

BACKGROUND DOCUMENT

EXPLORING THE LINK BETWEEN CLIMATE CHANGE HAZARDS AND COMMUNITY SAFETY

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INTRODUCTION

Background

Goal 11 of the United Nations' 2030 Agenda for Sustainable Development Goals (SDGs) encourages the global community to commit to the advancement of a holistic approach to achieving sustainable development, emphasizing the importance of cities and communities being "inclusive, safe, resilient and sustainable" [1]. With over half the world's population living in cities, and a larger percentage expected by 2030, the SDGs call for the creation and implementation of integrated policies and plans that facilitate adaptation to climate change and resilience to disasters [1].

More than 80% of Canadians reside in cities and towns, along with a high volume of businesses, economic and social infrastructure, and government services, making them uniquely and extremely vulnerable to risks associated with climate change [2]. Accordingly, these urban centres have become focal points of climate action [2, 3, 4], with national, provincial, and municipal authorities focusing on improving the capacity of cities to mitigate and adapt to climate change through a range of policies, plans, and programs (e.g., Green Municipal Fund, Municipalities for Climate Innovation Program, Partners for Climate Protection Program, Green Government Strategy, Federal Adaptation Policy Framework, Federal Sustainable Development Strategy and Emergency Management Strategy for Growth).

While these strategies and frameworks have benefited from consultations with experts in urban planning, health, disaster management and infrastructure sectors, security and safety experts have largely been excluded from these discussions. Further, research on the link between climate change and public safety, with a focus on violence and crime, is scarce, with little focus on the Canadian context. Existing research posits that acute hazards and long-term stressors have exacerbated the effects of climate change on violence and safety/security, which threaten to overwhelm policing, emergency, and social welfare responses [5]. Most recently, the COVID-19 pandemic has shown how lack of emergency preparedness undermines community safety and revealed safety blind spots like safety at home¹. Learnings from the COVID-19 pandemic foreshadow how a lack of preparation for climate change impacts may affect community safety. These gaps in knowledge limit the ability of decision-makers to devise and implement effective plans and strategies to maintain community safety amid the effects of climate change.

¹ COVID-19 has highlighted many vulnerabilities including violence in homes.

What is this Project About?

After identifying the research and preparedness gaps, our team recognized the need for purposeful exploratory investigation into the connections between climate change, violence, and crime. This project is the first step in this investigative process. It will set the foundation for a comprehensive approach that explores wide-ranging climate change risks and credible public safety outcomes in a municipal context. The goal is to provide a forum to facilitate interdisciplinary, stakeholder, and expert collaboration to bring greater attention to this critical challenge and elicit proactive responses to improve public safety outcomes.

Three virtual workshops were deemed the most effective forum to connect experts from different sectors and disciplines; synthesize and integrate current scholarly and practice-based knowledge; and identify and map potential climate risks, vulnerabilities, and safety outcomes.

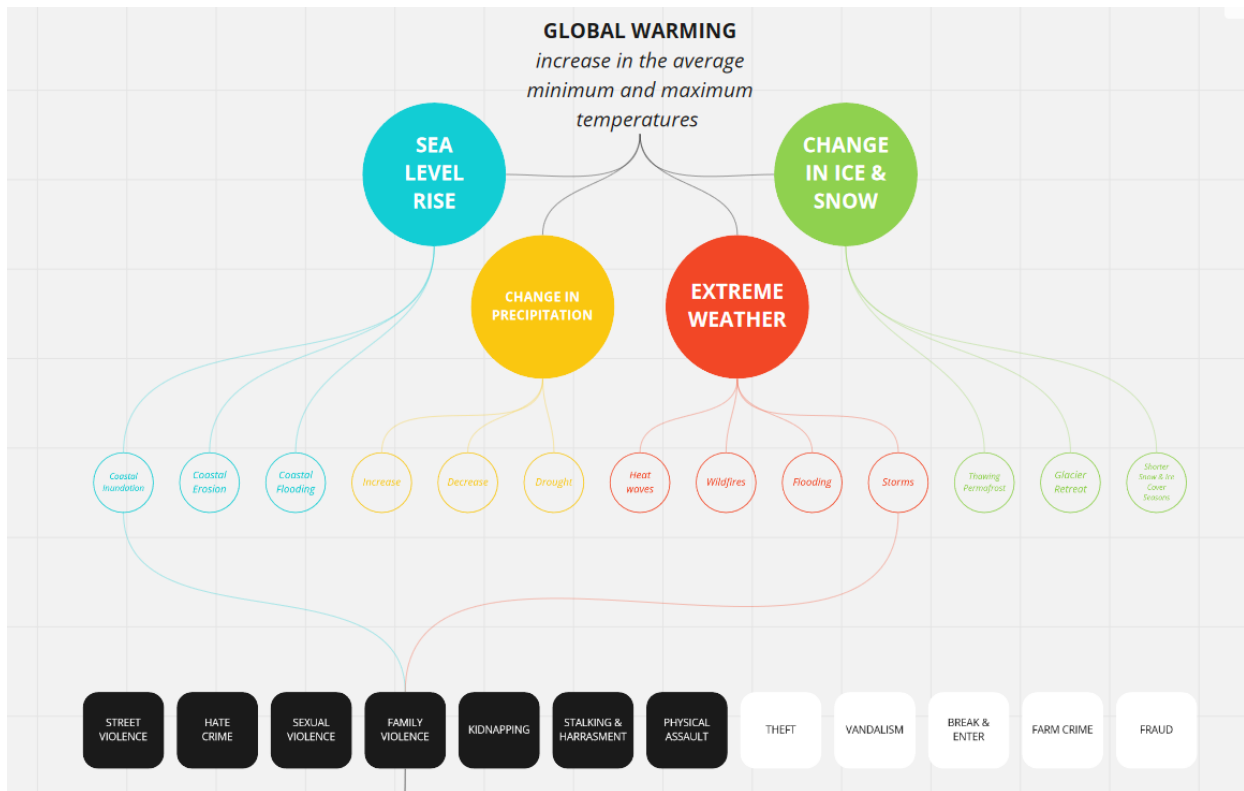


Figure 1: Example of the mapping tool that will be used in the workshop exercises

The findings from these investigations will support evidence-based decision-making and adaptation planning to mitigate potential climate change impacts on community safety.

The project was made possible through a **Social Sciences and Humanities Research Council (SSHRC)** connection grant.

Who is Participating?

This project brings together climate change experts, urban/rural safety and security experts, crime/violence experts, and experts operating at a municipal level from allied sectors (e.g., public health, emergency management, public safety specialists, urban planners, and community partners).

The community partners selected represent groups that experience increased vulnerabilities. These groups include children, women, seniors, racialized communities, refugees/newcomers, LGBTQ2S+, Indigenous peoples, people living with mental health conditions, and disabled persons.

Purpose & Outline of this Document

The document is intended to provide sufficient background information to ensure all workshop participants possess a base level of knowledge on climate change and 'crime and violence'. This document is not intended to be an extensive review of the literature as it is beyond the scope and needs of this project. Additionally, a podcast has been produced to accompany this document. It will provide much of the same information and serves as an alternative should you be unable to read this document in its entirety.

Below, we briefly introduce the concept of climate change, followed by a description of selected climate change hazard effects that workshop attendees will discuss. We then provide an overview of the (limited) literature that examines connections between climate change, violence, and crime. We conclude with a discussion of vulnerability and adaption assessments as a response to the impacts of climate change.

EFFECTS OF CLIMATE CHANGE ON NATURAL AND HUMAN SYSTEMS

Overview

Undeniably, human activity over the past 200 years has contributed to a rise in the global concentration of greenhouse gas emissions (GHGs), primarily attributable to the rampant burning of fossil fuels such as coal, oil, and gas. Increases in GHGs in the atmosphere have led to unprecedented warming of the earth's surface, where nine of the warmest years on record have occurred since the start of the 21st century [6]. Earth's surface temperature has increased by 0.18°C per decade since 1981 and reached approximately 1.19°C above pre-industrial levels in 2020 [7]. Some regions have experienced warming greater than the global average and will continue to do so. For example, according to *Canada's Changing Climate Report*, Canada is warming twice as fast as the other places on the planet, with the temperature of northern Canada increasing 2.3°C since 1948 [8,9]. In the United States, the temperature of the Northwest region is projected to increase up to 2.0°C degrees by 2035 [10]. In Finland, the increase in temperature is nearly twice as much as the global rate, with an increase of approximately 2.3 °C between 1847 and 2013 [11].

Global warming is one aspect of climate change that has been observed since the early 20th century. Climate change encompasses a range of other consequences due to the warming of the earth's surface, which pose risks to natural and human systems [6,12]. These include glacial retreat, thinning permafrost, sea-level rise, changes in precipitation patterns, and extreme weather events, including droughts, storms, more intense hurricanes/storms, and storm surges [9, 10, 13, 14]. Already, regions across Canada, the United States, and Europe have begun to experience the wide-ranging effects of global climate change. Thus, there is an urgent need for climate action to minimize potential climate change impacts (adaptation), as research has indicated that some effects are likely to occur even if GHG emissions are reduced (mitigation) [15]. We present some climate change effects and their associated risks to human systems in Canada, the United States, and Europe.

Climate Change Effects

Global Temperature Rise

Current trends project warmer global average temperatures (over both land and sea) over the coming decades [13]. Record high temperatures were observed in the

HIGHLIGHTS

- ❖ 70% of the world's coastlines are projected to experience a sea-level change [20].
- ❖ Sea-level rise throughout the 21st century and beyond will lead to coastal systems and low-lying areas experiencing adverse impacts such as submergence, coastal flooding, and coastal erosion [20].
- ❖ Factors like population growth, economic development, and urbanization will increase the population and assets exposed to coastal risks in the coming decades [20].
- ❖ Deadly heatwaves, like those in Chicago (1995), Pakistan (2015), India (2015), and Europe (2019), are expected to increase in frequency (possibly annually) and duration.
- ❖ Extreme heat events will be more severe in urban centres than rural areas because of the urban heat island effect.
- ❖ At warming above 1.5 degrees Celsius, twice as many megacities are likely to become heat-stressed, potentially exposing 350 million more people by 2050.

years 2016 and 2020 [15]. Experts expect more frequent hot, (and fewer cold) temperature extremes over most land areas on daily and seasonal timescales [14]. Heat waves are expected to increase in frequency and duration, with extreme heat days happening every two to three years by the end of the 21st century [13]. These occurrences will be more severe in urban areas (cities and towns). Urban areas already tend to be warmer than surrounding rural locations because of a phenomenon called the urban heat island effect².

Evidence suggests that rising air temperature contributes to ocean warming, with a recorded increase of 0.6 °C since 1969 [16].

Changes in Ice and Snow

Ice and snow are melting faster. Between 1993 and 2019, an annual loss of 148 billion tons of ice was observed in Antarctica [17]. Glacial retreat is occurring, uncovering land previously covered by snow and ice [15]. There is already evidence that global warming contributes to shorter snow and ice cover seasons, earlier spring peak streamflow, thinning glaciers, and thawing permafrost [9].

Sea Level Rise

Glacier retreat and ice melting are projected to cause increases in sea levels throughout the 21st century at a faster rate than observed from 1971 - 2010 [14, 15]. Since 1993, global sea levels have risen from -0.5 mm

² **The Urban Heat Island Effect** - Urban heat islands are built-up areas that are hotter than neighbouring rural areas. For instance, for a city with 1 million or more people, the average air temperature can be 1 to 3 °C warmer than surrounding areas. The paved surfaces and closely packed buildings in urban centers are more efficient at amplifying and trapping heat than natural ecosystems and rural landscapes where trees and vegetation provide shade and air cooling through evaporation. Furthermore, cities and towns generate heat from sources like furnaces, vehicles, air conditioners, etc. *Health Canada. (2010). [The Urban Heat Island Effect: Causes, Health Impacts and Mitigation Strategies](#).*

HIGHLIGHTS

- ❖ At 2°C warming, heavy rainfall events are expected to increase in frequency and intensity in many regions, leading to greater risks of devastating flooding [22].
- ❖ Changes in precipitation amounts and melting snow and ice are altering hydrological systems, affecting the quality and quantity of water resources.
- ❖ Urban flood risks will increase due to more intense rainfall.
- ❖ At 2°C of warming (compared to 1.5°C), about 61 million more people in urban areas will be exposed to severe drought [22].
- ❖ The intensity, frequency, and duration of North Atlantic hurricanes have increased since the early 1980s and are expected to continue to become more intense with further warming [12].

in 1993 to approximately 96.3 mm in 2020. In Europe, sea levels are projected to rise as much as 0.5 m by 2100 in various regions, with the highest expected risks to Amsterdam, London, and Rotterdam [13]. Further, this increase may lead to floods, putting highly populated coastal areas at risk [17]. In Canada, the impacts of rising sea levels have been observed in recent years, particularly in Nova Scotia [18,19]. For instance, higher tides and seven flooding events were documented between 2014 and 2017 in Halifax [18,19].

Changes in Precipitation Patterns

Changes in precipitation patterns will not be uniformly distributed. Some regions will experience increases in precipitation, while others will experience decreases. For instance, climate change models project gradual increases in heavy precipitation in the northern regions of the United States (US) [15]. Further, while Southwest regions of the US are expected to see an increase in heavy precipitation, this will occur at a slower rate [15]. In Canada, evidence suggests that the annual mean of precipitation may increase up to 7% in the 21st century, although summer rainfall may decrease in some areas [9, 21]. On the other hand, Southern Europe is expected to experience less rainfall due to changes in the annual precipitation patterns of 30-45% and up to 70% in the summer [13].

Extreme Weather Events

In the future, extreme weather events are expected to become more intense and severe, and possibly more frequent, because the climate is warming [9,14]. These extreme weather events include flooding, droughts, heatwaves, wildfires, storms, hurricanes, and powerful storm surges.

Climate Change Impacts

The climate change effects described before pose risks for a wide range of negative consequences to humans, human systems, and societal development. They may impact food security, natural resources and ecosystems, human health, livelihoods, migration, security, infrastructure, and economic growth. We have described some of these impacts below.

Food Security

Climate change will impact all aspects of global food security, including food production, distribution, access, utilization, and price stability of food items [23, 24]. For instance, climate models show that climate change may cause a decline in crop yield of between 10-25% by 2050, and it is expected that by 2030, food prices could increase by up to 50-90% more than would be expected if climate change were not a problem [23,24]. In turn, these threats can lead to increased hunger, lack of access to nutritional food and changes in diets.

Natural Resources

Natural resources such as forests and vegetation, fish and wildlife, and freshwater reserves are already in limited supply due to mismanagement, growing demand and inequitable distribution. Climate change and population growth present additional threats to the quality and reliability of natural resources and their services [25]. Natural resource scarcity may lead to food and water crises, rise in costs of consumer goods, increased competition for resources, growing conflict and humanitarian disasters.

Human Health

Health impacts are associated with various climate change effects such as rising temperatures, extreme heat events, changing precipitation patterns, air quality, increased frequency/intensity of extreme weather events [26]. Some of these impacts are injuries and fatalities, heat-related illnesses, a proliferation of food-, water- and vector-borne diseases, malnutrition/undernutrition, and various mental health ailments [26].

Property and Infrastructure

Climate change will likely result in damage and loss of personal property from extreme weather events and damage to critical infrastructure (buildings, roads, bridges and utilities) [20].

Livelihoods

Climate change can negatively affect livelihoods through multiple pathways. For instance, extreme weather events can have devastating impacts on vulnerable

economic sectors, impeding how people make money (e.g., farmers lose income when a hurricane or flood destroys a harvest). Rural livelihoods are more likely to see significant impacts from climate change due to the proximity and reliance on natural resources and the services they provide [27]. Climate change will also affect urban livelihoods, even if to a lesser degree and through more complex pathways [28]. These impacts are primarily associated with extreme weather events, which can damage homes and property and disrupt transport and other critical infrastructure. Another example is the impact of extreme heat on workers' health and work productivity [29]. These disruptions negatively impact financial wellbeing and contribute to unemployment levels, particularly among lower socio-economic groups. Repeated exposures to these various pathways can push people into poverty when they lose their assets and are unable to rebuild or grow these assets [20]. Furthermore, these climate change impacts can exacerbate existing inequalities, particularly affecting socially and geographically disadvantaged populations.

Migration

High exposure to extreme weather events and declining natural resources are linked to disaster-induced displacement of people [20]. Already, we have seen how these circumstances may lead to an increase in environmental migrants or climate refugees across the globe. Repeated exposure to climate-related hazards like flooding, droughts and sea-level rise will leave places uninhabitable, resulting in waves of climate refugees who are unable to return to their homes. The loss of livelihoods, sense of place, cultural norms and the disruption of social networks are all factors that negatively impact the wellbeing of displaced populations. Moreover, the sites receiving these migrants and refugees have to cope with the repercussions of incorporating large influxes of people into new environments.

Security

By amplifying drivers of conflict such as poverty, economic shocks and competition for access to limited resources, climate change will increase the risks of violent conflict [20].

In examining these impacts, one should be mindful of the interconnectedness between climate change hazards and impacts. Conceptualizing these relationships as a web of relations, rather than linear relationships, better represents these connections. A single climate change hazard can have a variety of immediate and secondary effects, and impacts—such as those describes above—can result from various hazards. The interaction of non-climatic factors and climate change hazards create these complexities and shape the uneven distribution of vulnerability to climate change (See Section **Vulnerability and Adaptation Assessments**).

Many of the global risks posed by climate change effects are concentrated in urban areas. Climate change is projected to increase risks for people, assets, economies, and ecosystems, including risks from heat stress, sea-level rise and storm surges, extreme precipitation, inland and coastal flooding, air pollution, food insecurity, water scarcity and drought. These risks are even more significant for populations living in locations that lack essential infrastructure and services or are highly exposed to these effects. Rural areas are not exempt from these effects. Through climate change impacts on water availability and supply, food security and agricultural income, climate change will also impact the wellbeing of rural populations [20].

The WHO classifies three types of violence:

1. Interpersonal violence (between family members, intimate partners, friends, acquaintances, and strangers)
2. Self-directed violence (e.g., suicide or self-mutilation)
3. Collective violence (inflicted by larger groups such as nation states, militia groups and terrorist organizations)

The WHO classifies two types of crime:

1. Crimes against persons (elder abuse, intimate partner violence, violence against children, street violence (guns and gangs), hate crime, kidnapping, physical assault, homicide, and sexual violence)
2. Crimes against property (break-and-enter, farm theft, fraud, vandalism and theft)

CLIMATE CHANGE, VIOLENCE, AND CRIME

Defining violence and crime

The World Health Organisation (WHO) defines violence as "the intentional use of physical force or power, threatened or actual, against oneself, a group or community, that either result in or have a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation" [30].

Within the context of this project, we expect that most discussions will focus on interpersonal violence and possibly self-directed violence. Collective violence (i.e., instrumental violence inflicted by larger groups such as nation-states, militia groups and terrorist organizations to achieve political, economic, and social objectives) is beyond the scope of this project and workshop discussions. The reason for this omission is that while we have a good understanding of how climate changes affect civil conflict and warfare, much less is known about how climate change might affect more localized categories of violence and criminal behaviours [5].

The World Health Organisation differentiates crime and criminal behaviours into two categories: crimes against persons and crimes against property [31]. Crimes against persons involve the use (or threatened use) of violence against a person. On the other hand, crimes against property involve unlawful acts but do not involve the use (or threat of use) of violence against a person.

Discussion throughout the workshops will feature both these categories of crime.

Research on Climate Change, Crime, and Violence

Recent theorizing on the connection between violent behaviour and climate change has been influenced by research from academic disciplines such as psychology, sociology, political science, economics, history, and geography. These studies have proposed both direct and indirect effects of climate change on crime and violence, and it is noteworthy that a small group of scholars conducted most of these studies.

Direct Connections Between Climate Change And Violence

Some research on climate change and violence highlight direct links between warmer temperatures and the effects on irritability, aggression, and violence [e.g., 32, 33, 34,35]. Scholars argue extreme heat can:

- be the impetus for activities that can trigger violence (e.g., alcohol use);
- cause physiological changes associated with mood disturbances, confusion, and anger (e.g., dehydration);
- alter human behaviour patterns in ways that create opportunities for criminal activity (e.g., people congregating outdoors, which facilitates creates conditions for contact crimes).

Indirect Connections Between Climate Change, Violence, And Crime

Through more complex interactions between environmental changes and human systems, indirect effects of climate change on violence and crime can occur. Indirect effects refer to consequences of climate change that are mediated by other factors. According to research, these connections can happen because of [32, 33, 35, 36]:

- the aftermath of natural disasters
- the effects of climate hazards on child and adolescent development
- the impact of climate change on the lives and livelihoods of populations living in vulnerable situations

Violence after Natural Disasters

Much of what is known of the change in rates of violence after natural disasters is based on a small number of systematic studies, as this problem has not been comprehensively studied [36]. However, there is consensus that natural disasters are

stressful events for individuals, families, and communities, and the stress of these events may increase the risks for violence in the home, neighbourhood, or community [38]. The evidence suggests that domestic and family violence, intimate partner violence, child abuse/neglect and sexual violence are highly prevalent in the months and years following disasters [36, 39]. Refer to Table 1 for more examples. Moreover, there is further evidence that the long-term effects of disasters can lead to an escalation of sexual, financial, and emotional abuse and an overall increase in crime and community violence [36, 39]. The risks of violence in these situations are linked to [36]:

1. increased stress and feelings of powerlessness due to grief, loss of property and loss of livelihood;
2. mental health problems such as post-traumatic stress disorder;
3. the scarcity of basic provisions;
4. the collapse of social networks;
5. the breakdown of law enforcement;
6. disruption to violence prevention and other social support programmes; and
7. disruptions to the economy.

The WHO also proposes that while elder abuse, youth violence, and violence related to the distribution of emergency aid have not been studied systematically, they are likely to affect communities after a disaster [36].

Effects of Climate Change on Child and Adolescent Development

According to some researchers, climate change may impact the physiological and psychological development of adolescents and children, increasing the likelihood of them developing into violence-prone adults [33, 35]. Pathways of impacts include the effects of climate hazards on prenatal and childhood nutrition. Another pathway is the impacts of climate change on livelihoods, leading to children growing up in poverty, poor living conditions, or limited access to quality education. Finally, family disruptions and high exposure to community violence linked to climate hazards create environments that negatively impact childhood development.

Effects of Climate Change on The Lives, Livelihoods, and Resource Availability

Climate change may affect violence through its impact on the lives and livelihoods of people in vulnerable situations. For instance, researchers have found the effects of climate change on agricultural sectors have contributed to increased rates of domestic violence [37]. There is a proposed connection between social and psychological pressure and the loss of income. While many of these impacts are triggered by extreme weather events and natural disasters, long-term changes to climate variability and efforts to mitigate climate change through greenhouse gas reductions may also trigger loss of income in vulnerable economic sectors.

Furthermore, other researchers have highlighted how climate change can trigger economic and political instability, force migration, weaken social support and cohesion, and cause social conflicts [32, 33].

Examples of interpersonal violence associated with natural disasters

Event	Type of violence	Evidence	Source
Australia: 2009 Victorian Black Saturday bushfires	Domestic and family violence	More than ½ of women interviewed reported experiencing domestic and family violence. Many had never experienced it before.	Parkinson, D., & Zara, C. (2013). The hidden disaster: Domestic violence in the aftermath of natural disaster. <i>Australian Journal of Emergency Management, The, 28(2)</i> , 28-35.
Australia: 2009 Victorian Black Saturday bushfires	Violence amongst women	Three years after the Black Saturday bushfires, women residing within high bushfire-affected communities experienced the highest levels of violence. These post-disaster experiences of violence are associated with post-disaster changes to income and with post-traumatic stress disorder and depression symptoms among women.	Molyneaux, R., Gibbs, L., Bryant, R., Humphreys, C., Hegarty, K., Kellett, C., . . . Forbes, D. (2020). Interpersonal violence and mental health outcomes following disaster. <i>BJPsych Open, 6(1)</i> , E1. doi:10.1192/bjo.2019.82
New Zealand: 2006 Snowstorm	Domestic violence	Demand for women's shelters increased by double the previous monthly average (over the past two years) in the months following the disaster	Houghton, R., Wilson, T., Smith, W., & Johnston, D. (2010). "If there was a dire emergency, we never would have been able to get in there": Domestic violence reporting and disasters. <i>International Journal of Mass Emergencies and Disasters, 28(2)</i> , 270-293.

Florida: natural disasters between 1999 – 2007	Interpersonal violence and domestic violence	<p>After longer-lasting³ exposure to natural disasters, police reports of simple assault⁴ increased.</p> <p>Longer-lasting exposure to disaster among Florida residents increased the expected number of assaults at the county level by approximately 78 per year.</p>	Gearhart, S., Perez-Patron, M., Hammond, T. A., Goldberg, D. W., Klein, A., & Horney, J. A. (2018). The impact of natural disasters on domestic violence: an analysis of reports of simple assault in Florida (1999–2007). <i>Violence and gender</i> , 5(2), 87–92.
Mississippi: 2005 Hurricane Katrina	Gender-based violence (GBV) (sexual and physical violence) among populations living in protracted displacement	<p>The rate of GBV, particularly intimate partner violence, increased within the year following Hurricane Katrina and remain elevated even years after the initial event.</p> <p>The crude rate of new cases of GBV among women increased from 4.6/100,000/day to 16.3/100,000/day in 2006 and remained elevated at 10.1/100,000 per day in 2007.</p>	Anastario, M., Shehab, N., & Lawry, L. (2009). Increased gender-based violence among women internally displaced in Mississippi 2 years post–Hurricane Katrina. <i>Disaster medicine and public health preparedness</i> , 3(1), 18–26.
Mississippi: 2005 Hurricane Katrina	Gender-based violence (psychological and physical abuse)	The percentage of women reporting psychological victimization increased from 33.6% before Hurricane Katrina	Schumacher, J. A., Coffey, S. F., Norris, F. H., Tracy, M., Clements, K., & Galea, S. (2010). Intimate partner violence and Hurricane

³ >199 days of major declared disaster

⁴ defined as an attempt to cause physical harm to someone and including fear of battery or reasonable apprehension that a crime is imminent if no physical harm occurs

		<p>to 45.2% following Hurricane Katrina ($p < .001$).</p> <p>The percentage of men reporting psychological victimization increased from 36.7% to 43.1% ($p = .01$).</p> <p>Reports of physical victimization increased from 4.2% to 8.3% for women ($p = .01$) but were unchanged for men.</p>	<p>Katrina: predictors and associated mental health outcomes. <i>Violence and victims</i>, 25(5), 588-603.</p>
<p>Canada: Manitoba Flood of 2011.</p>	<p>Family violence</p>	<p>In the aftermath of the flood, psychosocial impacts identified among individuals and families included increases in alcohol and drug use and family violence, along with other general symptoms of high-stress levels such as depression, anxiety, sleep disruption.</p>	<p>Warren, F. J., & Lemmen, D. S. (2014). <i>Canada in a changing climate: Sector perspectives on impacts and adaptation</i>. Government of Canada.</p>

VULNERABILITY AND ADAPTATION ASSESSMENTS

Introduction

Vulnerability and adaptation assessments allow practitioners to evaluate how climate changes may affect various human and natural systems. As the name suggests, they are two primary components [40]:

1. An assessment of vulnerability: This evaluates the scope and severity of potential climate change effects.
2. An assessment of adaptation: This identifies and evaluates practices, technologies, and policies that can be implemented in response to climate change.

Findings from vulnerability and adaptation assessments can be used to inform climate change adaptation plans. These are formal plans that allow countries or communities to deal with impacts, risks, and opportunities from climate change, by identifying and implementing policies and measures to address the risks posed by climate change [41]. Such plans can work alongside official community plans to address climate change impacts. The development, implementation, and assessment of an adaptation plan should be a collaborative process with experts and stakeholders from different backgrounds, including scientists, practitioners, decision-makers, and community members [41]. A common goal of adaptation action is capacity-building, which refers to the development of human resources, institutions, and communities so they can adapt to climate change [42]. Other goals of adaptation planning include integrating consideration for climate change in planning, practice, and policy.

Defining Vulnerability and Adaptation

What is vulnerability?

The Intergovernmental Panel on Climate Change defines vulnerability as the “degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes” [43]. It is characterized by three components: exposure, sensitivity, and adaptive capacity.⁵ These

⁵ Exposure: “the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected” (IPCC, 2007)

components tell us how vulnerable a system is to climate change impacts and the extent to which adaptation is possible. Vulnerability to climate change effects is not evenly distributed. It differs both among countries and within them. Uneven distribution of vulnerability to climate change impacts is linked to variation in exposure to climate change hazards, as well as exposure to non-climatic factors (i.e., social, cultural, economic, and political factors) and inequalities produced by uneven development processes [46]. We assess vulnerability to 1) identify the greatest risks from climate change, 2) identify factors that contribute to vulnerability, and 3) determine how to best allocate scarce resources [41].

What is Adaptation?

For this project, we are using the United Nations Development Programme definition of adaptation which is “a process by which measures and behaviours moderate, cope with, and take advantage of the consequences of climatic events are enhanced, developed, or implemented” [44]. This differs from mitigation, which involves limiting global climate change by reducing greenhouse gas emissions or enhancing sinks that remove them from the atmosphere [45]. Adaptation and mitigation are complementary actions and both necessary responses to climate change. Adaptation tends to have more immediate effects and involves different actors compared to mitigation [45].

As suggested by the definition above, adaptation may be twofold: it can involve actions that reduce the harm associated with climate change or actions that can take advantage of potential benefits that may arise because of climate change. Interestingly, adaptation action can also provide benefits outside the scope of climate change. For example, systems experiencing increased rainfall may have extended growing seasons that communities can take advantage of, which, in turn, may provide additional economic benefits.

Components of Vulnerability and Adaptation Assessments

Several steps go into conducting a vulnerability and adaptation assessment. Many researchers recommend a participatory vulnerability and adaptation assessment approach, meaning community and stakeholder engagement should be sought throughout the process, along with the participation of climate change and other

Sensitivity: “the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change” (IPCC, 2007)

Adaptive Capacity: “the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCCC, 2007)

experts [46]. This recommendation comes from recognizing that various factors (social, political, and economic) compound the vulnerability of populations. Community participants/stakeholders are best-suited to document their exposures and sensitivities and factors that constrain or support adaptive capacity [46]. Several frameworks can be used to guide the implementation of a vulnerability and adaptation assessment. Among these various frameworks, the stages/steps discussed below remain constant [40, 46, 47].

Stage 1 – Frame and Scope the Assessment

This stage requires persons leading the assessment to outline several parameters:

1. Defining the geographic region/spatial scale of interest.
2. Identifying the climate stimuli of interest. In so doing, one should consider the temporal and spatial characteristics of the stimuli. Three climate conditions typically considered are [48]:
 - a. Global climate change (the long term mean temperature and related climate norms)
 - b. Climate variability (the changes in climate norms over a period of time)
 - c. Extreme events (isolated extreme weather events, such as floods or droughts)
3. Outlining the issues to be addressed, sectors of focus, defining project terminology.
4. Identifying the questions to be addressed and assessment steps to be used.
5. Establishing a project team.
6. Establishing a stakeholder engagement process.
7. Developing a communication plan.

Stage 2 – Assessment

This stage involves an assessment of vulnerability, future impacts, and adaptation options.

1. Vulnerability – this is an investigation of the current exposures and sensitivities faced by the population, community, sector, or system.
2. Future impacts – this step projects future risks under climate change and should seek to describe risks, both with and without climate change. Integrating the experiences, knowledge, and expert opinions of stakeholders, community partners, and climate change experts with documented knowledge about climate change impacts is required to complete this step. It involves:
 - a. Creating an inventory of climate change impacts relevant to the system of interest.

- b. Identification of the risks associated with each climate change impact and assessing the frequency, damage, and adaptation cost of the impact.
 - c. Identifying future exposures and sensitivities that may be faced by the population, community, sector, or system.
3. Adaptation – this is an assessment of the opportunities available to respond to climate change. These adaptation options can be assessed based on factors such as economic value and ease of implementation. This step involves:
 - a. Identifying resources and barriers to the implementation of adaptation options.
 - b. Identifying and prioritizing policies and programmes to address current and projected risks.
 - c. Implementing adaptation strategies should include information regarding the participation and responsibilities of various sectors and organizations involved in implementing said actions. It is also essential to identify sources of funding for these activities.

Stage 3 – Monitor and Manage

The final stage of the assessment is establishing an iterative process for monitoring and managing the risks of climate change. Part of monitoring and managing climate change risks includes evaluating the effectiveness and efficacy of the adaptation plans, assessing the adaptation outcomes, ensuring accountability, and improving adaptive actions [49].

Adaptation Plans in Canada

The Pan-Canadian Framework for Clean Growth and Climate Change is the nationwide adaptation for Canada. This extensive plan includes goals such as reducing carbon emissions, building resilience through information sharing, infrastructure, improving the health and wellbeing of communities, and building clean technology [50]. Additional plans working alongside the Pan-Canadian Framework include the Green Municipal Fund, Municipalities for Climate Innovation Program, Partners for Climate Protection Program, Green Government Strategy, Federal Adaptation Policy Framework, Federal Sustainable Development Strategy, and Emergency Management Strategy for Growth.

An apparent gap in the current nationwide adaptation plan is the exclusion of community safety (i.e., crime and violence). While there is mention of improving community wellbeing, adaptation actions around wellbeing are limited to reducing climate change-related health risks, such as Lyme disease. The current plan does

not recognize the risk of increased violence resulting from climate change-related risks, for example, spikes in violence due to extreme heat.

CONCLUSION

Understanding the impact of climate change on violence requires examining a range of other contributing factors, such as socio-economic vulnerability, gender inequalities, substance abuse, and gun control [34]. The diversity of research across disciplines and the disparate nature of the existing knowledge necessitates this workshop series, which convenes researchers from different fields with various community practitioners to consolidate the current body of knowledge and develop a holistic and well-integrated research agenda. Given the broad range of violent threats posed by climate change, it is critical to establish platforms where stakeholders can engage in anticipatory discussions and develop necessary precautionary measures.

This project will utilize a series of virtual workshops that will provide a forum for a multidirectional flow of information between participants and allow us to map various community safety outcomes to acute climate change hazards and long-term stressors. The findings from these workshops will be presented during a public event (webinar/speaker series) in the fall of 2021 and shared with workshop participants and other interested organizations. We trust this project will generate sufficient attention and interest to escalate the priority assigned to this topic by various affected stakeholders, either at the community, municipal, or national level.

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