic stuff. But for the for the ones that were new or are new." Moreover, many health units also only have one person designing and implementing the climate adaptation strategies, which often slows down progress. A project manager located in a Southern Ontario city with over 600,000 people said that they were the sole person working on this and said,

> The impact adaptation planning process is mostly me. We do have a small, a small core team that represents a number of other city departments who we meet with once a month, or we meet once a month to discuss, you know, what the overall strategy, the next steps, get advice and feedback and provide some connection with their home departments when we need to… We're not at that point yet, but when we need to have communications with different teams, who will provide that bridge for us. Yeah, but it's mostly me.

Notably, there is currently only one individual hired to manage all seven Northern Ontario health units' climate vulnerability assessment and to develop reports which can help inform the region's adaptation strategies. Their role is funded through the Federal government's HealthADAPT program.

4.3.2 Attitudes

In this study, attitudes are the way the participants think and feel about themselves (in both their personal and professional spheres), as well as other people, actions or ideas. Two common sub-themes that emerged here included things that motivate public health actors to act to address climate change and beliefs they, or others hold about climate change.

4.3.2.1 Motivations to Address Climate Change

Surprisingly, many participants expressed strong emotional reactions to climate change or environmental degradation. The most common was eco-grief, anxiety or depression; it was observed in many participants but one policy analyst in particular noted how they used those feelings as a jumping off point to dive even deeper into the issue.

> I knew when I started my doctorate that I was going to focus on climate change impacts to health, and so I'd done a lot of research on it and looked at the variety of impacts and it was terrifying me to see the health impacts to see how many people were dying because of air pollution or heat waves or the morbidities related to heat waves there. wildfires and flooding, etc. And my own anxiety started to peak. And I thought, you know, why isn't there so much research on the mental health implications of climate change? So, for me, one of the ways that I addressed [laughs] the mental health implications of climate change in my own anxieties were to do research on it to find out more- to learn more, not only about who is impacted, but ways that people are addressing it. So how are they dealing with the mental health implications of climate change, you know, sometimes it's creating a community, sometimes just talking about it to other people, sometimes it's seeking, you know, mental health care from professionals. So, for me, the more I - whenever I have my own internal anxieties, for me, the way that I sooth them, which doesn't seem- [laughs] I go deep into them, I try and figure everything out as I can about them get better understand and make sense of the world and how other people are dealing with it, to see what tools and approaches that they're using.

Another more common feeling was shame, and this was often expressed in relation to intergenerational concerns, particularly as many of these participants had children. The most

emotional response came from a mother who demonstrated a degree of specialized knowledge on this topic, and the potential impacts on the health of Canadians.

> In terms of Canada, or overall, like, I really think… *[Begins crying]* … you know, what *[laughs awkwardly]* don't mind me... *[still crying]* … I really think we're talking about the existence of the planet. I think we're talking about whether or not I'm leaving my children and my grandchildren with a with a world that consists of... That's why I think we're talking about *[cries louder]*.

Guilt was also closely associated with shame, but interestingly, was expressed more in those that saw addressing climate change as a personal and/or professional responsibility. One health promoter whose portfolio directly includes climate change, and who is an author in their health unit's climate change adaptation strategy report, remarked, "I guess just like this psychological feeling of being involved in climate change work. It's like, we're doing everything. But are we doing enough?" Finally, fear also often manifested pessimism. One health unit manager was a self-described, "eternal pessimist" about this issue.

> We're doomed. It's unfortunate. Do I think we will figure it out at some point? Yes. People as a whole seem to get their shit together when things are at their worst. Right. All right. But unfortunately, it's 100 years to make this at the accelerated rate we're using. You're not going to get a five-year fix. Um, so coming up, will we probably make those 2050 limits they're looking at? It's possible. How well we're going to be able to… what the impacts are going to be at that time. Mm hmm. Who knows. It's going to sound terrible. But it's going to have to get worse before it gets better.

In terms of motivations, a pattern that was re-iterated was that those that were interested in climate action outside of work were also bringing it into their work environment. One individual in senior leadership with a "hard science" biology-oriented background mentioned that knowledge of this issue through academic/ professional training is not sufficient alone to motivate people to care about this issue.

> So, your question about what kind of training is needed to [make senior leadership of health units care more about climate change]? I'm not sure if it's training, I think it might be the kind

> of the interests of people… bring… what they bring with them into the training that might make them much more interested in this area of focus.

They continued that they believed having or developing an appreciation of nature helped motivate people to protect it.

> I would say for the whole of my life, I've had an ecology bend, to outlook on life. And I was raised, I guess, close to nature, my parents took us on camping and canoe trips, and whatnot throughout the entirety of my childhood. And I've kept that up, I still do canoe trips is my favorite form of recreation. So having that bond, you're early in life probably is the driver for me. And when it comes to the built environment, I've had a lifelong connection to cycling as a way of getting around. Since my youth, I used to do long cycling trips for recreation. And even now I for most the time that I've been here, except for during the pandemic, I have been cycling most of the year to, to work. And I, you know, I just see that the connection between being able to be physically active to get your meet your needs met, is far more efficient for the improvement of your own health and well-being well, also being really good for the planet. Right. But that you need a proper built environment to do that well, and [the belief that] we'd all be a lot better off if it is built for that has been in my mind, probably at some level since my youth.

4.3.2.2 Beliefs held by public health actors

Beliefs identified by participants were defined as interpretive perceptions (including their knowledge, experiences, morals, and opinions) of topics related to climate change. To this effect, two participants mentioned associations between climate change and over population. One health unit manager went so far as to attribute the primary cause of climate change to over population, saying, “One of the key problems with climate change, and the carbon monoxide or carbon dioxide releases is population and cutting us out by seven eighths of the population… Because everybody produces CO2, you know, doesn't matter where you are, you're going to produce it in one level or another. And the more people you got, it means the bigger the carbon dioxide footprint is worldwide, just because of number of people.”

Five participants noted that they thought Canada will not feel the effects of climate change like other countries due to our “lucky” geography as compared to other nations. One

participant who specialized in infectious disease and climate change-related health research gave the following description.

> Climate change… you know, a lot of people… disadvantaged populations that are really going to feel it. And it's also it's another thing without borders that, you know, here in Canada and the US, you know, really big polluters at plate, but we're not necessarily the countries that are going to feel the effects the most.

Most participants mentioned the role of economic concerns in relation to the impacts of climate change at some point in the interviews. A few mentioned that these concerns often outweigh health concerns at decision making table. One participant employed at a national health agency noted, "Health is so rarely at the decision-making tables around these bigger things like, the energy like Canada… where are we going to power everything from? Is health at the table for things like that? Speaking out, like, "hey, let's not go 100% coal?" … Because… I think like, [at] a lot of those big decision-making tables that the economy gets more weight than health." Six other participants expressed that they felt that Canadians as a whole, but more specifically those in positions of power, were not addressing climate change fast enough.

> We don't have a lot of time… We can't talk about this for the next 100 years and have people like fighting, you know, 10 years down the line before we decide to take action. Just seeing what the pandemic [brought], there's just so much resistance to taking bold steps to protect the health of the public. And I think… Well, I mean, we have seen it in climate change for the last 15 years or more, as climate change comes more and more light, but I think, yeah, I'm very concerned that like, we are taking action, but it's not fast enough to really get at like- to prevent all the health issues that are going to come with it and will that are coming with it… climate change is so time sensitive, like we need people out there being loud, too, like to like, really bring these things to attention.

Participants that expressed seeing climate action as a professional responsibility often lamented that the public health sector needs to play a more prominent role in climate action.

A 64-year-old who had decades of experience on this topic expressed that they felt that public health had not done a good job in addressing this issue over the years.

> I was writing about the health impacts of climate change 20 years ago… So, I kind of feel like where have we been? And how did we go 20 years without people realizing that? We'd say, people need to understand that these wildfires are, you know, presenting a health risk. And they have to understand that this is, you know, this extreme heat that we're experiencing in Ontario is a health risk… Where is the rest of the public health sector, for goodness sake?! I feel like there's a need for the public health sector to really weigh in on this issue at a larger scale… I feel like there's a need to have the public health sector coming out more, because we do… we are more aware of health equity, we're more trained in terms of policy.

Every participant in the sample expressed that climate change is already impacting us. One researcher specializing in infectious diseases and climate change expressed this in a uniquely ominous way when they stated, "…we are seeing it but it's so insidious and so hard to prove that oh, this person died from climate change, like you're never going to see that on a death certificate."

4.4 Aim 3: Risk Communication Need, Use and Production

To fulfill Aim Three, questions were added to the interview guide that asked participants about if they were sharing health promotion and/or risk communication materials about climate change-related health impacts, how they were designing these communications if so, and who was involved in the process. Often additional probes were asked depending on context and the results are outlined here. Unfortunately, many health units and non-governmental agencies were identified as not doing this work so responses answering the intended questions are from about half of the sample, and additional probes were used to elicit reasons from those who are not actively engaging in the creation of these communication materials, about their experiences and potential barriers. Interesting, health

advocacy organizations were taking on the role of communicating health risks associated with climate change on in earnest.

4.4.1 Need for Health-Risk Communications

Many of the respondent recognized the general need for risk communications messaging on the topic of the health impacts of climate change. However, eight of ten participants felt that the media's portrayal of this issue could be improved; particularly due to the influence that media reporting has on the public perception of climate change. One participant who often actively engages the media in coverage on climate change, by sending press releases from a health policy analyst perspective noted that they think the "media has been terrible" at making the link between climate change and health outcomes.

> They just haven't made those links. I think a few are starting to do that more and more the last few years, but I think that's been a new thing. I think they've been terrible about that. So, I think they haven't done a very good job of it, or we haven't done a good job in the health sector, and I think it is partially because in Canada, we have a good public health infrastructure. And we are lucky in our geography, I think it's really been the last decade where we've really started to experience… and also the fact that we now have research where we can actually attribute certain events to climate change. I think many of us from a scientific perspective, were nervous to say it. And then there was a whole view that if we kept talking about, oh, this is health impact, we need to do something that people felt we were being insensitive to the people who were impacted by a particular extreme event. So, Fort McMurray, I think people were nervous about looking like they were using this horrible tragedy for political means. Whereas I think that that we have to be, you know… I think we're changing our attitudes around that.

4.4.2 Production of Communication Materials

4.4.2.1 Effective Techniques

Channel, medium and messenger was said to matter as much as message; for example, healthcare workers such as doctors or nurses are seen as trusted sources so make good messengers for this topic, said one Director of Health Promotion.

> Our physician community and we do regular communication, we maintain a regular communications channel with them, and do regular updates. So, we'll do an annual vector borne disease at West Nile virus, we do an annual Lyme disease, we do an annual heat update, just to communicate to the physician community about what they need to know… So, there are technical reports, but climate change is woven into those messages because doctors and nurses are trusted sources of information. And so, if they're carrying the message forward, that, you know, climate change is happening, and we're seeing more of this, to have it come from a trusted source is really valuable as well.

A former health unit manager who now teaches students about climate change and health noted that using health co-benefits and co-harms framing is effective at helping to establish a stronger link between the two.

> It's the fact that it's the same exhaust, like from vehicles that releases local air pollutants that are going to impact their health today, it's also releasing global greenhouse gases that's affecting the global climate. So, I think, to talk about the health co harms right now, and that's what we're trying to do, if we try and communicate that, that it's, it's something immediate, because they don't see climate change happening now.

Moreover, locally oriented content was found to be used by health units and found to be a good application of audience segmentation practices for targeting communications. A Director of health promotion explained that “making sure that messaging around the risks of climate change [are] embedded in all the life cycles and all the points of contact that a public health unit has within their groups” is important. For example, they explained, “I don't know, if you remember a number of years ago, cauliflower went to $12 ahead for a short period of time because there was a shortage. Well, cauliflower is a staple food for many of our

communities, especially in the South Asian community and to buy a $12 head of cauliflower… it puts it out of reach for many families. And so, you know, talking about the issues of food security insecurity in the context of climate change." Targeting risk communications with structurally vulnerable populations was commonly mentioned. To this effect, an individual involved in the Ontario Public Health Agency's *Make it Better* provided an example of a lesson they learned earlier on in their work.

> We realized that after we did the first phase of the campaign, even though the messages were focused, tested, with a few people like some first- and second-generation families, we really didn't ask people with lived experience, like if you were from a marginalized communities or low-income community or racialized community, like, here's our messages is, is this something that resonates with you that you feel that you can act on? We didn't do that.

Furthermore, a Director of Health Promotion noted that addressing language and literacy barriers in communications is important towards achieving this as well.

> It's different than regular communication, and, you know, some of the learnings that came out of [a risk communication campaign] involved using pictorial stuff, because language, language may be a barrier literacy may be a barrier. So, you know, just being just being cognizant of the needs and being flexible in our communication styles as we go forward.

However, a couple participants noted that by were advised by managerial instruction to maintain professionalism in their messaging tactics and that posed a barrier for accessible messaging. One health promoter provided an example of their experience when creating health promotion materials on the impact of blue-green algae on local drinking water.

> I wanted to make [risk communication campaign on blue-green algae] more accessible like for, for readers of all levels and a lot of the changes, like weren't accepted by- I think it was our director at the time. Because [they] said, like, yes, we want it to be readable, but we also have to be accurate, and we want to sound credible- not credible, but like… to sound like an *authority* on the topic. So, I've definitely encountered some barriers when I've tried to change the communication. I think that's kind of like a barrier is just like, getting outside of our comfort level on some of our communications is not a strong point for the health unit. Like even I think, Ottawa Public Health has been using humor in their COVID social media and like, this is shocking. To us. We like a lot of us working in [a small town in Ontario]. We're like, we wish our health unit would use humor, but they just, they just don't ever let us.

Similarly, another project officer working on the vulnerability assessment for their region said, “even within the health unit, people see [climate change] as a politicized topic and it's yeah, it's challenging that way, for sure.”

Beyond content approvals, there was no use of theories or frameworks in production of communication materials. Many participants were confused when asked this question, and an individual working at the Federal level who had knowledge of many health units’ communication strategies broadly replied, “I wouldn't say no… I wouldn't say that. It wouldn’t be an overt theory that's being used” across the sector. Finally, making climate communications more commonplace, informative and less alarmist was perceived as helpful towards reducing eco-anxiety which can often immobilize action. The same Director of Health Promotion as above also mentioned that partnerships with media helps ensure regional coverage is informed by health units, and is more catered to serve the population.

> We have a good relationship with [the media]. We frequently communicate with them on issues, and it's a two-way street. We push out news releases, like the first few events of the year, and so on, and so forth. But they'll also come to us asking for, you know, stories or articles or, or interest pieces, we also do regular updates to our elected officials, because they put out newsletters to the community. And so again, if there's a climate change story, or some communication that we want to get out, we will provide it to our counselors in an electronic format, and they can just plop it into their newsletters, and pump it out to their constituents within the community. So, we take advantage of a variety of different communication and media sources that we can.

However, in an effort to minimize alarmist language, some public health units are not linking health outcomes which are known to be exacerbated by climate change, back to climate change as the root cause. One Program Director who has environmental health (among four

other topics) in their department's portfolio remarked that they feel public health units have not done a good job of that.

> I think it's more about us as communicating that immediate risk that there is, you know, elevated heat happening. And so, these are the precautions that you should consider, right. And no, we haven't. We haven't communicated that as a correlation to climate change. So no, I feel that we haven't done a good job with that at all.

4.4.2.2 Extensive Approval of Messaging

A number of additional reasons were identified for the practice of not connecting climate change to health outcomes in messaging. Many also avoid this practice due to a lack of data. One of the individuals with experience working on the *Make It Better* campaign mentioned an example of how important the role of data is in shaping this work.

> When we did our Make it Better campaign… one of our partners' associate Medical Officer of Health saw our statement on vector borne diseases. And [they] didn't want [their health unit] to sign on to the campaign, because [they] said that the data was from the previous year, so it wasn't as up to date. So, I mean, that was good to know, like, so because I wasn't working at the health unit. We didn't necessarily get approval from Public Health Agency of Canada. But she had wanted us to use more up to date data. So, we were able to tweak the message that way so that [the health unit] would feel comfortable, so I guess like we feel accountable to our members, and we're trying to increase our membership. And if the public health units across Ontario or anybody else doesn't feel that our messages, like if they read something that we put out, and they think you know, you don't really have strong evidence to support that. We're going to lose our membership. So, we need to be seen as a trusted source of information. And that's our accountability.

Additionally, a number of participants identified that the politicization of climate change makes it harder to create effective communication materials on this topic. One project manager working on their unit's climate adaptation strategy explained that they avoid mentioning climate change in their communications "to avoid the politicization that climate change often creates or is involved in" because they "want to focus on the health impacts

people are experiencing and how we can address them" and not to be hindered by "getting into a big fight about whether or not climate change is real is not".

4.4.3 Use of Risk Communication

4.4.3.1 Health Promotion Opportunity

Three of seven public health actors said that climate change related communications from a public health perspective did have health promotive potential, because there is an opportunity to inform the public about preventative behaviours. One infectious disease and climate change researcher provided the following example on Lyme disease prevention.

> We can't just tell people that like, let's just use, like ticks as an example, we can't just tell people like, yeah, there's probably more ticks around, like, be careful about it. Because that just scares them, but they're not really going to change their behavior. But if we say, there's going to be more ticks around in the forest, so walk on clear paths, and tuck your pants into your socks, that then people can know about it, and then take an action. So, I think any communication on that has to go with a prevention message as well.

4.4.3.2 PHUs Trusted by the Community

A number of individuals commented on the trust that the public has in health units and that messaging coming from the health unit would hold weight on informing their health behaviours. One interesting finding was that three people mentioned Ottawa Public Health's Twitter and cited it as one of the best examples of PHU communications due to its informal, funny and relatable commentary. A participant who could speak to that PHU's Twitter and how they produce their communications provided insights on OPH's "really strong social media presence".

> Twitter [for] example would be one of the stronger ways [that OPH] would do rapid communication with the public. [For] communication around, like, let's say heat events as a

> more, you know, immediate impact of climate change in terms of letting people know, what's happening, what their options may be, depending on the context for what's going on… If we were actively encouraging people to- um, we don't typically open cooling stations, for example, but if we did, that would be where we would be pushing it out process. The more general pieces about climate change, and health impact, we don't probably do as frequently. But like you mentioned, tick. So as just as a sort of standalone piece that's got some relation to climate change. So, [since Ottawa is] considered endemic for blackleg ticks… over the last few years, [OPH] will be talking about protection strategies and, and, you know, checking your kids for ticks… and all that sort of thing. So, [most of the communications comes] through [a health unit's] Communications Group um… So, if we're talking about ummmm… you know, like heat, a heat event, for example, that would come from [the] environmental health program, people [and be worked on in collaboration with the communications group]. [OPH] does a lot of that kind of communication. And you know, some of the more traditional stuff like pamphlets and things like that still happen, but for the most part [OPH] would use principally social media, [OPH's] Twitter following is one of the largest in Canada and North America in terms of public health units, so [OPH] has a really strong and far-reaching presence there, and there's been a really big effort over the last couple years to develop that as a- as a health communication tool.

4.5 Organizational and Behavioural Opportunities for Intervention

These are inductively conceptualized themes that emerged through the open-ended interviews. There were a few general questions about funding and accountability procedures in the interview guide, however most of the findings reflect new concepts outside of the anticipated responses because of the grounded approach that was taken in this research.

4.5.1 Funding

A majority of the sample (82.4%) commented on the role that funding plays in capacity-building within health units, non-governmental health agencies and in health advocacy organizations. Given that climate change is not always seen as a priority in this space, one health unit manager said, "I think a lot of it really comes to capacity at the health unit region, at the health unit level. So, you know, there are some health units that just may not be able to

afford resources or capacity to be engaged in this kind of work. And it's a so I think capacity is a big issue."

4.5.1.1 Specialized Climate Policy Positions

Five participants specifically noted the critical role of individuals who are hired to specifically work on climate policy work within the health unit. Often the presence of these individuals ensures that climate change work cannot be put on the back burner as easily. However, a lack of funding often means a lack of dedicated people working on developing and implementing a health unit's climate action work. One participant noted again, the impact of "climate champion" Medical Officers of Health in advocating for this to be a part of resource allocations for the health unit.

> The reason I was [a climate policy specialist] in [specific health unit] is because the Medical Officer of Health! He was a huge champion for climate change activism and mitigation and adapting to climate change. And there was one position on it, you know, but in other health units, it's not something that's necessarily a position that people have. It's kind of taken on by a few different departments [normally].

Another participant noted that they were the only person hired for a very large region of Ontario. They mentioned that COVID-19 did impact resource allocations, but regardless of that, they were still the only person hired for the job of generating reports on that region's vulnerability to climate change and their climate adaptation strategies.

> I'm, I'm the only one who is hired to do work for the entire group. It's good, because there's like, there's a climate and health team within each within each of the health units. And that's been like severely reduced, understandably, because of COVID. So, before we had a project of like, yeah, like 35 people, and now it's like, basically, like, one representative, maybe from each health unit and me. So, it's, it's, it's a lot less but yeah, you know, make the best of nothing?

A unique take from the Director of a health unit in Southern Ontario was that perhaps that is the most efficient next step: that regions should collate and hire regional climate policy specialists who could be dedicated to doing this work because he questioned if there were significant differences in the vulnerabilities of populations of neighboring health regions. At present, he noted that many smaller health units relying on other public health units' work (e.g., vulnerability assessments/ data) to draw conclusions for their region as they are more resource scarce.

> Where I find challenges is that, you know, there's the 35 public health units now maybe it's 34, I lose track. But there's lots of regions, right. And so, you know, what are really the differences between [two neighbouring health units in Ontario], like geographically, we're almost we're side by side. Right. And so, are those vulnerabilities different? In some ways? They are, in some ways, they're not, you know, the vulnerabilities as it relates to rural health. Perhaps they're a little more emphasized in our region than they are in [health unit that has both rural and urban regions within its jurisdiction], but [rural region]… [the urban side] still has [the rural side within its jurisdiction], right. So, they still have a rural component to it. And so, you know, does it make sense to create, you know, 35 vulnerability assessments to represent all 35 health units in Ontario? I don't think so. I think it's, you know, it's probably better to do some sort of regional approach. And so, what I mean by that is, you know, getting together with [list of health units in the area], and work collectively collaboratively on a regional approach to climate change in [our] region. And once again, you know, recognizing, acknowledging that there are some differences between all those regions, but I don't think those differences are large enough where it needs its own. It needs its own document. Right. So. So that's, that's an approach that I would prefer, but you know, we haven't got there yet.

One solution to the rampant under-funding for this issue was HealthADAPT, a federal government-funded initiative where ten health units across Canada received funds to do regionally oriented climate action work. An individual from the Federal government explained the funding allotments as “really the, each of the funding recipients gets a certain amount” but how they use the funding is up to them, noting that “they have to kind of have a detailed plan of how they're going to use the funds but it can be different for everyone”.

> One Health Authority might contract out the work to a contractor who does climate change, you know, assessments, and they might hire two to three people, they might only hire one, they might hire an epidemiologist for the first half. And then they might, it's really up to them to decide how they use their funding. And because all of the projects are different. So, for example in… before the pandemic, we also had to consider travel for particularly northern communities. So, we have the Northwest Territories who's doing a project. So that also has to be factored in, right, because it's going to cost them more to engage with their communities and say, in New Brunswick, as well in New Brunswick is doing an urban and a rural community. So, it really depends on each of the projects. For additional funding… so… grants and contribution funds, like that's where the funding comes from. And basically, we need to make sure that all of the funding recipients are using their money. If they're not using it, then someone else of the 10 can use that money. So, it's always like assessing how to do it. Then, that goes to our director for approval.

4.5.1.2 Data Gaps

One of the biggest reasons that funding specialized positions for climate change and health work was deemed important, is because then there would be someone dedicated to addressing the large data gaps that are currently present in this landscape. One participant outlined the impacts of data gaps and said, “we really just need to… be in huge, like information collection mode”.

> I just, I don't think we can be blind to any of it... Let's understand as much as we can, so we can pre prepared and we can't have prevention messages if we don't know what we're trying to prevent, or we don't even know if it's going to happen in the first place. So, I think like, really like knowledge is power.

4.5.1.3 Equity-Centred work

Another critical area in need of funding is in the realm of equity-focused work. Often, “diversity” needs are being met through consultation with community stakeholders, which is good; however, in the context of the aforementioned lack of diversity in staffing that was observed by many participants, it speaks to how many of the communications and adaptation strategies are being developed by predominantly white people until they are complete and

sent for feedback to stakeholders. One Director in a suburban region reflected and said the sector widely is “not perfect with respect to it”.

> We have a relatively small Indigenous population in [our region]. And that was an area that we have identified that. And, again, pre COVID, we were working towards it. But unfortunately, things have stalled. That's an area where we've identified that we need to do better and to reach out to and make sure that we have better input into the plans. We wanted to make sure that our heat warnings were reaching the appropriate group. So, we invited a range of stake stakeholders in to come and talk to us… we were asking, we were asking questions with respect to our reaching newcomers to Canada, are we reaching the linguistically challenged are we reaching those that are that are disabled, etc., etc.… but there were there were other populations that came through loud and clear that we weren't reaching as effectively as we needed to be reaching. And so that gaps analysis allowed us to, to step back, ask, how do we reach these groups? Because, you know, not everybody's on social media, not everybody is, is reading the English language newspapers, who do we need to be working with? To make sure that we are reaching and addressing these populations that are vulnerable and that is still a work in progress. No health unit is ever perfect on it. And it's something that we are in a continual process of refinement to work towards. So long winded answer, but we do have certain communities that we still need to do significant more work with. And as part of that whole strategic process that I've talked about identifying and developing those bridges to those communities is, is part of the work that we still need to do.

However, when asked for reasons why there might be exclusion (intentionally or unintentionally) of historically and presented under-represented groups, one individual who has worked in four health units previously before working in the environmental health advocacy space said that equity-centred hiring practices are resource extensive. The cost often was seen to de-incentivize the practice and this prevents from increased diversity in climate policymaking. They stated that dedicated funding for this would help tremendously.

> As a rule, [public health units and the environmental health space at large] is not too diverse, actually. But… but it's hard… I know sometimes people say this about the environmental movement, I think [one of my previous places of work] had three staff… With my 30 years’ experience, me and my two young staff that were working with me, we're making like $30,000. So, I think sometimes people forget that, you know, these groups that we're working with, they're really underpaid. So sometimes, you just take whoever… you'd be lucky to get anybody to like, you know, you get three or four people who would be interviewed. And by the time the interview, the interview came up to them, they dropped out because they found something else that paid better. So, there are there are challenges in the environmental movement, I think sometimes people don't understand is the resourcing can be an issue. But

> in terms of so… anyways that's, that's not an excuse for not having an… an ethnically diverse population, but just kind of getting people to recognize it sometimes in the environmental movement... I know for me, people kept saying, “Why aren't you guys working with Indigenous people?” And it's like, well, we're really small, we have a budget of $300,000 a year. To work with an Indigenous population, I would need to have the resources to actually go in and do a proper consultation, and to be really collaborative, and be really respectful. And that requires a certain amount of resources. And you don't really want to go and do it improperly… and I'm not trying to excuse it, but just saying, I think if we want people to do like, it's probably more for funders, but if we want people to in involve ethnically diverse and low-income populations, that we have to ensure that those projects are properly funded to allow for those kinds of processes to be done in a respectful manner. And we have to ensure that they include financial resources for the groups that we want to involve.

4.5.2 Structural Effectiveness

Barriers and enablers at the systemic and societal level were identified through this work, and a few of the ones that resonated with the most participants are identified below.

4.5.2.1 Barriers

Thirteen participants said that COVID-19 negatively impacted climate action progress. One epidemiologist characterized how their priorities were forced to shift, despite their primary focus pre-pandemic being on environmental health.

> COVID has essentially derailed everything by shifting everybody from their substantive portfolios into COVID stuff.. substantively, it's- it's pretty much taken up most if not all of the resources at a health unit level. So, when we're talking case management as an example, operationally, typically case management of infectious disease would be dealt with a relatively small team. And now we've got like 900 people working in it. So, there's been a big shift in terms of priorities. And that is changed a lot as well, even in the last few months as vaccination has come on stream, that people are being diverted into vaccination contexts. So, it's, it's been a big… [long pause] perturbation, in terms of the kind of work we do, and how much of that we do and what else we're able to do in the meantime. So pretty much it's a priority over if there's other things we need to deal with… in terms of how we can affect change and climate related policy and such at a municipal level… that's it's an interesting juxtapose for that piece.

A barrier that emerged again was surrounding data gaps, however in this context they were seen to perpetuate uncertainty in the public health hindering progressive actions. An

individual elaborated on the significant impact this has on climate change communications and the development of adaptation strategies from a health unit perspective:

> We don't have baseline data. And sometimes data is difficult to collect. So, for example, linking wildfire smoke to a respiratory impact or cardiovascular impact that maybe never like in a person that never presents to their doctor or to you know, they just have the impact. And, and but they don't present anywhere. Or they do present to their doctor or to emergency department, but it's just not, like real collected or related, or there's just like so many. And if you I don't know, if you have an understanding of like this, of trying to collect this type of data, it's really, really tricky. But it's something that everyone asks for. So, I find sometimes it's difficult to get around those questions or get past not having that data and still acting.

Another former health unit manager mentioned that this is a hindrance towards helping to establish that connection between climate change and public health and increased data points would help to communicate and strengthen this link for the public as well.

> [It's] really difficult if you don't have the data, or you're not able to make that connection. So that when we say how many heat related illnesses, we want it nice to have a number so you can say why it's so important. How many waterborne illnesses, it's good to have a number, I would say the vector borne diseases, even though there's other factors that are contributing to the spread of vector borne diseases, like land use development, like how our habitat the habitats changing, but it's certainly climate change. So having those numbers is really helpful. I think we do need more data. So where would resources go? vulnerability assessments? And then I would say, yeah, collecting the data.

Finally, all participants who could speak to Northern Ontario's experience stated that there were unacknowledged differences between Northern Ontario vs. Southern Ontario. One health promoter said, "we kind of have to take, like a lot of the plans and adaptations, and because so much of the work comes from Southern Ontario, and then we have to kind of take those ideas and try to adapt like, Okay, what could possibly work for this tiny town?" Another manager noted the health regions that each health unit in Northern Ontario are responsible for are much larger than the condensed, population dense regions in Southern Ontario.

> You can take half a dozen health units in southern Ontario, and that's including the larger ones and rattle them around in [region of Northern Ontario]. There's a push right now for electric vehicles. And it sounds like a wonderful system. But most people who are saying it's a wonderful system are looking at Southern Ontario and saying you're an hour to where you have to go. Well, I drive from here to Toronto, it's four hours. Dry. But at least if I'm going here to Toronto, I can start to get charged and Parry Sound, I can start to get charged. And direct, I go north… [I can drive 4 hours] and there's no place to stop. Like I said, the guy who's living out of the bush, no access at all to health facilities, food, not always the best education, not always the best… You know, so you start to you start to deal with that aspect of it.

Finally, a project officer who can speak to multiple health units in Northern Ontario mentioned how health units play a different role in communities there versus in Southern Ontario.

> I think, especially in Northern Ontario, is where the health units play such a predominant role in community health. And like, I mean, and… I just think like it, like everyone knows where the health unit is, and what the health unit does and cares into. I think some Southern Ontario places where there's just so many different types of health services that are available to you, whereas in Northern Ontario, like the health units is it sometimes.

4.5.2.2 Enablers

Four participants mentioned that public health needs to take a more active role in advocacy for this issue. One project officer explained that despite the public health standards mandating action, many *meaningful* actions were deemed to "radical" or progressive to be done by a health unit.

> The updated public health standards mandate that health unit's need to start engaging in climate change, right. But like what that engagement looks like, is, is- yeah, it's I think, where it sort of becomes tricky. It's almost, like people have to… they want to say that they're engaging in climate change, but like, not want to show that like too radical… which I think is, is tough, because at some point, I think we actually need what that radical action is sort of what we what we need. And by radical, I mean, like ground shaking action, not like, like action that that really like pushes us out of our comfort zone and out of the status quo, because that's how we're getting in terms of lowering emissions and adapting to the impacts.

A federal health authority mentioned that change requires both policy and community-led actions.

> Often policies are changed because we have advocates, you know, my background is looking at how kind of policies are created. And so, one of the frameworks is called the advocacy coalition framework. And so, what we see in that framework is where you have a ton of advocates who are really pushing for change, like the Friday Strike for Futures, the Greta Thunbergs of the world, who have really pressured and pushed and vocalize their issues, and starting to see and demanding some changes that, you know, create some changes within the policy environment.

Finally, six participants expressed the impact that youth advocacy has had on progressing awareness and elevating the importance of this issue. Many reflected that this advocacy reverberates to higher levels of governance and has implications on their own worldview.

> We've actually declared a climate emergency back in 2019 I think or 2020. And that got started because of the like, from my perspective, what I kind of saw, it was around the time of the climate marches that were happening all around the world. And then there was a group of youth. But I know for sure there's like one influential youth in [our city]. And she's been a climate advocate for like, since she was a little kid. And her mom is a big climate advocate, too. [The young person] started like Friday's for Future marches in [small Northern Ontario town] and [it] really brought it out into the public, like people could actually see that everyone else cared, and that all these kids cared. And so, to me, I think that that was one of the big things that propelled our municipality to declare a climate emergency and that, that, like, now, our municipalities kind of making commitments, about climate change, they're already you know, making their way and everything. But, um, that was big like to see that happen. I was, I didn't know if that would ever happen.

4.6 Policies and Practices That Can Be Leveraged

This category reflects policies and practices that were inductively identified as key leverage points; these findings offer insight into where high-level change can happen occur for systemic impacts across the public health sector. These findings also help to elaborate upon the intricacies of the conceptual framework surrounding organization of power, knowledge and responsibility across the public health sector for climate change-related work, which was developed through the theoretical sampling process and is summarized in Appendix E.

4.6.1 Structural Accountability

The most important policy identified from this data consisted of the updated public health standards; alongside this, an aspect of the public health structure that was found to be influential was the interactions between the health units and their regional government. Given the role of governance implicated by both of these sub-themes, the category was decided to reflect upon accountability measures at a structural, systemic level for climate action.

4.6.1.1 2018 Public Health Standards Mandate Climate Action

One of the most interesting findings of the results was the varied response on participants' perspectives of the public health standards which, as of 2018, mandated that public health units were to address the health impacts of climate change in their work. Two individuals in particular, notably the youngest and the eldest in the sample (potentially reflecting their perceptions of this from a personal but also professional experience standpoint, respectively) had incredible depth to their responses. The individual with arguably the most experience in this work within the sample explained their viewpoint on the standards. Firstly, they mentioned that there are no strict accountability measures for what health units *actually* have to report on completing, nor a time frame.

> With the healthy environments program, where it says, you have to, you know, assess the climate change vulnerability in your community. That could be you looked at the number of heat events in your community, you [could do] some type of communication, but it's not as prescriptive, unfortunately. So, [an individual at the Ministry of Health] was saying that they were going to put something in the standards that says that the health units *had* to complete their vulnerability assessment by 2021. And then every year thereafter, they would have to provide an update… but that's not in there at all. So, the accountability, you know, even

> though it says you *have to do this*, there isn't a strict guidelines or requirements for what you would actually have to report on.

They mentioned that the standards were developed from a "revenue neutral" standpoint, meaning they were a requirement, but health units were not provided additional funding or resources specifically to uphold the mandate. They also outlined that the vulnerability assessments often take two-three years to complete and require multiple staff members, so it is unrealistic to see meaningful actions resulting solely from the mandate prescribing that health units need to act on this issue.

> I remember, back when it was first introduced to health units, the Ministry of Health said, you know, this is going to be revenue neutral. And that was the challenge… That to say to a health unit, *you're required to do this*, but it's going to be revenue neutral, which means that you don't have to add any more staff. And of course, that happened every time they updated the standards. Because if you're going to require health units to do something new, you have to then provide the resources for them to do it. Because we could look at it and say, "hey, we need two more public health inspectors or environmental health officers to do this job." So, they're very careful to say, you know, it's revenue neutral, and perhaps you could do this climate change and health vulnerability assessment, you know, by just doing a bit of like- they tried to simplify it, but for the [vulnerability assessments] that I've been involved in, you realize it's a two-to-three-year process, you have to, you know, it involves two to three staff. So, when I was still [working] at [health unit], we started the climate change and health vulnerability assessment. So, I know the scope of it. But you know, I've heard that before, too… That, "we're medical officers, I'll say it's not our job to do that." It's the way they might interpret the language in the standard.

The youngest individual in the sample, who is employed at a health unit, expressed the same concerns surrounding the lack of funding to support direct actions from the mandate.

> It's hard because they mandated it, but then there's no, like direct funding for like people to hire like a specific climate change person. So, like, yes, I think it's made a difference… I think it's hard because… I think this was changed with the previous government, if I'm, if I'm correct. And then and then that conservatives took over. So, it's, but yeah, so there's no like, specific person to like, did engage in this climate change work, which is like why, which is so interesting. For instance, in our project, we're applying to this federal fund to engage in climate change work to fulfill our provincial mandate, which is like, like, it's, it's wild, because health units already are, like, stretched so thin and then you want to modernize this, and you want to reduce the capacity, that health units have. So, I think it has made a difference. Because I think, if it wasn't mandated, I don't know if there's certain partners within our collaboration that would like to feel as engaged or as, like, motivated to

> participate. Whereas like, because it's mandated, and we have this funding- people are recognizing, like, oh, let's engage, like, let's do something right now. We have somebody who can sort of help us as a whole collective.

This individual later brought up the standards again when discussing accountability and they identify that it's the Board of Health's responsibility to ensure that their unit is meeting the prescribed mandates:

> I think something I struggle with it a little bit because like, you look at the updated standards, right. And they, I mean, I think it's nowhere where it's mandated that health units have to conduct a climate change and health vulnerability and adaptation assessment. Like it's almost like saying, like, you need to engage in climate change work. And I think that's hard. And that's where like, when we think about like the public health system and how the meant the public health mandates are upheld, it's really falls on the Board of Health, to like, sort of make sure that things are going smoothly.

They also highlight that the wording of the mandate is vague, and this is good because it is more realistic to acknowledge that under-resourced or small health units cannot undertake vulnerability assessments and so mandating them without funding would be impractical, however without specify in the wording, this decreases the weight of the impact of the mandate on ensuring health units meaningful engage in climate action work.

> I think I think it's vague in terms of that accountability piece is really mandated from health units to do in terms of climate action. Which it's hard because, like, Yes, I'd love it for like to say like, yeah, health units have to conduct a vulnerability adaptation assessment, it has to include yada, yada, it has to be like this detailed [and] has to do all these things, but like recognizing like capacity and funding limitations and existing, like maybe perceived as more urgent challenges that are that are around it's, it's tough to do that. And tough to think about having to mandate that… I think - yeah, it'd anger a lot of people and just wouldn't be realistic. But I think that the public health mandates have like you just see the amount of health units that are engaging in climate change work now. And whether or not they're recognizing that these are becoming big impacts. And it's something to do or whether or not it's because of the mandate, or I'm not sure, but people are, like, a lot like lots and lots of health units, if not all health units are engaging in like purposeful climate change work, which is, I mean, positive to see.

Additional thoughts from all 14 individuals of the sample that provided thoughts are summarized in Table 4.7.

Table 4.7: Public Health Actors' Thoughts on Updated Public Health Standards.

Positive Feedback	Areas to Improve
Did lead to increased awareness of climate change in public health sector broadly	Lack of accountability metric (i.e., no guidelines in what to report on) for progress so often gets bumped to bottom of list
Additional professional development opportunities/resources for health unit staff if they wish to learn more	No significant cultural or behavioural shift following the introduction of the standards because leadership does not prioritize it
Mandate by Ministry helps staff bring issue to their Board of Health to prioritize more	Use of revenue neutral language (no funding provided to uphold mandate i.e., no dedicated staff and health units are already stretched thin, so it is unrealistic to do vulnerability assessments)
Flexibility for each region because of the broad nature of the mandate statement	Inconsistencies in interpretation of vague language of mandate so each unit doing different things (Medical Officers of Health don't necessarily see it as part of their work, and it is not mandated by law to conduct climate change health vulnerability assessments)
Incentivized increased engagement with community stakeholders on climate action strategies	Climate change should be made a health priority, so it explicitly gets dedicated resources/prioritized because currently, many public health units are helping inform regional climate strategies initiated by the city/ town not generating their own because climate change is considered it to be a subset of other existing programming, not its own program

4.6.1.2 Relationship with Regional Government

All but one individual from the sample commented on the impact of interactions between health units and their regional government upon their climate adaptation strategies and risk communications. There was a variety of perspectives captured, including conflicting viewpoints. There are a variety of organizations for public health units across Ontario, and

there were marked differences experienced by those whose health unit is associated or under the regional government directly, often as a department, versus those who were independent of regional governments and instead worked to engage municipalities under their jurisdiction more so on their own.

Firstly, being independent from one's regional government was said to allow for more progressive climate policy work. One participant who has an affiliation to both health units and non-governmental health agencies provided a remarkable example;

> Let's say I use [a health unit employee, assigned pseudonym John]- he might be on an OPHA Committee, and he might provide input on comments that [OPHA] was making about the province's environment plan. But that's not from John, from X health unit. That's John [as] a member of the Ontario Public Health Association. So, and his name is never associated with the comments. So many health units have said that, and I felt the same way. When I worked at [my health unit], I wouldn't have been able to put my name to certain comments, to say, you know, we oppose this, or we feel there should be stronger standards, because being part of a regional government, we might not have had the same opinions as our counterparts within the regional government.

Further, an individual who works at an independent public health unit explained that they feel they can do more work in the realm of environmental health and climate action in general, without a political conflict of interest.

> Probably [we can do more work], as we, we aren't part of [our county] as, as an agency or any of the other municipalities here. So, it's an independent board of health. Whereas many other health units are part of a region like the Region of Peel or Region of York. And my understanding is, when they're operating in that kind of a structure, it's a much more political and constrained environment to work, and they have a lot less freedom to do what they need to do in any particular about communications, there will often be a communications department for the entire region, and everything that they do would have to be approved by communications, right. And so, they wouldn't have necessarily control over what they decided they want to communicate to the degree that we do.

An individual who works at a health unit that is associated with its regional government identified that their funding sources present a conflict of interest for certain actions, including commentary on choices made by political leaders which go against what is scientifically

sound or what public health units "should" be supporting if they are following their mandates.

> 100%. And I think I think that's why [the] MoH is like, or that's why leadership at least has trouble engaging because like, we're funded by the government, right? So, like, if we're going out and saying, like, Doug Ford's decision to cut- what was it like $300 million in renewable energy sources, or whatever it was- saying that's a horseshit decision… man I've never seen- that was a terrible decision. Then. Then, like, that's, like, obviously going to impact funding and then at the same time… they want to frame it as it's coming down the line. Yeah, not wanting to like step on people's toes. And I think that's, like, only amplified by the fact that, like, we have a conservative government in play right now. Yeah, I mean, the dynamics in terms of balancing that message is really, really, really tricky. And I think like, that would be like the number one barrier, in terms of open advocacy and open follow on engagement is because [of] this perceived politicization.

A participant with over 30 years of experience working in public health explained that Ontario is very tied to regional health units but is also one of the few provinces with independent health units as well. She described the increase in bureaucratic barriers that are imposed when health is tied to governmental oversight and said,

> In Ontario, we have this system where public health is very tied to regional local governments, or they're independent and they're working with multiple local governments like [an independent health unit]. And there's good and bad to that the good in my, in my experience has been that they can really respond very uniquely to the needs of their communities… They also feel like they have more of a political voice when it comes to provincial issues, at least they did until the Ford government came along, and then start to threaten to shut them all down. And then everybody kind of felt like *oh, my gosh, we have to be careful*. But across the country, I think most of the public health units in the other provinces work directly with the Provincial Ministries of Health. And then you have, less nimbleness. So, it's more bureaucracy. So, you know, [one of the health units that I previously worked at], that was when there was a problem, it came up through City Council, it came directly to us to the Board of Health, we would be given very tight timelines to respond to… to research and respond to it. And that made us kind of nimble and responsive, very democratic, with my sense of these other health units is that they're more ensconced in the Ministry of Health. And that things kind of take that time that it takes with a larger, more senior level of government, and that they're more closely monitored, in terms of what they're saying. And so, there's things they can't say.

Despite these negatives, some individuals identified benefits to being associated with regional government. One Southern Ontario health unit manager whose unit is associated

with their regional government stated that it enabled better communication and easier interdepartmental collaboration.

> I would even argue that you would want to [be a department under the regional government]. So, in our case, in our region, being part of a year ago, starting a local municipality, even just the councillors, the mayors that are involved, I think, would be really key as well, because if something is coming from that level, it's likely to impact all departments. And I think that facilitates then, you know, more collaboration across departments or being on the common agenda, so to speak.

Another individual whose health unit is also a department under their regional government, they went so far as to say that they see great value in being integrated within the regional government's structure, but they acknowledge that agenda items that come off as "advocacy" have to be "couched" due to the nature of the affiliation.

> So, it has pros and cons, nothing is perfect. It however, I think for from a climate change perspective, it's been more pros than it has been cons. Were talking to sister departments when we're working, we're all under the same umbrella. We can, we can work openly, we can share resources, we can go back and forth. There are no institutional barriers with respect to that, and even just easy things like facilitating document sharing, you know, when it's all done internal, it's easy to do it on a SharePoint or OneNote site. So that has its benefits. Our board of health is also our Regional Council. So that facilitates it as well because our Regional Council councillors are also local tier Councillor, so, you know, the communication flows, I think a little bit easier than, than if we were stand alone. So, so by and large, I would say overall, it's been, it's been positive. Um, you know, sometimes though, you have to, if you're doing pure advocacy, you have to couch things because you're advocating to internal, folks. And so, you just do you do things a little bit differently. But no, I overall it's been it's a largely positive, positive situation.

Consequently, even independent health units have to working with their municipality or municipalities to fulfill climate action strategies in region. This interaction is sometimes made difficult if the health unit does not already have a relationship with senior leadership and this is often avoided in units integrated with the regional government.

> We are not part of regional government, right. So, we do have [a number of] separate municipalities within the region plus [a number of] upper tier municipalities within the region. So, if we're to develop a program, if we wanted to develop a heat strategy program, for example, like we'd it would be a lot of outreaches to [many] different municipalities, rather than just dealing with a city, you know, a city of Ottawa or city of Toronto kind of

> thing? [It's] very limiting. Because it's just, you know, you kind of have to sell the idea. You know, you have to get the municipality on board, it's a cost to them. With shelters, or cooling centers, whatever. And it's just, it's very limiting.

Finally, many individuals note that broadly at the municipal level, the health perspective is often underrepresented in conversations about environment and climate change. A former health unit project officer who now worked in a health agency remarked that these discussions often happen with "more relevant" departments such as planning or conservation.

> When you look at climate change, in particular, worse, health is still often not at the table around, like climate change decision making. And so, we're often expected to deal with the downstream health impacts. But to get us around the table of like, no, how do we like look at this upstream and prevent things? I just don't think there's like that system, where health is given an equal weight when these decisions are taking place. So yeah, I think like, there's the [climate change and] health in all policies approach, which, like, you know, really integrating that into everything that we do, I think, is a really interesting way of like valuing health and really, really thinking through our decisions and making those connections. And I think just like communicating the idea that like health, health is everyone's priority.

Chapter 5: Discussion

To identify opportunities to optimize the Ontario public health sector's response to climate change, this study placed great emphasis upon elucidating the knowledge, perception, understanding and attitudes of Ontario public health actors, alongside documenting their unit or agency's ongoing mitigation, adaptation and risk communication efforts in relation to climate change. The first two sub-sections of this chapter explore the findings in the context of the two primary research questions of this study; **(1) "**How does knowledge, understanding, perception and attitudes towards climate change-related health risks differ amongst public health sector actors in Ontario?" **(2) "**What mitigation, adaptation and risk communication strategies are public health units implementing or proposing for climate change-related health risks, and to what degree are they locally contextualized?" Following this, the inductive findings are integrated into the discussion within a few-sub-sections to provide more context for the research questions' findings. Based on the findings of this research, policy recommendations are provided that have the potential to improve the prioritization, efficiency and impact of climate change-related work in the Ontario public health sector.

5.1 Public Health Actors' Mental Models: Implications for Progressive Climate Action

A mental model is a person's internal, personalized, intuitive, and contextual understandings of how something works (Kearney & Kaplan, 1997). Mental models carry three important

functions: to be a framework which people fit new information into, to define how individuals' approach and solve problems and to help formulate actions and behaviour (Carey, 1986; Morgan et al., 2002). As previously described, the Theory of Mental Models is often practically applied to develop expert models. This is generated from a combination of a literature-informed diagram used to visually represent interdisciplinary knowledge (Morgan et al., 2002) as well as through findings elicited via open-ended, semi-structured interviews. For this study, the definition, causes and impacts of climate change are summarized into a diagram found in Figure 5.1.

5.1.1 Knowledge, Understanding and Perceptions

According to Morgan and Colleagues (2002), thematic analysis can used for mental models-related work, with frequencies and patterns being identified amongst participants. This was operationalized in this study. To this effect, 14 of 17 public health actors provided a definition of climate change but only eight demonstrated knowledge of the topic when compared to the baseline of knowledge set by the literature-informed diagram. Furthermore, only eight participants provided their thoughts on differences between global warming and climate change, and of this, many varied responses were provided (summarized in Table 4.3 in Results). For example, some individuals had the misconception that climate change was a part of global warming, or that they were exchangeable terms, with one being newer. However, in the context of the scientific literature, the most accurate conceptualization – which was reflected in a small minority of the respondents – is that global warming causes, or in a part of, anthropogenic climate change (NASA, 2020). Generally, individuals with

specialized roles in environmental health or climate policy work knew the most and provided both the most in-depth and most confident answers. People that did not answer the question or refused to answer all expressed that they had not "prepared" or "read up on this in a while".

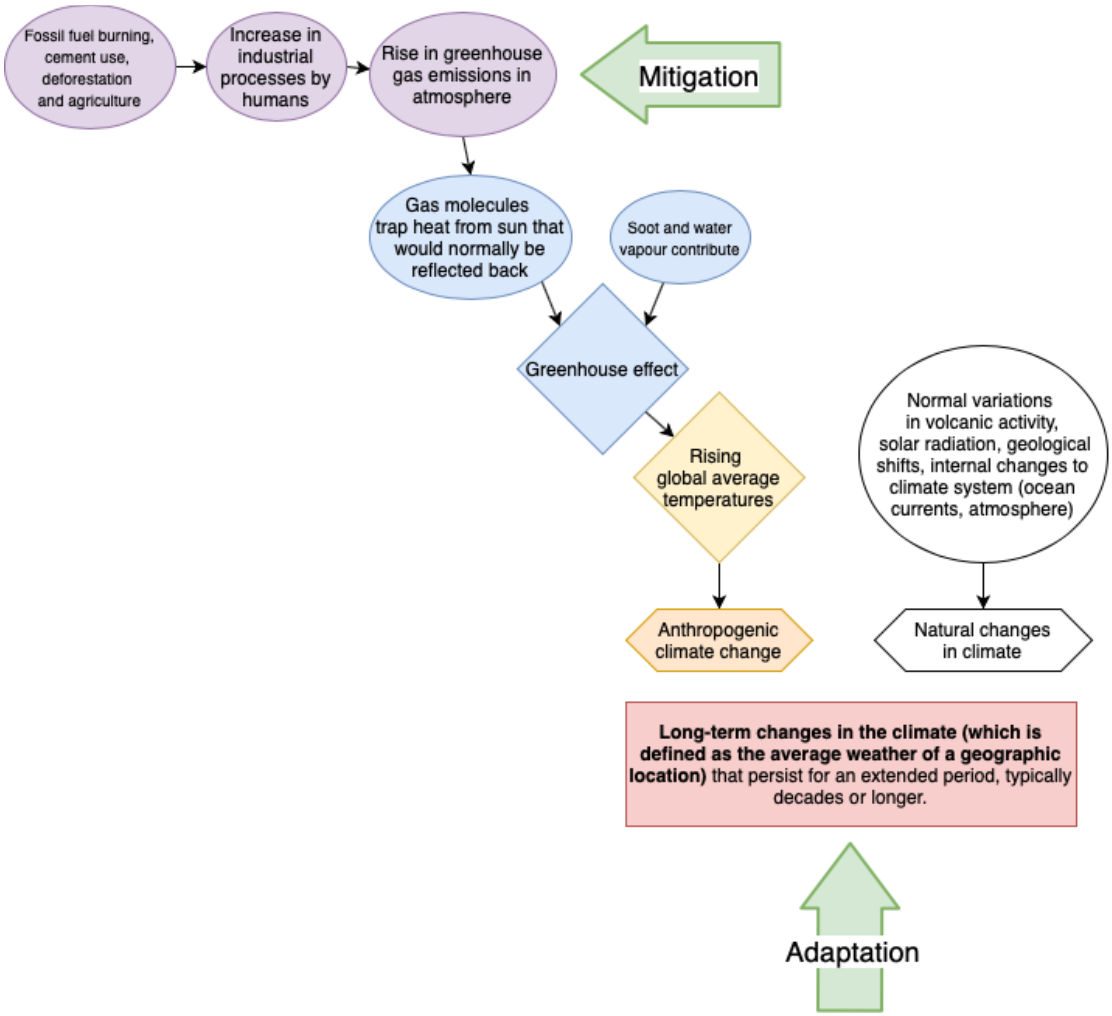

Figure 5.1. Simplified diagram outlining causes and definition of climate change (IPCC, 2018; NASA, 2020); includes green arrows indicating what "mitigation" and "adaptation" as intervention strategies refer to.

Interestingly, most respondents demonstrated a greater understanding of the impacts of climate change than knowledge of the causes (summarized in Table 4.4 in Results). This is potentially because in their professional roles they work more closely with the impacts rather than the causes. This was described by one epidemiologist at a health unit though the example of his health unit setting up cooling stations during heat waves, for example rather than advocating for emissions reductions. This is likely also reflected in the heavier focus on adaptation strategies over mitigation strategies within the public health sector broadly because climate adaptation is seen as more within their jurisdiction (Fox, Zuidema, Bauman, Burke, & Sheehan, 2019).

All of the individuals in the sample brought up the social determinants of health, and many easily identified ways that structurally vulnerable and marginalized communities could be disproportionately impacted by climate change. This can likely be attributed to their training, as indeed over the years there has been a greater emphasis on the social determinants of health within the public health sector in Ontario (Shahi, Karachiwalla, & Grewal, 2019, pp. 183-185). However, the small number of respondents who had more interdisciplinary academic backgrounds in post-secondary education were also able to draw deeper intersectional connections between climate change impacts and the differing impacts on sub-populations in Ontario. This finding, along with the literature on risk perception that found that racialized people (Hathaway & Maibach, 2018, pp. 197-204) and young people (Besel, Burke, & Christos, 2015, pp. 61-75) perceive a greater risk to their health as a result of

climate change, might provide some basis for valuing interdisciplinary academic backgrounds and diverse lived experiences in senior leadership more within the sector.

In terms of perception, one aspect that was interesting was the mention of a study called "Six Americas" by multiple participants when asked about their view of how community members in their jurisdiction viewed climate change, and if they established a link to health. The Six Americas study essentially characterizes the six predominant archetypes of individuals with respect to beliefs and level of urgency felt surrounding climate change (Leiserowitz, Roser-Renouf, Marlon, & Maibach, 2021, pp. 97-103). Despite this being an American study, the viewpoint that Canadians are the same would mean that individuals holding this belief also believe that we have the same hyper-polarized political environment. However, there is a great possibility that the Canadian population would differ considerably from the six archetypes of the Six Americas study, given that we have a multi-party-political system. In fact, Mildenberger and colleagues' (2018) interactive map of the differences in Canadians' beliefs about climate change separated by each Federal Electoral District demonstrates that as of 2018, there was not considerable variation observed between regions that voted, for example, Conservative versus Liberal. Potentially, this reflects the participants' own viewpoints surrounding the perceived polarization of climate change within the public health sector. However, more research would be required to draw conclusions to this effect. Notably however, a few participants mentioned that there are opportunities within the public health context to contribute to the continued de-politicization of climate change.

Overall, these findings suggest that there is a sufficient amount of knowledge, understanding and general concern for climate change by select public health actors that chose to participate in this study. Although, it is important to note that there is a potential reduction in the generalizability of these findings given that there might have been a potential selection bias built into the design. As elaborated upon in the "values" sub-theme in the Results section, this study's recruitment and data collection was conducted over the span of a public health crisis and so those that participated in this work during this time were likely individuals who already recognize climate change as an emerging threat to the health of Canadians and already had a certain degree of knowledge and understanding on this topic. Other work in this field completed in 2018 has determined that across the sector more widely, health unit staff *did* still need to better understand climate literature and models, and that there needed to be more experts involved in the process to support evaluation of the data (Levison et al., 2018). Consequently, it could be beneficial to conduct a similar study with individuals who have no formal specialization or personal interest in climate change and compare the findings.

5.1.2 Values, Attitudes, Motivations and Beliefs

In the context of the behaviour of public health actors, there were two main themes (values and attitudes) that were observed, alongside a number of sub-themes surrounding aspects that influence the motivations towards and prioritization of climate change-related work, as well as relevant decision-making practices. Generally, in terms of values, the individuals who felt

strongly about this topic also felt that the public health sector has a responsibility to act and that it was both their personal and professional responsibility to work on climate action work. Despite this, many stated that the prioritization of climate change-related health work in public health units relied greatly on the values of senior leadership, including the Medical Officers of Health and the Board of Health. This theme is touched upon in greater detail in the organizational and behavioural barriers towards effective implementation of climate action strategies sub-section, within the Results chapter, as well as below in the description for the mental model of a "climate champion".

Those that demonstrated the attitude that engaging in climate action is a professional responsibility also believed that the public health has a role in advocating for mitigation efforts alongside adaptation. Amongst all of the beliefs mentioned, one that was concerning was where two individuals that felt that overpopulation played a role in causing climate change. This association has been seen as problematic from a climate justice policy perspective because it fails to acknowledge that a majority of the world's population is not responsible for a majority of the emissions (Boothe & Boudreault, 2016). In fact, Canada is one of the top ten emitters in the world and Canadians have the highest per-capita greenhouse gas emissions per person with our whole population emitting three times more emissions that nations with a similar population size (Boothe & Boudreault, 2016).

The most unexpected finding from this research was the role of emotions as a motivator for climate action, and for influencing the prioritization of climate change-related work in public health work. Importantly, the emotions experienced by public health actors in relation to this issue that most readily identified were anxiety, shame and guilt, and these often were cited to motivate those public health actors to care more about this issue, perceive a greater risk to the health of their families and underlined a greater urgency to act. In the context of literature on emotional appraisals in decision-making, this aligns with the expectation that emotions do play a critical role in decision-making and should be further explored in the context of climate change and health policy work (So et al., 2015, pp. 359-371; Wong-Parodi & Feygina, 2021, pp. 571-593).

Overall, the sense-making processes posited by the Theory of Mental Models were both useful in this work and were found to interrelate frequently (Figure 5.2). One practical application of this theory in the context of these results is that one can use these processes to develop the mental model of what a "climate champion" would look like.

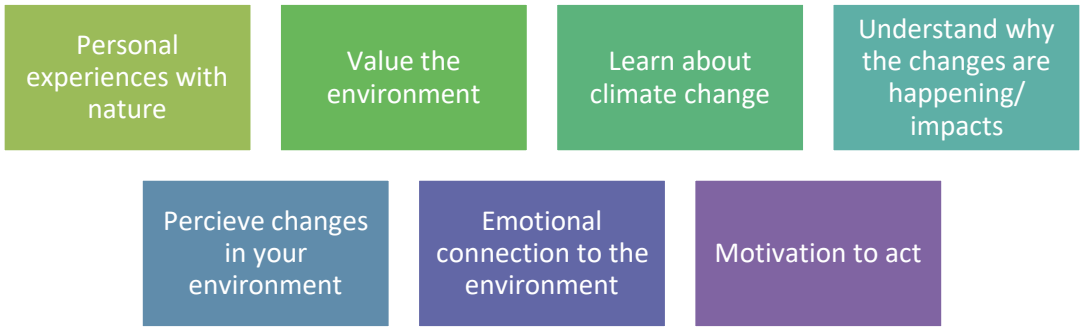

Figure 5.2. Sense-making processes identified in this work.

The best example of this is found through one interview with a Medical Officer of Health who expressed that they make both personal lifestyle choices and professional choices with the intention of doing all they can to "walk the walk" when it comes to climate action. When asked about their motivations, they reflected on their connection to nature and that growing up, spending time in nature, having a free, active childhood and engaging in outdoor activities was something that they really valued. They said that they continue to value these things into their adult life, and wish for their children, and other young people to be able to experience this as well. Despite being an individual who, as part of the job description, has a medical degree, and thus has not completed post-secondary education that would offer specialized training for climate change-related health work, they demonstrate a personal connection to this topic and have thus advocated for it to be a greater focus at their health unit. They have actively sought out more knowledge and they reflect a deep understanding of the topic through their ability to make connections between their lived experiences and their knowledge structures. One such example was the description of the connections between built environment, urban sprawl and health and the surge in organized sports over the years due to less access to a free and active time spent with nature, engaging in outdoor activities and play. They further established a connection between the aforementioned and the implications on childhood obesity rates. Bringing this together, it is clearer to see why certain individuals who have a personal interest are able to not only prioritize this issue better, but also conceptualize strategies to address this issue in a pragmatic way. The lack of personal attachment to this issue may provide an answer to why some Medical Officers of Health did

not view climate change as being a part of their portfolio, despite the public health standards mandating that it is of concern to, and should be addressed by, all health units. This further raises the question of whether we need more "qualified" individuals from an environmental background in senior leadership or if we rather need more passionate individuals. The findings of this work favor the latter, and postulate that knowledge structures are less influential than affective influences alone (i.e., those who feel stronger about climate change, seek to gain more knowledge on it, and once they know more, they have an increasing urgency to act). However, it is maintained that both are involved in shaping one's worldview, both are inseparable, and both interact with each other (so the more you know, the more you feel inclined to act and vice versa as a general rule). This is aligned with the Theory of Mental Models' view of sense-making (Westbrook, 2016, pp. 563-579), and is an emerging field of study at the moment in climate change risk perception and communication work (Wong-Parodi & Feygina, 2021, pp. 571-593).

5.2 Improving Health Promotion and Risk Communication Materials

Risk communication-wise, despite many participants recognizing a need for communication materials on climate change, not many health units were identified as being proactive in producing such materials. Individuals with experience in health promotion and risk communication offered effective strategies for the creation of such materials, including some that warrant further investigation and/or elaboration before they can be deemed as truly effective. Most notably, a critical aspect needing further inquiry is if associating health outcomes related to climate change, with climate change should or should not be a practice in

health promotion materials. In addition to some individuals being advised not to due to this either due to insufficient regional data to make that claim, or due to the politicization of climate change, there's also the consideration that this might be using fear appeals in risk communication messaging (Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010, p. 299).

In this study, many participants' used words such as "terrified", "insidious" and "species extinction" to describe climate change. Often, these were the same individuals who provided remarkably emotional responses to the questions surrounding their biggest concerns associated with climate change. This data leads us to question whether or not knowing more about climate change is productive towards motivating meaningful climate action, or if there is the potential for this to cause more eco-anxiety and grief that can eventually immobilize individuals through feelings of futility (Comtesse, Ertl, Hengst, Rosner, & Smid, 2021).

Moreover, many participants expressed grave concerns for their children, and the future of humanity. This presents an opportunity to investigate the efficacy of intergenerational impacts-based narratives on climate change-related health communication materials. One example of this was seen through the *Make It Better* campaign, which was cited by numerous respondents as being effective at targeting mothers through their health promotion materials focused on the health impacts of climate change on children. Additional audience segmentation work would be required to know more about the effectiveness of this framing

approach; however, these findings are enlightening and contribute significantly to the discourse.

5.3 Greater Focus on Resource Allocation

As suggested by the data, the greatest areas identified by the participants that need additional resource allocations include funding for dedicated personnel to work on climate change and health policy work, who can both progress this issue and begin to close data gaps, as well as an increased focus on equity-centred hiring practices to increase the representation of historically and presently underrepresented groups.

5.3.1 Steps Towards Better Equity-Centred Policy Work in Public Health

The findings of this work elucidated that underfunding of the public health sector broadly has direct implications on equity, diversity and inclusion practices as this is reportedly the first aspect to be sacrificed when there is a resource scarcity, according to study participants. This, coupled with the existing lack of diversity in the Ontario public health sector generally presents a grim portrait for how the communications and climate action strategies are informed.

Previous literature has noted the critical role of equity-centred hiring practices and the value of having diversity in the public health sector broadly in Ontario (Buse, 2015; Shahi et al., 2019, pp. 183-185). Importantly, a US-based study by McCright and Dunlap (2011) found that white, conservative males, particularly those who "self-report understanding global

warming very well", contribute to a high level of climate denial, even when controlling for the direct effects of political ideology (McCright & Dunlap, 2011, pp. 1163-1172). Other US studies have found that Hispanics/Latinos (69%) and African Americans (57%) are more likely to be alarmed or concerned about global warming than white individuals (49%), whereas white individuals were more likely to be doubtful or dismissive (27% vs. 11% for Latinos; 12% African Americans) (Ballew et al., 2020); Further, non-white Latinos were more likely to be citizen activists for climate change than white individuals as they reported higher perceived risk for the impact of this issue, which was noted by researchers to be the single strongest predictor of citizen activism (Ballew, Goldberg, Rosenthal, Cutler, & Leiserowitz, 2019). Given that the impacts of climate change will not be borne equitably across all populations, the perceived risk of climate change as a public health threat will differ amongst individuals and this could translate to a lack of urgency to act on this issue.

Moreover, it is interesting how advocacy and justice-oriented approaches were generally seen as politicized or unprofessional in the context of the professional roles/ responsibilities and expectations of public health actors. A handful of the participants most concerned about climate change mentioned that they believe public health professionals and units did need to play a bigger role in advocacy-type work. Despite this, many of them also recognized that this is a polarizing opinion even within their workspaces. The connotations associated with these words are possibly a reflection of the lack of diversity within the workspace, and have the potential to be associated with white, patriarchal professionalism practices (Gray, 2019),

however more research and data on the demographic compositions of health unit staff would be required to draw any conclusions to this effect. Overall, it is interesting that all of the participants mentioned the social determinants of health and acknowledged that health equity is an important aspect of public health work, but no one mentioned climate justice. Climate justice, according to the UN's definition, is essentially addressing climate change using a health-equity lens to ensure added consideration for the social determinants of health (Mendez, 2015, pp. 637-663).

5.3.2 Closing Data Gaps

Many participants cited that data gaps hindered progress, with a number of them providing examples of senior leadership preventing them from sharing communication materials due to lack of updated and/or locally contextualized data. The aspect of this that was most concerning was how data gaps perpetuated uncertainty about if observed phenomena were actually attributable to climate change or not. In the absence of data that reflect this correlation, many health units in Ontario would, based on this study's findings, be unable to link the health risk back to climate change. They would also then be limited in their impact when discussing why emissions mitigation is important in the context of human health, as it would be difficult to draw a connection between the health co-harms and co-benefits, as one participant noted.

One possible solution to this is found through the increased use of the "precautionary principle". With origins in environmental health, the precautionary principle states that when

faced with serious threats to health, action to minimize harms with the information available are favoured over waiting to resolve or address the scientific uncertainty (Goldstein, 2001, pp. 1358-1361). Based on a few of the participants' insights, it seems that some in the sector are inclined to use this approach because of the speed at which this problem is proceeding. In particular, one health unit employee noted that an associate Medical Officer of Health would not allow for them to include one year old data in their campaign, for fear of uncertainty regarding how that would reflect on the health unit if found to be inaccurate, however, no alternative data existing in the local context to be able to speak to the topic of the campaign. The director of a health unit further discussed this, when he reflected that he did not believe data from the neighbouring health unit's vulnerability assessment differed significantly from what his unit's health region would. Given that his unit was more under-resourced than the neighbouring unit, he said that for now, they rely on that to inform their strategies and communications on climate change-related health risks. Consequently, in the interim before data collection hopefully ramps up for each local context, it is recommended that health units should more readily rely on the precautionary principle to address this concern over uncertainty. In doing so, health units, agencies and organizations should use the best data available to them at the present time to begin to address this issue and create strategies and communication materials on this topic, rather than perpetuating further inaction.

5.4 Improving Structural Accountability

The effectiveness and accountability of existing climate action work is impacted by the associations with regional government in both helpful and unhelpful ways. Some respondents

felt it facilitated better interdepartmental collaborations and made it easier to work directly with municipalities in the region who would be otherwise difficult to connect with. However, as one of the participants noted, there is a great degree of "nimbleness" that comes into play when you are working for a health unit that is associated with its regional government, and funding, as well as the reputation and responsibility associated with being considered an extension of the region's governing body. This presents great restriction over the activities and stances that public health units and their employees can take. Another health unit director remarked that things "get couched" because you are working through "internal networks", implying that stances on policies and communications must be watered down to be palatable to other departments of the Region.

Although previous literature has broadly characterized key enablers for climate adaptation efforts in the public health sector in Ontario included, "political will, inter-agency coordination and local leadership", particularly support from non-public health municipal actors such as the city councillors (Frumkin et al., 2008, pp. 435-445; Paterson et al., 2012, p. 452), no known previous study on Ontario public health actors has identified this same organizational barrier surrounding regional government. However, these findings do resonate with the conclusions of a 2019 report entitled, *Assessing the State Of Climate Action in Ontario Municipalities: The Drivers And Barriers To Implementation* (Coningsby & Behan, 2019). In this report, a major barrier for climate action within the province at the municipal broadly level was low climate literacy amongst Ontario's municipal actors, particularly

senior managers and city councillors (Coningsby & Behan, 2019). This low literacy was suggested to have a negative downstream effect on funding for meaningful mitigation and adaptation initiatives, and in developing necessary programs for the public (Coningsby & Behan, 2019). This study also indicated that each municipality had been creating their own unique climate action plan with policies and programs that municipal actors in public health and in adjacent sectors, such as conservation and urban planning, as well as city councillors, felt were most pertinent to that community. However, most actions taken by municipal actors were deemed reactionary by the authors rather than being preventive in nature. This was determined to be largely due to a lack of experts in managerial positions, leading to a reduced emphasis on upstream interventions such as health promotion (Coningsby & Behan, 2019). Aligned with the findings of Pajot (2016), even in Ontario municipalities where climate action initiatives include cross-sector actors and are informed by frameworks such as the *Local Environmental Initiatives Climate Adaptation Framework*, the progress is slow and at times, inefficient. They attribute it on the municipal side due to high staff turnover that leads to a need to consistently train individuals, alongside four-year election cycles that fail to allow ongoing initiative to mature (Coningsby & Behan, 2019; Pajot, 2016). Consequently, all of these inefficiencies within municipal governance structures have great potential to implicate downstream barriers that will dampen the response of health units.

5.4.1 Public Health Standards

As of 2018, it was mandated that public health units in Ontario were to, “assess the health vulnerability of their community, monitor health impacts, and engage partners to develop and

promote strategies that reduce the health impacts of climate change" (Minister of Health and Long-Term Care, 2018). When asked if participants had noticed significant changes in their unit following this mandate, there were many varied responses, but a majority of them cited criticism. Of the 14 participants who provided commentary on their experiences with, and opinions of, the public health standards:

- five felt that the mandates in the public health standards are not prescriptive enough,
- three felt that, since the mandate does not come with guaranteed funding to accomplish it, the accountability needed to ensure that there is follow through is not present;
- three felt that COVID-19 interrupted progress that the updated mandate had the potential to spark, so it was difficult to know if there had been a significant change;
- two had a generally positive review of impact of the public health standards, noting that they had observed a general increased awareness and consideration for climate change within their unit and/or the sector at large; and,
- three generally acknowledged that most people feel the mandate was good for getting the conversation started, but still lacked demanding accountability from health units

Of these findings, the components that were identified as most urgently in need of being added to increase the impact of the standards, are funding and accountability. These findings are novel because these results are among the first results to emerge on this topic after the 2018 update to the public health standards was implemented.

5.5 Policy Recommendations

It is well-accepted among climate scientists that anthropogenic climate change is the biggest contributor, and possibly the only significant contributor to our rapidly changing environment (IPCC, 2018). The actions that we need to take have been extensively reported across many of western science's peer-reviewed publications but also by individuals who hold Traditional Indigenous Knowledge (in the context of what is currently North America) and those with ancestral, cultural knowledge of the land and water in a global context (Dhillon, 2021, pp. 898-911). As mentioned by many participants in this study, the polarization of this issue is hindering meaningful action. Therefore, based on these findings, it is important to separate the political and economic conflicts of interests from health advocacy work. To this effect, the Ministry of Health should immediately clarify the role of public health in climate change to resolve uncertainty on the stances that public health units can or cannot take, particularly in the context of the units that are affiliated with their regional government's positions. This can also serve to increase legitimacy for the issue to be addressed openly and progressively by public health actors. There also needs to be more inquiry into the organization of the Ontario public health sector from a systems analysis perspective to determine if the lack of uniformity in structure and form is an organizational efficiency barrier, and if it is indeed better to make health units more independent from the regional government from the perspective of depoliticization of issues that impact health.

Given the time-sensitive nature of this issue, as expressed by many of the study participants and in line with current literature on this topic (Watts et al., 2019, pp. 1836-1878), there should be a greater focus on regulation and accountability for actions or inactions in the climate change and public health space. One area of policy that can be improved to help enhance the sector's response to climate, as identified by the respondents, is the public health standards' mandate for health units' work with respect to climate change. Most study participants agreed that this mandate should be made more prescriptive and include accountability indicators for all health units. It should also include guidelines for what activities each health unit should be undertaking, at minimum, to uphold this mandate, with timelines. Ideally, this should be provided to the general public more readily for transparency purposes as well as for accountability. This is because the highest level of governance for health units is the Board of Health, as explained by numerous participants and verified through grey literature (Region of Waterloo Public Health and Emergency Services, 2018). As such, Boards of Health usually comprises of elected officials who can be held accountable by the region's constituents through democratic processes. Despite this, there should be a deeper inquiry into the effectiveness of Board of Health as a governing body for health units. Two facets that need to be explored more critically include the impact of their qualifications or experiences (or lack thereof) in health and climate change work, as well as the role of potential conflicts of interest associated with their personal interests (e.g., the development of economic prospects for regions in the form of land development or industrial processes often oppose emissions mitigation efforts) and/or political affiliations.

Further legislature that could be useful towards making progress for this issue can include creating a law requiring each health region to conduct a vulnerability assessment (or provide an update on their existing one), similar to the United States. This is not advised until funding and better resource allocation is first made available, as many public health units are under-resourced and stretched thin at present with the looming fear of increased provincial funding cuts. A different approach which can be seen as complimentary to the aforementioned is the implementation of regulatory by-laws which can be crafted to help the public make healthier choices. One health unit director outlined in this study that this would be similar to, for example, the smoking ban in indoor public settings enforced by health units in the past, which has led to increased smoking cessation in Ontario. What this looks like, and how we ensure that these by-laws are equity-informed and not inadvertently oppressive to under-served and structurally vulnerable populations, however, would require greater inquiry. Moreover, the findings of this research confirm Levison and colleagues' (2018) data from research conducted on the same study population in 2018; both studies agree that we need to adopt a stronger "climate in all policies" approach across all health units in Ontario.

Most urgently, the respondents identified a need for the public health sector to receive an influx of funding to address data gaps. One way that participants identified as being able to address this is if there is dedicated funding allocated for climate policy specialists whose job would be to generate data and to provide consequent policy recommendations. One possible

way to execute this would be if health regions with similar geography and demographic characteristics have dedicated personnel working to address climate change mitigation and adaptation strategies, as seen in the three Ontario health units that received HealthADAPT funding. Along these lines, since risk perception for this issue has been seen to differ amongst different demographic characteristics, as aforementioned, this might present an opportunity to enforce equity-centred hiring practices to increase the representation of low-income, racialized, Indigenous, neurodiverse, and/or young professionals in the public health and climate change policy. In doing so, the health units would also be able to better ensure that the communications and adaptation strategies are being developed with diverse perspectives from beginning to end. Examples of this were illustrated through the respondents whose health units did have increased representation from a diverse array of groups, as well as through vignettes from Ontario Public Health Association's *Make It Better* campaign. This would further aid to minimize the underrepresentation of Traditional Knowledge, as observed in the context of most local and regional climate change and public health policy spaces at present.

5.6 Strengths and Limitations of Study

In terms of study design, a key limitation to note is that the Ontario Climate Change and Health Vulnerability And Adaptation Assessment Guidelines' (2016) recommendations for stakeholders with an impact on local climate-sensitive health outcomes includes other key informants, such as those involved in conservation, public works and utility provision as well as health service providers, regional offices for Ministry of Environment and Climate

Change, and district offices for the Ministry of Natural Resources and Forestry (Ebi et al., 2016). These individuals were not included in this study's sample; however, this research's aims were to provide unique in-depth insight into the Ontario public health sector, and many individuals with environmental backgrounds already have a clear directive on climate change, alongside a specialized background on the topic.

Similarly, as prefaced in the results section, entitled values, many individuals that responded to the recruitment are anticipated to already care or be concerned about climate change to some degree, or were asked to participate by senior management supposedly, but that still reflected that at some level, there was a preconceived concern for climate change within that organizational unit. As such, a lot of the findings with respect to values and beliefs are likely skewed on the side of increased urgency, and it is likely that the knowledge and understanding of the group overall is higher than that of the general population, but also of the public health sector more broadly. Despite having four different intentionally vague posters with broad eligibility criteria with the intent of recruiting individuals who might not necessarily know or care too strongly for climate change, it was evident from the conversations surrounding recruitment before, during and after interviews that most participants already had a specialized interest in this topic already and were eager to discuss it.

Consequently, an area of concern is social desirability bias, where the data could reflect participants' desire to have themselves or their organizational unit be portrayed in a more positive light. Alongside this, there also is a general concern for privacy, as interviewees are all employees. Mitigation strategies for these concerns included interviewing all participants individually and reassuring them that their interview is confidential and will be anonymized to remove any identifying information about their identity, specific job title and location, respectively. They were reminded that the audio recordings will be deleted after the analysis is complete. This aided to ensure that participants are able to freely provide input without worrying about offending other employees or supervisors or facing any risk to their job security.

Chapter 6: Conclusions

This section outlines the key findings of this research, future research directions as well as the significance of these findings.

6.1 Summary of Key Findings

The primary aims of this study surrounded public health actors' mental models in relation to climate change and their input on ongoing, proposed or anticipated climate mitigation, adaptation and risk communication strategies. To this effect, public health actors demonstrated a fair knowledge of climate change but had a better understanding of the impacts versus the causes. Most individuals recognized that climate change was impacting us already and many noticed changes in their own environment to reflect this while recognizing the impacts will be felt different across different geographies and will be experienced disproportionately by structurally vulnerable populations. Many public health actors that demonstrated a more in-depth understanding of the impacts of climate change on human health and on the natural world expressed great concern for the "future of humanity". This was both from the perspective of intergenerational concerns for children but also changes to our normal way of life, highlighting a greater urgency to act fast and build the adaptive capacity of our communities.

Many individuals who felt strongly about this topic, namely those who expressed strong emotional responses to questions inquiring about their concerns, also felt that the public

health sector has a responsibility to act. These individuals also often felt that it was both their personal and professional responsibility to work on climate action work, and that public health has a role in advocating for mitigation efforts alongside adaptation. This aligns with the upstream approach that aligns with the overarching goal of effective public health work. Often, emotion played a role in their decision-making process and served as motivation for this work, particularly for those experiencing eco-grief or anxiety. The individuals also identified that certain senior leadership that also felt strongly about climate change related-health work were bringing it into the public health space, and that that was a determining factor for if health units would be able to do significant work in this area or not, introducing the role of individual values and beliefs and resulting implications upon the prioritization of climate change over other health issues.

With respect to risk communication, few health units were identified as being proactive in producing materials, but almost all participants identified a need for there to be increased awareness, alongside better media coverage of the health impacts of climate change. The public health actors with experience in health promotion and risk communication offered effective strategies to do this. There was conflict regarding whether a link should be made back to climate change for health outcomes associated with climate change, in health promotion materials; some employees were advised not to do so due to insufficient regional data or due to the politicization of climate change.

The Secondary Aims of this study provided insight into how to better allocate resources for greatest impact and elucidated numerous ways to improve the structural efficiency and accountability of the public health sector to enable more meaningful climate action. Consequently, the areas identified as having the greatest need for additional resource allocations included funding for dedicated personnel to work on climate change and health policy work, who can both progress this issue and begin to close data gaps, as well as an increased focus on equity-centred hiring practices to increase the representation of historically and presently underrepresented groups. The effectiveness and accountability of existing climate action work is impacted by the associations with regional government in helpful and unhelpful ways. On one hand it facilitates better collaborations with the municipalities and with other departments in the region, such as planning; however, there is a great degree of restriction over activities and stances that public health units and actors can take due to political and economic conflicts of interest due to their affiliation with the regional government. Moreover, in terms of accountability, many individuals felt that the public health standards that as of 2018 mandated that public health units had to address the health impacts of climate change were good at getting the conversation started on climate change in the public health sector but were insufficient to create any meaningful impact alone.

6.2 Future Research Directions

There were insufficient resources within the timeframe of this research to conduct a public model survey or focus groups, and as such the specific aims of this work did not include

assessing the public's viewpoints on climate change. To create a public model, researchers would conduct a confirmatory questionnaire containing the expert literature model and expert interview beliefs integrated into a survey instrument and they administer it to a small cohort of the intended target audience to capture the prevalence of those beliefs amongst them. Following that, researchers would use the findings to draft risk communication materials they believe to be most effective and these materials would be evaluated and refined in further focus groups with the intended audience until they are considered effective enough to be used for a larger population (Morgan et al., 2002). Although this is beyond the scope of this research study, there is potential to use the findings of this research as a starting point towards this next step in future work.

Furthermore, literature on the topic of emotional appraisals in decision-making is extensive, and the finding of the role of emotions in motivation and in decision-making presents an opportunity to explore environmental governance from the aspect of emotions more.

This study also identified that additional research is required to determine the potential impact of diversity in the public health sector upon culturally safe climate policy and health governance as well as participatory action research to determine how to best incorporate Traditional Knowledge within the work being done in public health units. Moreover, it would be interesting to expand this type of work to other provinces.

Finally, in the context of Ontario's public health sector specifically, more critical inquiry is required to determine if the health units' associations with the regional government is the best organizational set up, and if the Board of Health's member qualifications, governance processes and oversight present any barriers towards progressive climate action.

6.3 Significance of this Work

Due to its multisectoral impact, climate change and environmental degradation is projected to simultaneously undermine any progress we make towards the UN Sustainable Development Goals, as well as universal health care (Watts et al., 2019, pp. 1836-1878). Given that one of the most disastrous impacts of climate change will be on human health, it is of utmost importance to gain insight into factors contributing to inaction in the public health landscape. This study deepens our understanding of why the link between climate change and health is difficult to establish and demonstrates the knowledge, understanding, perceptions and attitudes held by public health sector actors in Ontario. It also helps to illuminate why the implementation of climate mitigation and adaptation plans has been a persistent problem for many municipalities in Ontario (Paterson et al., 2012, p. 452). Further, this research provides insight into the type of risk communication and health promotion messaging being produced by public health sector actors to engage with the public on this topic. It demonstrates the degree to which the risk communication and health promotion messaging and recommended actions are being considerate of the unique cultural needs of the specific municipality as well as the province, as informed by the general demographic composition of the region. This is of great importance as alongside the province's diverse population, the latest Ontario

Environment Plan states the importance of factoring in components from Traditional Knowledge systems, as informed by Indigenous Knowledge Keepers, in both the framing of the issue and in informing action (Ministry of the Environment, 2018). Beyond the primary Aims of this work, the Secondary Aims presented targeted policy implications which can serve as critical leverage points for progress for this urgent issue.

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APPENDIX

Appendix A: Positionality Statement

I reside in the geographical confines of what is currently known as Canada on land that is home to the Neutral, Haudenosaunee and Anishinaabe peoples. The treaties of this land include the Haldimand Treaty* and Treaty 3. I want to acknowledge, with pride, my ancestry as a Sikh woman from Punjab, while also acknowledging that I have grown up in what is currently Canada almost all of my life. I often reflect upon the honour of both being a woman of colour, and importantly of being someone who sees, experiences & interacts with the world using a neurodiverse view. I see my severe ADHD diagnosis in adulthood as something that has offered me clarity towards the unique struggles I've encountered in my life, within a world that is not built to accommodate my neurodivergence. Moreover, I also see this intrinsic part of me as a superpower that enables me to be a passion-driven, dynamic, quick and immensely creative intellectual. As an academic and as a community organizer, I recognize the duty I have to offer representation for others that share my intersections of identities. I find strength in using my lived experiences to inform my activism practice, and I find healing in maintaining connections to my ancestral roots.

I want to acknowledge privileges I have, of both my access to post-secondary education, and being able to volunteer my time to a multitude of causes. There are many voices, namely of my Black, Indigenous and South Asian peers, that go unheard because they are working, living and thriving as best they can, in a world that doesn't guarantee livable wages, income, gender or racial equity, nor social security in all forms. While I am thankful to be given a platform, through my research and through my work in community organizing, I do not intend on speaking on behalf of Black or Indigenous communities, nor communities of colour in general. My only goal is to use opportunities such as these to help the cause in the best way I can, which is through the education and empowerment of others, with knowledge that will allow them to become meaningful allies.

I move through this space guided by the practice of centring community voices and commit to continuing my own learning alongside these efforts, always. Working in the realm of health and wellbeing promotion for all that inhabit Turtle Island, I recognize (and work to engage others in the idea) that we cannot fix a problem that has its roots this deep in colonization without first decolonizing our practices as researchers, educators, and advocates. I lead by encouraging non-Indigenous allies that wish to help, to actively take up less space where we can, and offer more to the collective recovery of the land and all its peoples, as we are all treaty peoples. I continue to vocally and visibly support any initiatives that aid us in moving closer towards a collective liberation from oppressive systems.

*On 25 October 1784, Sir Frederick Haldimand, the governor of Québec, signed a decree that granted a tract of land to the Haudenosaunee (Iroquois), also known as the Six Nations, for their alliance with the British during the American Revolution. The proclamation stated that he permitted them to "for ever" enjoy this land. However, this forever he mentioned only lasted 57 years, as by 1841 the lands "permitted" to the Six Nations' diminished from approximately 950,000 acres to 46,000 acres, and the community was left with less than 5% of the original Haldimand Tract (source). This is shameful.

Appendix B: Recruitment Posters

There were a total of four (4) recruitment posters that characterized the different types of people who would be considered key informants for this study.

POSTER 1:

Have You Helped To Inform Regional Climate Action Strategies?

We are looking to speak to individuals **working in Ontario** whose job(s) **involve them being a part of discussions on strategies or policies to address the health impacts of climate change.**

We invite you to participate in a **40 - 60 minute one-on-one online** (Zooms, Webex, Teams, etc.) **or phone interview** about current perspectives on the health impacts of climate change and the implementation of mitigation, adaptation, and risk communication strategies in your local jurisdiction.

For more information and to participate, please email: Manvi Bhalla at **m3bhalla@uwaterloo.ca**

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POSTER 2:

Are you a Public Health Decision-Maker in Ontario?

We are looking to speak to public health authorities in Ontario (e.g., Health Unit Manager, Medical Officer of Health, Board of Health Chair and other similar roles) about current perspectives on the health impacts of climate change and the implementation of climate change mitigation, adaptation, and risk communication strategies in their local jurisdiction.

We invite you to participate in a **40 - 60 minute one-on-one online** (Zooms, Webex, Teams, etc.) or **phone interview**.

For more information and to participate, please email Manvi Bhalla at: **m3bhalla@uwaterloo.ca**

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POSTER 3:

Do you create risk communication materials on the health impacts of climate change?

We are looking to speak to public health professionals **working in risk communication for environmental health concerns in Ontario.**

We invite you to participate in a **40 - 60 minute one-on-one online** (Zooms, Webex, Teams, etc.) **or phone interview** about current perspectives on the health impacts of climate change and the implementation of mitigation, adaptation, and risk communication strategies in their local jurisdiction.

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POSTER 4:

Do you work at a Public Health Unit in Ontario?

We are looking to speak to **Ontario Public Health Unit employees** about current perspectives on the health impacts of climate change and the implementation of climate change mitigation, adaptation, and risk communication strategies in their local jurisdiction.

We invite you to participate in a **40 - 60 minute one-on-one online** (Zooms, Webex, Teams, etc.) **or phone interview**.

For more information and to participate, please email:
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m3bhalla@uwaterloo.ca

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Appendix C: Recruitment Emails

FOR RESEARCHERS TO EMAIL PUBLICLY AVAILABLE CONTACTS DIRECTLY (we will let them know how we found them indicated by the blank below)

Subject: *Invitation to Participate in a Study on Public Health/ Understanding of Climate Change-related Health Risks in Ontario.*

Hello,

My name is Manvi Bhalla and I am an MSc student under the supervision of Dr. Martin Cooke, in the School of Public Health and Health Systems at the University of Waterloo. This email is an invitation to participate in a research titled Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario.

We are looking for key informants who are actively involved in, or have knowledge of, the creation and dissemination of risk communication materials and/or mitigation/adaptation strategies concerning the health impacts of climate change. I came across your profile/ obtained your contact information/ was referred to you through/by _____ and I would like to invite you to participate in a 40-60 minute long one-on-one interview, held via an online platform (e.g., WebEx, Teams, Zoom etc.) or by phone. This interview will be audiotaped to facilitate analysis, but your identity will be kept confidential by the researchers. Your participation is free and voluntary.

Attached is a Letter of Information and Consent Form where you can learn more about the study's purpose and procedures. I would like to assure you that the study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Committee.

If you are interested in participating, please email me, Manvi Bhalla (m3bhalla@uwaterloo.ca) to confirm your interest and please return the completed/signed consent form (attached in this email). Following that, I'd be happy to set up an interview at a date and time that is most accommodating of your busy schedule.

I am very grateful for your time and consideration! If there happens to be someone who you feel would have valuable insight for this study, please feel free to share the recruitment poster and/or my email address with them so I can follow up with them if they are interested.

Sincerely,

Manvi Bhalla (she/her)
MSc candidate, Public Health and Health Systems
Faculty of Health
University of Waterloo
905-928-1244
m3bhalla@uwaterloo.ca

FOR EMAIL SCRIPT PROVIDED TO CONTACTS ON BEHALF OF RESEARCHERS TO RECRUIT OTHER INTERESTED PARTIES

Subject: *Invitation to Participate in a Study on Public Health/ Understanding of Climate Change-related Health Risks in Ontario*

This email is an invitation to participate in a research titled "Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario". This study is being conducted by Manvi Bhalla, an MSc student under the supervision of Dr. Martin Cooke, in the School of Public Health and Health Systems at the University of Waterloo.

The study is seeking key informants who are actively involved in, or have knowledge of, the creation and dissemination of risk communication materials and/or mitigation/adaptation strategies concerning the health impacts of climate change. Participation involves a 40-60-minute-long one-on-one interview, held via an online platform (e.g., WebEx, Teams, Zoom etc.) or by phone. This interview will be audiotaped to facilitate analysis, but your identity will be kept confidential by the researchers. Your participation is free and voluntary. This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Committee.

If you are interested, please email Manvi Bhalla at m3bhalla@uwaterloo.ca for more information and next steps. If there happens to be someone who you feel would have valuable insight for this study, please feel free to share this with them.

Sincerely,

[Name]
[Affiliation]

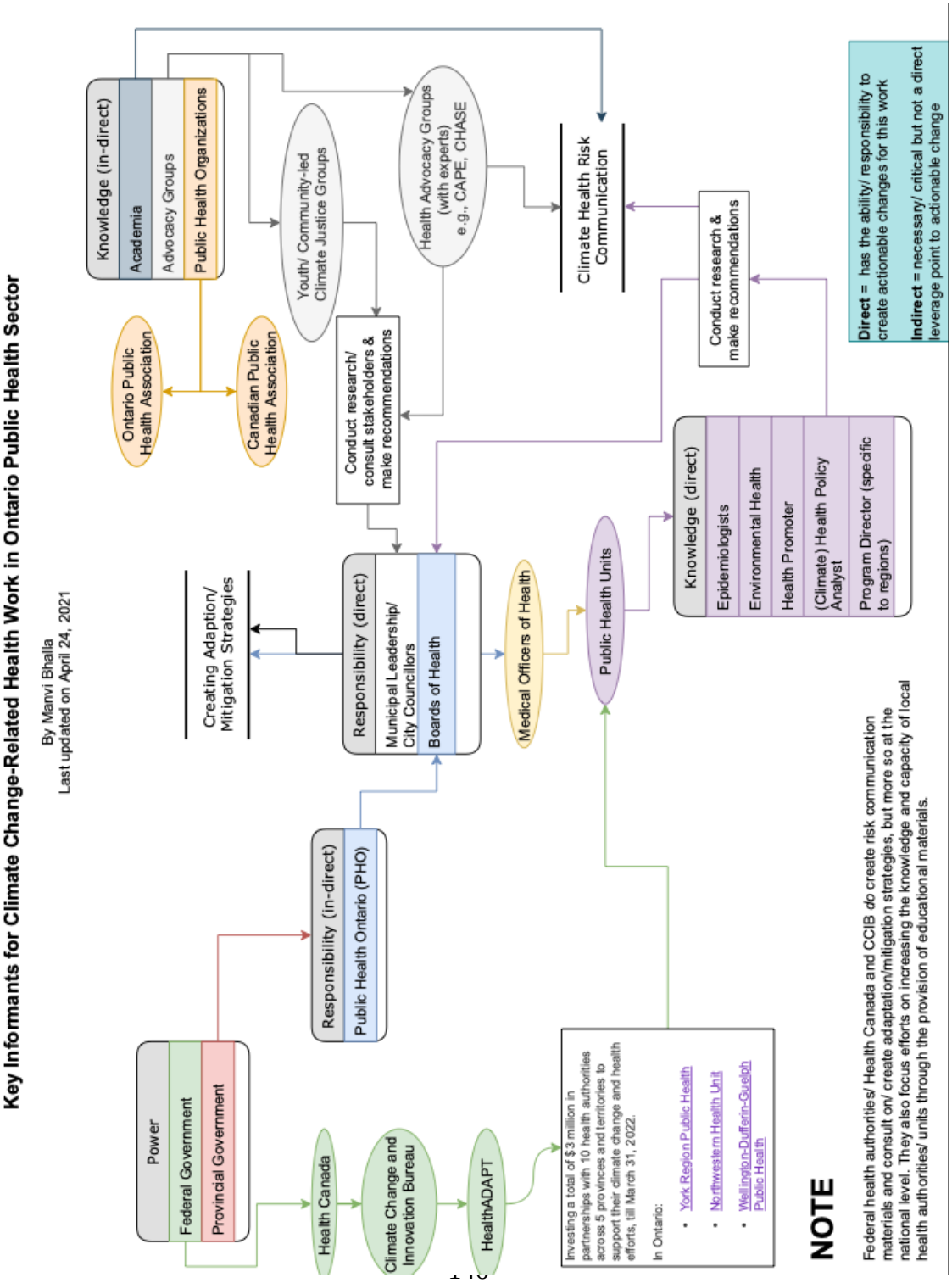
Appendix D: Recruitment List for Public Health Units

Table 1: List of Ontario Public Health Units, organized into regional clusters (LHINs) (Last updated December 2020)

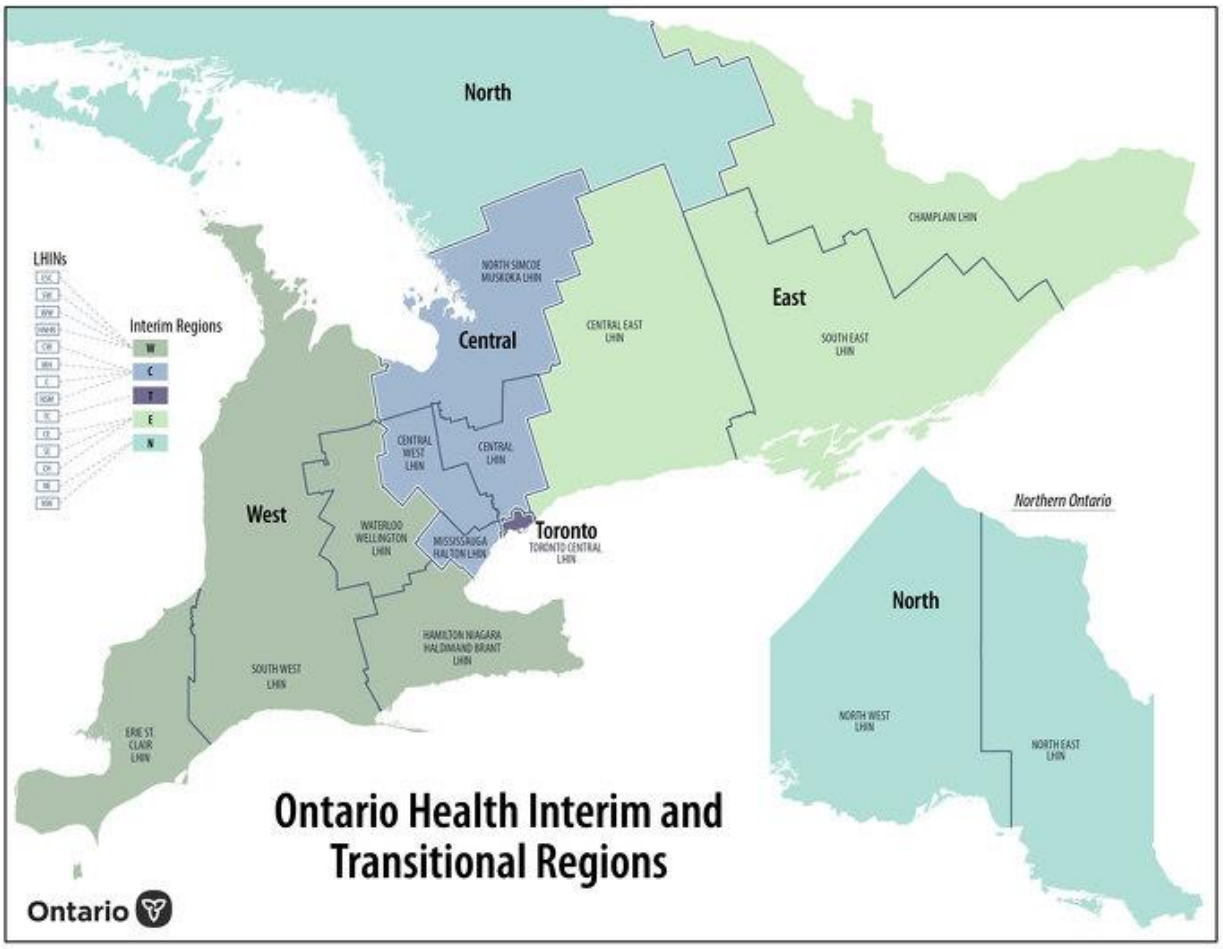
LHINs (2019)	LHINs (2006)	Public Health Units
West	Erie St. Clair	Chatham-Kent Health Unit Lambton Health Unit Windsor-Essex County Health Unit
	South West	Middlesex-London Health Unit Grey Bruce Health Unit Haldimand-Norfolk Health Unit Southwestern Public Health Huron Perth Health Unit
	Waterloo Wellington	Wellington-Dufferin-Guelph Health Unit Grey Bruce Health Unit Region of Waterloo, Public Health
	Hamilton Niagara Haldimand Brant	Brant County Health Unit Hamilton Public Health Services Halton Region Health Department Haldimand-Norfolk Health Unit Niagara Region Public Health Department
Central	Central West	Wellington-Dufferin-Guelph Health Unit Toronto Public Health
	Mississauga Halton	Peel Public Health Halton Region Health Department Toronto Public Health
	North Simcoe Muskoka	Simcoe Muskoka District Health Unit Grey Bruce Health Unit
	Central	York Region Public Health Services Toronto Public Health
Toronto	Toronto Central	Toronto Public Health
East	Central East	Peterborough Public Health Haliburton, Kawartha, Pine Ridge District Health Unit Toronto Public Health Durham Region Health Department
	South East	Hastings and Prince Edward Counties Health Unit Leeds, Grenville and Lanark District Health Unit Kingston, Frontenac and Lennox & Addington Health

		Unit Haliburton, Kawartha, Pine Ridge District Health Unit
	Champlain	Leeds, Grenville and Lanark District Health Unit Eastern Ontario Health Unit Ottawa Public Health Renfrew County and District Health Unit
North	North East	Northwestern Health Unit Timiskaming Health Unit North Bay Parry Sound District Health Unit Algoma Public Health Unit Sudbury and District Health Unit Porcupine Health Unit
	North West	Northwestern Health Unit Thunder Bay District Health Unit

Appendix E: Conceptual Framework



Appendix F: Map of Ontario's 2006 LHINs re-organized to 2019 LHINs



Appendix G: Letter of Information

Monday, February 15, 2021

Dear Participant:

This letter is an invitation to participate in a research titled **Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario**. The aim of this study is to contribute to the global response to address climate change, by identifying approaches that public health units in Ontario are taking to mitigate and adapt to our changing environment, and the resulting impact on the health and wellbeing on our population. This study will be undertaken by Manvi Bhalla, as her Master of Science research thesis, under the supervision of Dr. Martin Cooke, at the University of Waterloo in the School of Public Health and Health Systems within the Faculty of Health.

Participation in this study is voluntary. It will involve taking part in an open-ended interview that will take approximately 40-60 minutes to complete. In addition to questions surrounding your professional role and thoughts on climate change-related health impacts/ climate action plans in your jurisdiction, demographic information (e.g., age, race/ethnicity, gender) will be collected in order to describe the characteristics of the participants in this study as well as to examine differences and trends across these characteristics. With your permission, the interview will be audio-recorded to facilitate the collection of information, and later transcribed for analysis. Your identity will remain confidential. Your name or any other personal identifying information will not appear in any research papers or publications resulting from this study. However, there is always the risk of sharing information that might identify your position or role. During the interview, you may decline to answer any of the interview questions and/or share your personal information with me. Further, you may withdraw from this study up to 2 weeks following your interview by advising the researcher. If you decide to withdraw, we will erase the interview transcript and all the research notes that were taken during the interview process. Note that participation in this study has no bearing on your professional role, as it is being conducted entirely independent of/ without the knowledge or involvement of your institution/organization.

The interview will take place over phone or via an online platform (WebEx, Zoom, Teams) or by phone, depending on what method works best for you. When information is transmitted over the internet, privacy cannot be guaranteed. There is always a risk your responses may be intercepted by a third party. University of Waterloo researchers will not collect internet protocol (IP) addresses or other information which could link your participation to your computer or electronic device without first informing you.

To protect your confidentiality, we will erase the audio recording of the interview after we complete our analysis fully and determine that we no longer require it, however the transcription of the audio will be assigned a pseudonym and will remain. The consent form that you signed and/or a document confirming the verbal consent you provided will be stored on Manvi Bhalla's personal password protected computer alongside your anonymized interview transcripts for a minimum of seven years. Electronic data will be deleted from servers after 10 years. Audio data will be deleted upon the completion of analysis for this study.

The data we collect will contribute significantly to the ongoing body of work that hopes to examine the public health sectors' response to the climate crisis. The ultimate goal of this work is to identify novel strategies to improve health risk communication, adaptation and mitigation strategies and to improve organizational performance in the Ontario public health sector. Participation in this study may not provide any personal benefit to you. There are no known or anticipated risks to you as a participant in this study beyond the one outlined above regarding the risk of being identified despite anonymization, due to certain individuals' roles (e.g., public health authority) being a part of a small population subset. However, as mentioned above, you have full agency over managing what you share as part of your participation in this important study.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have questions for the Committee contact the Office of Research Ethics, at 519-888-4567, ext. 39187 or ore-ceo@uwaterloo.ca. For all other questions, please contact Manvi Bhalla at m3bhalla@uwaterloo.ca or Dr. Martin Cooke at cooke@uwaterloo.ca.

I very much look forward to speaking with you and thank you in advance for your time and assistance in this project. Please don't hesitate to reach out if you have any questions or concerns.

Sincerely,

Manvi Bhalla (she/her)
MSc candidate
Public Health and Health Systems
Faculty of Health
University of Waterloo
905-928-1244
m3bhalla@uwaterloo.ca

Appendix H: Written Consent Form

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities. I have read the information presented in the letter of information about the study being conducted by Manvi Bhalla and Dr. Martin Cooke, in the School of Public Health and Health Systems at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I was informed that I may withdraw my consent at any time prior to or during the interview, and up to 2 weeks after the interview, by advising the researcher, via email (m3bhalla@uwaterloo.ca).

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have questions for the Committee contact the Office of Research Ethics, at 519-888-4567, ext. 39187 or ore-ceo@uwaterloo.ca. For all other questions, please contact Manvi Bhalla at m3bhalla@uwaterloo.ca or at (905) 928-1244, or Dr. Martin Cooke at cooke@uwaterloo.ca.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.
☐YES ☐NO

I agree to have my interview session audio recorded.
☐YES ☐NO

I agree to the use of anonymous quotations in any publications based on this research.
☐YES ☐NO

I agree to the use of my interview session's transcript in the future research projects conducted by Dr. Martin Cooke and Manvi Bhalla.
☐YES ☐NO

I agree to the use of anonymous quotations in the future research projects conducted by Dr. Martin Cooke and Manvi Bhalla.
☐YES ☐NO

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____

Appendix I: Verbal Consent Form

VERBAL CONSENT FORM

By agreeing to participate in this study, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities. You have read the information presented in the letter of information about the study being conducted by Manvi Bhalla and Dr. Martin Cooke, in the School of Public Health and Health Systems at the University of Waterloo. You have had the opportunity to ask any questions related to this study, to receive satisfactory answers to your questions, and any additional details you wanted.

You are aware that you have the option of allowing this interview to be audio recorded to ensure an accurate recording of my responses. You are also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. You were informed that you may withdraw my consent at any time prior to or during the interview, and up to 2 weeks after the interview, by advising the researcher, Manvi Bhalla via email (m3bhalla@uwaterloo.ca).

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have questions for the Committee contact the Office of Research Ethics, at 519-888-4567, ext. 39187 or ore-ceo@uwaterloo.ca. For all other questions, please contact Manvi Bhalla at m3bhalla@uwaterloo.ca, or at (905) 928-1244, or Dr. Martin Cooke at cooke@uwaterloo.ca.

With full knowledge of all foregoing, you agree, of my own free will, to participate in this study, and:

- ☐ agree to have your interview session audio recorded.
- ☐ agree to the use of anonymous quotations in any publications based on this research.
- ☐ agree to the use of my interview session's transcript in the future research projects conducted by Dr. Martin Cooke and Manvi Bhalla.
- ☐ agree to the use of anonymous quotations in the future research projects conducted by Dr. Martin Cooke and Manvi Bhalla.

Participant Name: _____

Participant Signature: **Verbal consent was obtained.**

Witness Name: Manvi Bhalla

Date: _____

Appendix J: Interview Guide

INTERVIEW GUIDE *for key informants* (Last updated: Feb 16, 2020)

NOTE: This is a semi-structured/open-ended interview guide, so it is subject to adjustments as needed based on the conversations with the participants and in particular, due to the nature of their professional affiliations/ experiences. However, all line of questioning will involve the same themes as outlined here.

INTRODUCTION

Thank you so much for agreeing to take part in this study entitled, Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario. This work is of significance as it aims to identify knowledge gaps held by public health actors and will identify underlying organizational and behavioural barriers towards the implementation of effective climate mitigation, adaptation and effective risk communication. If at any point you have a question you'd like to pass, or that which you require great clarification on, please feel free to ask, and I'd be happy to move on or elaborate as necessary.

Professional introduction/priorities

We'll firstly discuss your professional experiences in public health. Please tell me more about your position at (THEIR ORGANIZATION/INSTITUTION).

1. What is your job?
2. What is your official title?
3. What are your main responsibilities?
    a) Who do you report to in the Health Unit?
    b) How long have you been working in this role?
    c) What were you hired to do? Have your responsibilities changed since you were hired?
        - *If relevant*:* If hired before 2018, has your role shifted since the 2018 update to the public health standards?
        - *If relevant:* How have your responsibilities changed since the start of the COVID-19 pandemic?
        - *If relevant:* Do you find that other programs, including health promotion campaigns or risk assessments associated with climate-related health impacts have taken a back seat in light of the pandemic?
4. What are your previous experiences in public health?
    a) What other positions have you had?

*New Public Health Standards in 2018 mandated that public health units in Ontario, "assess the health vulnerability of their community, monitor health impacts, and engage partners to develop and promote strategies that reduce the health impacts of climate change" (Minister of Health and Long-Term Care, 2018).

Personal introduction

Okay, wonderful! I'm now going to shift from your professional role, into a more personal introduction. For starters, I am collecting demographic data of all participants, so if it's okay with you, I'll ask a series of questions related to that. You're welcome to skip any question or ask for clarification as needed!

1. What is your educational background?
    a. What schools did you go to?
2. How old are you?
3. What gender do you identify with?
4. How would you describe your racial or ethnic background?
5. Where were you born?
    a. If not Canada, when did you come to Canada?

Personal meanings associated with climate change and health

Perfect! Thank you for sharing that with me. The first line of questions surround associations between climate change and health. Let's get started!

1. In your opinion, what are the main factors that have the ability to impact an individual's health?
    a. How does it differ in Ontario vs. in Canada broadly, vs. globally?
2. What about the health of a community?
    a. Include social, mental, physical, environmental aspects
3. How would you define "climate change"?
    a. Do you think there's a difference between climate change and global warming?
    b. What about climate change and environmental degradation, such as air pollution?
4. Have you noticed changes in your environment?
    a. If yes, what aspects of your life do these changes have the most impact?
    b. If not, do you believe that the effects of climate change are more noticeable in other regions? What effects are those, and where?
5. How would you describe your current understanding on the health impacts of climate change (e.g., poor, good, very experienced)?
    a. What informed your understanding? (e.g., school, professional development, other sources)

6. In the context of your community/health unit/health region, do you think climate change poses major health concerns?
    a. Why or why not?
    b. What local context supports this/these claim(s)?
7. What aspect of climate change concerns you the most?
    a. What do you do on a personal level to address these concerns?

Perceptions of the public on climate change, environmental degradation and health
Wonderful, thank you for sharing that. Speaking of health concerns – let's talk about how constituents in your jurisdiction view climate change and health.

1. Thinking about people in your health region, what do you believe people think about climate change?
    a. Do you think they perceive it as a threat to health?
        i. If so, what do you think are their main concerns?
        ii. If no, do you think people are unconcerned about climate change?
    b. What do you think contributes to this perception?
2. In your view, how do the media (traditional and online) influence the public's perception on climate change-related health impacts?
    a. If it is significant, then how are you collaborating with the media in your work?
3. Do you have any insights into what the primary concerns are of those who do see climate change as having the potential to impact their health?
    a. Have you noticed differences between individuals and groups (e.g., based on gender, sex, age, socioeconomic background, race, ethnic origin or otherwise)?

<u>If relevant</u>: **climate change-related health risk communication strategies** *(depends on their job)*
Interesting! Thank you for all this great insight so far. Speaking of public perception of climate change, one area that is of interest to me in this study is looking into how climate change-related health risks are being communicated to the public.

Based on everything you've mentioned so far, and due to your role in developing strategies and materials to communicate health information, risks and public health measures to the public…

1. Can you tell me about the media you use to communicate climate change-related health risks to the public and how you decided on these communication strategies (e.g., channels, messages, spokesperson)?

2. Can you speak about any feedback you received from the public regarding these public health communications?
3. What are your thoughts about the effectiveness of these communication strategies?
4. Can you give me an example of one campaign or communication intervention that went well and one that went wrong?
5. What are the challenges or the difficulties that you face in your work of information communication?
    a. Specifically, what about in the context of climate change-related health risk communication?
6. What sources of information or theories did you or do you use in developing your communication strategies?
7. Who would you say are the most vulnerable to experiencing health impacts as a result of climate change, and why do you think this is?
    a. What about specifically in your jurisdiction/health region?
8. Do you use any strategies to ensure your messaging reaches these vulnerable populations?
9. Okay, now particular, let's talk about specifically about Indigenous communities for a moment.
10. Are they any risks you recognize that Indigenous individuals living in your health face to a disproportionate degree?
    a. What about specifically in the context of climate change and/or environmental degradation?
11. Are there any specific strategies you use to reach Indigenous communities in your region?
12. Are you familiar with Traditional Knowledge systems?
    a. If yes, how do you incorporate this into your communication strategies to Indigenous communities?
    b. If no, what is your organization/institution's reasoning?

Public health strategies to promote climate mitigation/adaptation & risk communication
Now we'll pivot slightly to more broadly discuss your unit/organization/institution's strategies to adapt, mitigate and communicate the risks surrounding the health impacts of climate change locally.

Given the implication that your role has on (choose whichever is most relevant):

- *decisions made in your local jurisdiction concerning climate-related health impacts*
- *the development of local climate adaptation and mitigation strategies*
- *the implementation of strategies to mitigate and adapt to climate-related health risks*

1. What are major health concerns in your jurisdiction/health region/health unit?
    a. Why?
    b. How do you best address these?
2. Where do you think climate change ranks among the issues that your health unit/region has to address?
3. Can you provide me with an overview of your unit and/or region's climate action plan?
    a. Are there specific programs or are there policies being put in place in relation to climate change and its effect on health and wellbeing?
4. Could you describe who was involved in informing the strategies you just mentioned?
    a. What are their job titles and organizational/institutional affiliations?
    b. Were there any consultations with external groups? (e.g., community groups, NGOs, other experts/researchers, etc.)
5. Who would you say was involved in the final decision-making towards the implementation of this/these aforementioned strategies?
6. How diverse would you say the group of people that came to inform and implement this plan are? (I.e., Do you feel there was sufficient representation of historically underrepresented groups, such as women, gender-diverse, racialized, neurodiverse and/or disabled peoples?)
7. Who would you say is responsible for the accountability aspects for this/these strategies?
8. Can you provide me with additional resources following this interview? I would appreciate any documentation you are able to share on this/these strategies. If you can even just provide me with website links, if that's easiest, to re-direct me to your region/unit's plan(s) or if you happen to have documents you are able to share with me for my analysis. I won't be circulating these documents and will likely just be using them as supplemental to my interviews in an effort to document the ongoing efforts by those in public health across Ontario.

CONCLUSION

Amazing! That concludes my questions. Is there anything you would like to ask me, or anything further you'd like to share? (Pause to let them respond).

Thank you so much for your time. I am immensely appreciative of your time, and if you happen to know of anyone else that would be a good fit for my study population, please be sure to pass along the recruitment poster, or feel free to pass along my contact. I'll also remind you that I'd really appreciate being forwarded any additional documentation if you have it, concerning your local climate mitigation and adaptation plans and/or risk communication materials and strategies for this topic.

Appendix K: Statement of Appreciation

Monday, February 15, 2021

Dear Participant,

I would like to thank you for your participation in this study entitled, "Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario". The aim of this study is to contribute to the global response to address climate change, by identifying approaches that public health units in Ontario are taking to mitigate and adapt to our changing environment, and the resulting impact on the health and wellbeing on our population. Your participation is greatly appreciated towards furthering our knowledge on this important issue. The data we collect will contribute significantly to the ongoing body of work that hopes to examine the public health sectors' response to the climate crisis. The ultimate goal of this work is to identify novel strategies to improve health risk communication, adaptation and mitigation strategies and to improve organizational performance in the Ontario public health sector.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have questions for the Committee contact the Office of Research Ethics, at 519-888-4567, ext. 39187 or ore-ceo@uwaterloo.ca. For all other questions, please contact Manvi Bhalla at m3bhalla@uwaterloo.ca or Dr. Martin Cooke at cooke@uwaterloo.ca

Please remember that your identity will be kept confidential. Once all the data is collected and analyzed for this project, we may share this information with the research community through seminars, conferences, presentations, and journal articles.

If you wish to receive the results of the study, please provide your email address and, when the study is completed, the researchers will send you the information.

Martin Cooke, Ph. D.
Associate Professor,
Department of Sociology and Legal Studies
School of Public Health and Health Systems
Associate Dean, Undergraduate Students, Faculty of Arts
University of Waterloo
Email: cooke@uwaterloo.ca

Manvi Bhalla (she/her), MSc candidate
School of Public Health and Health Systems
Faculty of Health
University of Waterloo
Email: m3bhalla@uwaterloo.ca

Appendix L: Ethics Approval

UNIVERSITY OF WATERLOO

Notification of Ethics Clearance to Conduct Research with Human Participants

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Principal Investigator: Martin Cooke (School of Public Health and Health Systems)

Student investigator: Manvi Bhalla (School of Public Health and Health Systems)

File #: 42795

Title: Determining Public Health Actors' Understanding of Climate Change-related Health Risks to Better Inform Climate Mitigation, Adaptation and Risk Communication Strategies in Ontario

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The Human Research Ethics Committee is pleased to inform you this study has been reviewed and given ethics clearance.

Initial Approval Date: 04/06/21 (m/d/y)

University of Waterloo Research Ethics Committees are composed in accordance with, and carry out their functions and operate in a manner consistent with, the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), International Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (HREC) and IRB00007409 (CREC).

This study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Expiry Date: 04/07/22 (m/d/y)

Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified. Studies will only be renewed if the renewal report is received and approved before the expiry date. Failure to submit renewal reports will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Level of review: Delegated Review

Signed on behalf of the Human Research Ethics Committee

Joanna Eidse, Research Ethics Officer, jeidse@uwaterloo.ca, 519-888-4567, ext. 37163

This above named study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Documents reviewed and received ethics clearance for use in the study and/or received for information:

file: Other - Ontario Climate Change and Health Vulnerability And Adaptation Assessment Guidelines' (2016)_Feb15.pdf

file: Statement of appreciation_Bhalla_Feb16.docx

Appendix M: Instructions for Second Coder

How to code

(NOTE: Since sense-making is central to mental models, questions in interview guide for Aim 1 work to build out the individual and/or their unit's mental model and Aims 2 and 3 are explored through more procedural questions, are elucidated during analysis, and are used to provide further context to the overall findings.)

DEDUCTIVE

- Aim 1 questions in interview guide are centred around sense-making (determining social influences that informs logical reasoning)
    - Emotion coding → K/U/P: descriptive subcode (explain the social context/ personal situation/ affective influences) and/or in-vivo subcode (use direct quote)
- Aim 2 questions in interview guide are centred around discourse analysis (analysis of communications to identify underlying assumptions)
    - Value coding → V/A/B: in-vivo (direct quote)
- Aim 3 questions in interview guide are centred around domain analysis (comparing information need, production, and use)
    - Evaluation coding →
        - +/- RC Need: descriptive subcode (explain the process(es)) and/or in-vivo subcode (use direct quote)
        - +/- RC Production: descriptive subcode (explain the process(es)) and/or in-vivo subcode (use direct quote)
        - +/- RC Use: descriptive subcode (explain the process(es)) and/or in-vivo subcode (use direct quote)

INDUCTIVE

Conceptual coding → Any "concept" you think is important, some suggestions for emerging themes provided in chart (e.g., funding, accountability, personnel, effectiveness, prioritization etc.)

Definitions

Sense-making: giving meaning to experiences/things

- **Knowledge:** information held about a subject from any source (experience, education)
- **Understanding:** realizing the intended meaning or cause of something and being able to think about it/ use concepts to deal adequately with it
- **Perception**: process by which we acquire information about the world around us using our senses

Behavior: how someone acts in response to a particular situation or stimulus

- **Value:** importance we attribute to ourselves, another person, thing or idea
- **Attitude:** the way we think and feel about ourselves, another person, thing or idea
    - Emotional appraisals: refers to processes by which individuals' cognitions about events predict their emotional reactions to those events
- **Belief:** is a part of a system that includes values and attitudes, personal knowledge, experiences, opinions, prejudices, morals, and other interpretive perceptions of the social world

Appendix N: Second Coder Analysis

Roughly 10% of data (2/17 transcripts = 11.8%) was used for the second coder analysis, as informed by the acceptable standard in qualitative methodology literature (O'Connor & Joffe, 2020). Similarities and differences were measured to the sub-theme level; to be considered a similarity, it had to be the same theme and sub-theme on the same (general) quote. Additional or ambiguous coding was marked for discussion and led to generation of new categories, re-categorizations or clarifications about classification, so discussed tags were not included in the calculation. Differences were also discussed, and changes were recommended if relevant.

Calculating inter-rater reliability score (Miles and Huberman, 1994):
(similarities) / (similarities + differences) x 100%

Transcript 1 (Interview 1)

Coders	Discussed codes	Similarities	Differences	Inter-reliability reliability score
MB	8	97	20	82.9%
KB				

Discussion of tags led to following changes to codebook

<u>6 new sub-themes</u>

- Addition of "gender-based differences in experience of female public health employees" under "perception" (theme) > "lived experiences" (subtheme) due to identification of gender roles
- Addition of "environmental health can cause burnout for specialists who take on burden of labour" (sub-subtheme) formerly under "effectiveness" (theme) to "barriers" (subtheme) due to there being few positions in public health for climate policy specialists
- Addition of themes surrounding influence of media on community's perception, including climate denial and differences in perception based on demographic characteristics under "perception" (theme) and "risk communication production"
- Addition of "community's perception of climate change and health" (subtheme) under "perception" (theme)
- Moved "personnel" from being an inductive theme to under "effectiveness" (theme) > "barriers" (subtheme)
- Added "intergenerational concerns" (subtheme) under "perception" (theme)

<u>2 ambiguous codes (coded with same intent but chose different categories and/or sub-themes)</u>

- Discussed and agreed on differences between specialized knowledge and lived experiences (subthemes) (lived experiences can inform specialized knowledge, but specialized knowledge can also be gained from other knowledge acquisition sources)
- Differentiated between "risk communication use/need/production" (themes) and when interviewee is just highlighting where they feel "professional responsibility"

Transcript 2 (Interview 11)				
Coders	Discussed codes	Similarities	Differences	Inter-rater reliability score
MB KB	14	62	12	83.8%

Discussion of tags led to following changes to codebook

- KB added "Positive review of public health standards" as a sub theme tag but we decided to just keep the description broad at the sub theme level as many people felt both positively and negatively with respect to the public health standards and reasoning largely varied and instead added this as a sub-sub theme alongside "Public health standards did not have a significant and/or the desired impact" and "Public health standards were not prescriptive enough/ did not mandate enough"
- KB selected health equity-related sub- theme tags for 3 quotes related to Traditional Knowledge instead of the specific tag for it; this led to moving "Traditional Knowledge underrepresented, under resourced or considered not important" (sub-sub theme) to be under "Equity-informed approaches" (sub-theme)
- Over 20 tags had been tagged with 2 appropriate labels each due to uncertainty about which fit more despite both researchers meaning to tag the quotes with the same intention; this led to re-categorization to better organize the sub themes, reflecting the following changes which both researchers agreed upon:
- "Public health standards" (sub theme) moved to be part of "structural accountability" (theme)
- Created the sub-theme, "Influence of media reporting on public perception of climate change" and moved sub-sub theme, "Media's portrayal of climate change could be improved" under theme, "Identifies need for risk communications for climate change"
- "Make it better campaign" sub-sub theme was repeated tagged by MB at every mention, but KB only tagged sometimes when it was mentioned; clarified purpose of the tag to be to capture information about the lessons learned from the campaign
- Elaborated on differences between the sub-theme tags of "public health sector's role" vs. "barriers"
- Notably, many sub-sub and sub-sub-sub themes were also coded, but are not included in this analysis because the inter-coder reliability only goes to the sub-theme level

Inter-rater reliability scores The accepted standard is 80% agreement on 95% of codes (Miles & Huberman, 1994).	
Transcript 1	82.9%
Transcript 2	83.8%
Overall average	83.4%

Appendix O: Codebook

DEDUCTIVE CATEGORIES (Corresponds to primary aims of study; categories 1 & 2 are informed by theory of mental models)				
Category	Theme	Sub theme	Sub-sub theme	Sub-sub-sub theme
Sense-making	Knowledge	Specialized knowledge of public health actors	Definition of climate change	(Expanded upon in results section)
			Differences between climate and global warming	(Expanded upon in results section)
			If climate change poses big health risk where they live	(Expanded upon in results section)
			Factors that have the ability to impact a community's health	(Expanded upon in results section)
			Factors that have the ability to impact an individual's health	(Expanded upon in results section)
			Social determinants of health	SES impacts people's capacity to engage in climate change
				Low SES have more immediate health concerns
			Built environment has implications on health outcomes, particularly in regions with sprawl	Active transport has health co-benefits
			Aware of traditional knowledge	
		Knowledge acquisition source	Interdisciplinary academic background enhances ability to make intersectional connections	
		Knowledge gap	Mental health work underrepresented in public health research and policies	
			Vulnerability assessments are critical for filling locally-oriented data gaps so we know where to focus actions	
	Understanding	Similarities between COVID-19 and climate change	Leveraging COVID-19 for a Just Recovery post-pandemic	(Expanded upon in results section)

		provided lessons useful for addressing climate crisis		
		Understand the impacts of climate change will differ for those most structurally vulnerable to climate change	Understand the locally-contextualized effects of climate change	
	Perception	Community's perception of climate change and health	Climate denial or minimalism	Climate change is too big and complex
				Doesn't see climate change as threat to health
				People tend to question if certain extreme weather events are truly due to climate change
				Frustration by other countries' lack of response
			Differences between different demographics and perception of risk	Differences in risk perception between races or ethnicities
				Increased climate denial or apathy with increased age
				Gender differences in risk perception
			Individuals are worried about everyday basic needs before climate change	Addressing negative health outcomes associated with social determinants of health is climate (justice) action too
			Rural communities are concerned about climate change	
		Lived experiences	Noticed changes in their environment	Changes due to climate change aren't always negative

				When you feel the changes, you feel more inclined to act
Behaviour	Value	Decision-making	Aspects of climate change that concerns them the most	Intergenerational concerns
				Changes to “normal” way of life for humanity as we know it
				Serious and consequential impact to human health, particularly for structurally vulnerable
		Equity-informed approaches	Greater focus on equity in the past few years across PH sector	Leadership prioritizes training for health unit staff to ensure cultural safety in their work with Indigenous communities
			Representation of historically underrepresented groups (women, gender diverse folks, racialized folks, neurodiverse, or disabled peoples)	No acknowledgement of neurodiverse or disabled peoples
				Some gender diversity is present but generally no other form of diversity measured
				Insufficient representation of racialized folks (except for in urban regions with higher new immigrant populations)
			Traditional Knowledge under resourced so is considered hard to incorporate and/or is underrepresented in work	Doesn't know what Traditional Knowledge is
				Traditional Knowledge is incorporated as an afterthought, not embedded despite recognizing value
				Organizes committees or stakeholder consultations for direct input from Indigenous peoples

		Prioritization of climate action strategies in health unit	Leadership (e.g., Medical Officer of Health) prioritizes climate change related health work	Climate change ranks in list of health issues
				Climate in all policies approach is centred more
			Board of Health's governance of health unit	Board of Health members don't need any specific qualifications to be elected; they are often local leadership with non-health backgrounds
				Board of Health has oversight over health unit's activities
				Board of Health plays role in approvals for strategic priorities and for connecting with community stakeholders including municipality
			Leadership (e.g., Medical Officer of Health) doesn't prioritize climate change related health work or doesn't believe it's in their portfolio	Climate change is siloed to be one person or department's portfolio hindering interdepartmental/ meaningful progress
			Making progress on health unit's climate action strategy	Little to no progress on unit's climate action strategy
				Many small and/or rural health unit's only have one person designing and implementing the strategy
				Initiating the plan and holding accountability for continued progress
	Attitude	Motivation	Feels emotionally strong about climate change or environmental degradation	Eco-grief, anxiety or depression
				Shame
				Guilt
				Fear
				Hope

			Has interest in climate action outside of work	
			Having or developing an appreciation of nature helps people feel more motivated to protect it	
			Makes individual changes in their personal life to address climate change	
		Beliefs held by public health actors	Climate change is caused by over population	
			Canada won't feel the effects like other countries	
			Economic concerns outweigh health concerns at decision making table	
			Regulatory components are necessary when public education is not enough to spark behaviour change	
			We're not addressing climate change fast enough	
			Public health sector needs to play a more prominent role in climate action	
			Climate change is already impacting us	
			Climate change is politicized which makes it harder to address	Six Americas study
			Important to differentiate between adaptation and mitigation	
			IPCC report was influential on changing public opinion	
			It will get worse before it gets better for people to wake up and see the urgency of climate change	
			Sees climate action as a professional responsibility	Public health actors have a responsibility to help the population and be

				held accountable for their actions or inactions
				The general public might not recognize or know what constitutes public health work, but it includes many facets of preventative policy-making
				Need to prepare for the mental health impacts of the changes to everyday life that climate change will bring on
Risk Communication	Identifies need for risk communications for climate change	Influence of media reporting on public perception of climate change	Media's portrayal of climate change could be improved	
	Production of risk communication materials	Effective techniques for risk communications involve combination of many factors	Channel, medium and messenger matter as much as message	Healthcare workers such as doctors or nurses are trusted sources so make good messengers
			Making climate communications more commonplace, informative and less alarmist will help reduce eco-anxiety which can immobilize action	Partnerships with media helps ensure message is informed by health unit
				Minimizing alarmist language
			Links health outcome to climate change	Use health co-benefits and co-harms framing
			Locally-oriented content	
			Targeting risk communications with structurally vulnerable populations	
			Make It Better Campaign was a good example of effective communications	
			Addressing language and literacy barriers in communications is important	Receptive to feedback from community on communications
			Need increased awareness of audience segments when	

			designing communication materials	
		No use of theories or frameworks in production of communication materials		
		Only communicate immediate risk to health and does not link the health outcome to climate change	Keeping the message short is important to maximize engagement	
		Extensive approval of messaging is a barrier to effective communication	Avoids talking about health outcome's link to climate change	Due to lack of data
				By managerial instruction to maintain professionalism
			Politicization of climate change makes it harder to make effective communication materials	
	Use of risk communication to inform general public	Health promotion opportunity	Proactive vs. reactionary risk communication	
		PHUs are trusted by community	Ottawa Public Health's Twitter is one of the best examples of PHU communications	

INDUCTIVE CATEGORIES
(Additional findings in line with the anticipated secondary aims of the study)

Category	Theme	Sub theme	Sub-sub theme	Sub-sub-sub theme
Organizational/ Behavioural Interventions	Funding	Personnel	Urgent need for specialized climate policy positions	HealthADAPT served as an example that health units really benefit from dedicated climate-related funding
				Lack of funding means a lack of dedicated people working on progressing unit's climate action work
				Medical Officers of Health choose prioritization

			Representation of historically excluded, oppressed or underrepresented people	New immigrants more easily centre global devastation associated with climate change
				Women tend to mention children/ future generations more
				"Diversity" needs are met through consultation with community stakeholders instead of dedicated staff
		Limitations	Equity-centred work and perspectives are under resourced	Equity-centred hiring practices are resource extensive; de-incentivizes the practice and prevents from increased diversity in climate policymaking
			Need funding to be able to fill in data gaps	
			Inefficient resource allocations	Specialists at risk of experiencing burnout due to bearing brunt of environmental work
				Relying on other public health units' work (e.g., vulnerability assessments/ data)
	Structural effectiveness	Barriers	Barriers for women to engage in higher level positions due to gender roles	
			Use of internal accountability processes over opting for third-party audit for progress on climate action strategies	
			COVID-19 negatively impacted climate action progress	
			Data gaps perpetuate uncertainty hindering progressive actions	Unseen help, unseen work due to "ghost data"
			Healthcare system is not optimized to handle climate change adaptations	Healthcare workers and health sector advocacy organizations are working

				on climate mitigation and adaptation
				The medical field needs to be better equipped to handle impacts of climate change on mental health
			Public health norms prevent political advocacy due to conflicts of interest	
			Unacknowledged differences between Northern Ontario vs. Southern Ontario	Challenges due to accessibility to health services
				Different health priorities due to differing population demographic
				Challenges are due to large distances between small towns all under the jurisdiction of fewer health units
		Enablers	COVID-19 pandemic helped identify capacity-building opportunities	(Expanded upon in results section in earlier section with “lessons learned”)
			PH needs to play a more active role in advocacy	
			Youth advocacy's influence reverberates at higher levels of governance	
Policies and Practices	Structural accountability	PH sector interactions and roles	Government's roles and responsibilities in adaptation and mitigation	Federal government's role is to provide education and information to regional public health sector actors
			PH unit structure and governance	
			Relationship with regional government	Being independent from regional government allowed for more progressive climate in all policies work in PH sector

				Health perspective is underrepresented at municipal level in conversations about environment and climate change
			Impact of public health unit's affiliation to municipality or municipalities	Independent PH units unaffiliated with municipalities can do more in climate action work without political conflict of interest
				Ontario is one of the few provinces with independent regional health units
				Differences in approach to climate change between municipal departments
				Benefits of being associated with regional government enables better communication and easier interdepartmental collaboration
				Working with municipality or municipalities is necessary to fulfill climate action strategies in region
			Stakeholder engagement	Indigenous Services Canada's climate change program incorporates Traditional and Western knowledge research work
		Updated public health standards (2018) that mandate each health unit to	Mandates in the public health standards are not prescriptive enough	(Expanded upon in results section)

		address climate change	The mandate doesn't come with funding, so accountability for follow through is hard	
			COVID-19 interrupted progress that the update to the standards sparked	
			Positive review of impact of the public health standards	
			Most people feel they were good for getting the conversation started but lacked demanding accountability from health units	
			Public health standards did not have a significant and/or the desired impact	

Appendix P: Frequency Table

To sub-sub theme level

Refs = references (or mentions)

Theme	Refs	Sub theme	Refs	Sub-sub theme
Knowledge (n=17; 100% of participants)	116	**Specialized knowledge of public health actors** (n=17; 100% of participants)	86	**Provided a definition of climate change** (n=14; 82.4% of participants)
				Differences between climate and global warming (n=8; 47.1% of participants)
				If climate change poses big health risk where they live (n=8; 47.1% of participants)
				Factors that have the ability to impact a community's health (n=8; 47.1% of participants)
				Factors that have the ability to impact an individual's health (n=16; 94.1% of participants)
				Social determinants of health (n=17; 100% of participants)
				Built environment has implications on health outcomes, particularly in regions with sprawl (n=2; 11.8% of participants)
				Aware of traditional knowledge (n=4; 23.5% of participants)
		Knowledge acquisition source (n=8; 47.1% of participants)	14	**Interdisciplinary academic background enhances ability to make intersectional connections** (n=3; 17.6% of participants)
		Knowledge gap (n=8; 47.1% of participants)	12	**Mental health work underrepresented in public health research and policies** (n=2; 11.8% of participants)
				Vulnerability assessments are critical for filling locally-oriented data gaps, so we know where to focus actions (n=3; 17.6% of participants)
Understanding (n=11; 64.7% of participants)	21	**Similarities between COVID-19 and climate change provided lessons useful for addressing climate crisis**	10	**Leveraging COVID-19 for a Just Recovery post-pandemic** (n=3; 17.6% of participants)

		(n=6; 35.3% of participants)		
		Understand the impacts of climate change will differ for those most structurally vulnerable to climate change (n=5; 29.4% of participants)	6	**Understand the locally-contextualized effects of climate change** (n=5; 29.4% of participants)
Perception (n=17; 100% of participants)	117	**Community's perception of climate change and health** (n=17; 100% of participants)	70	**Climate denial or minimalism** (n=12; 11.8% of participants)
				Differences between different demographics and perception of risk (n=7; 41.2% of participants)
				Individuals are worried about everyday basic needs before climate change (n=6; 35.3% of participants)
				Rural communities are concerned about climate change (n=5; 29.4% of participants)
		Lived experiences (n=16; 94.1% of participants)	39	**Noticed changes in their environment** (n=8; 47.1% of participants)
Value (n=17; 100% of participants)	86	**Decision-making** (n=16; 94.1% of participants)	27	**Aspects of climate change that concerns them the most** (n=15; 88.2% of participants)
		Equity-informed approaches (n=13; 76.5% of participants)	20	**Greater focus on equity in the past few years across PH sector** (n=6; 35.3% of participants)
				Representation of historically underrepresented groups (women, gender diverse folks, racialized folks, neurodiverse, or disabled peoples) (n=6; 35.3% of participants)
				Traditional Knowledge under resourced so is considered hard to incorporate and/or is underrepresented in work (n=2; 11.8% of participants)
		Prioritization of climate action strategies in health unit (n=14; 82.4% of participants)	32	**Board of Health's governance of health unit** (n=4; 23.5% of participants)
				Need a behaviour shift to climate in all policies and departments (n=11; 64.7% of participants)
				Medical Officer of Health determines if climate change ranks in list of health

				issues impacting region/ is part of strategic priorities (n=4; 23.5% of participants)
				Leadership (e.g., Medical Officer of Health) doesn't prioritize climate change related health work or doesn't believe it's in their portfolio (n=6; 35.3% of participants)
				Making progress on health unit's climate action strategy (n=10; 58.8% of participants)
Attitude (n=17; 100% of participants)	128	**Motivation** (n=15; 88.2% of participants)	40	**Feels emotionally strong about climate change or environmental degradation** (n=10; 58.8% of participants)
				Has interest in climate action outside of work (n=2; 11.8% of participants)
				Having or developing an appreciation of nature helps people feel more motivated to protect it (n=2; 11.8% of participants)
				Makes individual changes in their personal life to address climate change (n=3; 17.6% of participants)
		Beliefs held by public health actors (n=17; 100% of participants)	83	**Climate change is caused by over population** (n=2; 11.8% of participants)
				Canada won't feel the effects like other countries (n=2; 11.8% of participants)
				Economic concerns outweigh health concerns at decision making table (n=4; 23.5% of participants)
				Regulatory components are necessary when public education is not enough to spark behaviour change (n=1; 5.8% of participants)
				We're not addressing climate change fast enough (n=4; 23.5% of participants)
				Public health sector needs to play a more prominent role in climate action (n=10; 58.8% of participants)

				Climate change is already impacting us (n=17; 100% of participants)
				Climate change is politicized which makes it harder to address (n=3; 17.6% of participants)
				Important to differentiate between adaptation and mitigation (n=3; 17.6% of participants)
				IPCC report was influential on changing public opinion (n=1; 5.9% of participants)
				It will get worse before it gets better for people to wake up and see the urgency of climate change (n=3; 17.6% of participants)
				Sees climate action as a professional responsibility (n=9; 52.9% of participants)
Identifies need for risk communications for climate change (n=10; 58.8% of participants)	20	**Influence of media reporting on public perception of climate change** (n=8; 47.1% of participants)	16	**Media's portrayal of climate change could be improved** (n=8; 47.1% of participants)
Production of risk communication materials (n=17; 100% of participants)	83	**Effective techniques for risk communications involve combination of many factors** (n=16; 94.1% of participants)	47	**Channel, medium and messenger matter as much as message** (n=2; 11.8% of participants)
				Making climate communications more commonplace, informative and less alarmist will help reduce eco-anxiety which can immobilize action (n=2; 11.8% of participants)
				Links health outcome to climate change (n=5; 29.4% of participants)
				Locally-oriented content (n=4; 23.5% of participants)
				Targeting risk communications with structurally vulnerable populations (n=9; 52.9% of participants)
				Make It Better Campaign was a good example of effective communications (n=4; 23.5% of participants)
				Addressing language and literacy barriers in communications is important (n=3; 17.6% of participants)

				Need increased awareness of audience segments when designing communication materials (n=2; 11.8% of participants)
		No use of theories or frameworks in production of communication materials (n=3; 17.6% of participants)	3	
		Only communicate immediate risk to health and does not link the health outcome to climate change (n=2; 11.8% of participants)	3	**Keeping the message short is important to maximize engagement** (n=1; 5.9% of participants)
		Extensive approval of messaging is a barrier to effective communication (n=6; 35.3% of participants)	13	**Avoids talking about health outcome's link to climate change** (n=2; 11.8% of participants)
				Politicization of climate change makes it harder to make effective communication materials (n=4; 23.5% of participants)
Use of risk communication to inform general public (n=7; 41.2% of participants)	9	**Health promotion opportunity** (n=3; 17.6% of participants)	3	**Proactive vs. reactionary risk communication** (n=2; 11.8% of participants)
		PHUs are trusted by community (n=3; 17.6% of participants)	4	**Ottawa Public Health's Twitter is one of the best examples of PHU communications** (n=3; 17.6% of participants)
Theme	**Refs**	**Sub theme**	**Refs**	**Sub-sub theme**
Funding (n=14; 82.4% of participants)	59	**Personnel** (n=5; 29.4% of participants)	10	**Urgent need for specialized climate policy positions** (n=4; 23.5% of participants)
				Representation of historically excluded, oppressed or underrepresented people (n=3; 17.6% of participants)
		Limitations (n=13; 76.5% of participants)	37	**Equity-centred work and perspectives are under resourced** (n=5; 29.4% of participants)
				Need funding to be able to fill in data gaps (n=4; 23.5% of participants)
				Inefficient resource allocations (n=10; 58.8% of participants)
Structural effectiveness (n=17; 100% of participants)	103	**Barriers** (n=17; 100% of participants)	74	**Barriers for women to engage in higher level positions due to gender roles** (n=1; 5.9% of participants)

				Use of internal accountability processes over opting for third-party audit for progress on climate action strategies (n=1; 5.9% of participants)
				COVID-19 negatively impacted climate action progress (n=13; 76.5% of participants)
				Data gaps perpetuate uncertainty hindering progressive actions (n=4; 23.5% of participants)
				Healthcare system is not optimized to handle climate change adaptations (n=3; 17.6% of participants)
				Public health norms prevent political advocacy due to conflicts of interest (n=7; 41.2% of participants)
				Unacknowledged differences between Northern Ontario vs. Southern Ontario (n=3; 17.6% of participants)
		Enablers (n=12; 70.6% of participants)	28	**COVID-19 pandemic helped identify capacity-building opportunities** (n=5; 29.4% of participants)
				PH needs to play a more active role in advocacy (n=4; 23.5% of participants)
				Youth advocacy's influence reverberates at higher levels of governance (n=6; 35.3% of participants)
Structural accountability (n=17; 100% of participants)	115	**PH sector interactions and roles** (n=16; 94.1% of participants)	85	**Government's roles and responsibilities in adaptation and mitigation** (n=5; 29.4% of participants)
				PH unit structure and governance (n=7; 41.2% of participants)
				Relationship with regional government (n=4; 23.5% of participants)
				Impact of public health unit's affiliation to municipality or municipalities (n=13; 76.5% of participants)
				Stakeholder engagement (n=11; 64.7% of participants)
		Thoughts on updated public health standards (2018) that	27	**Mandates in the public health standards are not prescriptive enough**

		mandate each health unit to address climate change (n=14; 83.4% of participants)		(n=5; 29.4% of participants)
				The mandate doesn't come with funding, so accountability for follow through is hard (n=3; 17.6% of participants)
				COVID-19 interrupted progress that the update to the standards sparked (n=3; 17.6% of participants)
				Positive review of impact of the public health standards (n=2; 11.7% of participants)
				Most people feel they were good for getting the conversation started but lacked demanding accountability from health units (n=3; 17.6% of participants)
				Public health standards did not have a significant and/or the desired impact (n=2; 11.7% of participants)