

# Assessing Climate Change Vulnerabilities of Ontario's Rural Populations

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## Abstract

Climate change causes considerable challenges for both urban and rural communities. Our study aimed at enhancing the understanding of climate change effects on rural populations. The study was promoted in Middlesex County library locations and on Middlesex County's social media accounts; all residents of Middlesex County were eligible to participate. Through this method of convenience sampling, we successfully recruited 40 rural residents and conducted five focus group sessions. The study was conducted in Middlesex County, in southern Ontario, Canada, which provided a good representation of southern Ontario's rural communities. Thematic analysis was used to analyze the data collected in focus group discussions. Focus group discussions yielded four main themes and provided valuable insights on several climate change-related topics. The four identified themes are: frequent extreme weather events, access to food and safe drinking water, protection from vector-borne diseases, and living in a rural community. Our results indicate key parameters to address the climate change issues for rural residents and lead to a series of recommendations to revamp climate change policy at local, provincial, and federal levels. Study Participants commented on the need for adaptation skills concerning the physical and mental health aspects of increased indoor activity (avoiding natural spaces/pollution). This could also be an indicator/opportunity for future health programming and funding to support new realities. Future research is needed to develop effective local solutions with collaboration among government, business sectors, and rural residents.

**Keywords:** environmental health, food security, water quality

## 1. Introduction

Climate change affects both urban and rural communities. Rural residents are often more disadvantaged in responding to challenges compared to urban dwellers. Using a qualitative approach with focus group discussions, our study aimed to enhance the understanding of climate change effects on rural residents. Ontario is the most populous province in Canada, with 14.73 million people representing 38.8% of the country's population (Statistics Canada, 2020). It is comprised of many metropolitan areas, but Ontario also has a rural population of 2.5 million residents (Bollman, 2017) that may be readily compared to numerous geographic regions and demographics.

Expanding on the Public Health Agency of Canada's definition, Kipp et al. (2019) define rural communities as areas that either have under 10,000 residents or have less than 50% of the population who commute to an urban center for employment. Canada is composed of approximately 20% rural communities that have less than 10,000 residents (Lavoie, Wong, Katz, & Sinclair, 2016). Rural populations include vulnerable groups that are the least resilient to the effects of climate change, such as children, older individuals, and immunocompromised people (Yusa et al., 2015; Schleussner et al., 2018). However, adaptation strategies can be established at the local, provincial, and federal levels to fortify the resilience of the vulnerable populations against climate change effects (Laycock & Caldwell, 2018; Thornton & Comberti, 2017; Ford, Labbé, Flynn, Araos, & IHACC Research Team, 2017).

Climate change effects result in extreme weather events. These events include storms, flooding and heat or cold waves with intensified negative impacts on rural communities (Kipp et al., 2019; Yusa et al., 2015; Ford et al., 2017; Waldie, 2011; Ogden, 2017). Storms and flooding cause property damage and adversely affect farming

activities (Waldie, 2011; Curtis, Fair, Wistow, Val, & Oven, 2017); severe weather events such as heat and cold waves are also linked to the increase in cardiac and respiratory diseases, hospital visits, and emergency service calls (Kipp et al., 2019; Curtis et al., 2017). These events can also create psychological distress and decrease psychological resilience by increasing the prevalence of psychological disorders, which often leads to the out-migration of youth and families (Vasseur, L., Thornbush, M., & Plante, S., 2017; Drolet & Sampson, 2017). The feelings of isolation (Higginbottom et al., 2016) and deep connection to nature make the rural population highly vulnerable in responding negatively to the effects of climate change (Kipp et al., 2019), they often become more anxious, depressed, and distressed due to the significant changes (Kipp et al., 2019). This is exacerbated by existing problems; researchers have found that recruitment and retention of healthcare professionals have been ongoing issues for numerous rural communities (Lavoie et al., 2016; Lauckner & Hutchinson, 2016; MacLeod et al., 2017). Further, healthcare professionals in rural communities must cope with limited resources such as access to diagnostic tools and the risk of travelling to patients' homes during inclement weather (Yonge et al., 2015; Fleet et al., 2015, 2017, 2018; Martin, O'Meara, & Farmer, 2016).

Healthcare professionals are not the only group affected by travelling in extreme weather events such as freezing rain, this is also a general concern for rural residents who commute to work (Yonge et al., 2019). Transportation systems in rural settings are rarely able to alleviate this concern as they often face limited operational resources and increasing demands due to the fast-growing aged population (Chen, Ahtari, Majkut, & Sheu, 2017). The emerging challenges include cost control, equity, and priority (Chen et al., 2017; Picketts et al., 2016). The majority of residents in rural communities possess a vehicle, and active transportation is difficult due to large geographic areas and long-distance travel to the nearest urban centres (Picketts et al., 2016).

Long-term climate change effects also interrupt wildlife, vegetation, and sea ice duration, which create inequalities in affordability, distribution and consumption of food in the rural community (Kipp et al., 2019; Vermeulen, Campbell, & Ingram, 2012; Christ & Niles, 2018). Climate change effects result in reduced productivity, increased pests and disease distribution on crops and livestock (Yusa et al., 2015) and freezing rain also physically destroy crops leading to reduced yields and increased insurance claims (Dow Jones Institutional News, 2008). Extreme weather events can also greatly affect water security for the rural residents who live on private water systems (Kipp et al., 2019; Yusa et al., 2015; McMartin et al., 2018) where contaminants may be introduced to private water systems due to the reduced water levels and streamflow (Kipp et al., 2019; Yusa et al., 2015). These issues surrounding food and water insecurity can lead to poor nutrition, obesity, cardiovascular disease, diabetes, acute gastrointestinal illness, and mental health concerns (Kipp et al., 2019). Further, rural communities with a high ratio of an ageing population are often financially incapable of relocating post-extreme weather events (Vasseur et al., 2017; Manuel, Rapaport, Keefe, & Krawchenko, 2015; Krawchenko, Keefe, Manuel, & Rapaport, 2016) to improve their nutritional and dietary requirements and safety.

There is strong evidence that links climate change to the spatial ranges and increased intensity of vector-borne diseases such as Lyme disease and West Nile virus (WNV) (Hoover & Barker, 2016). The disease-carrying vectors emerge into new locations as seasonal temperatures increase (Ogden, 2017; Ebi, Ogden, Semenza, & Woodward, 2017). The observation is affirmed by the black-legged tick population's expansion northward due to regional warming in northern Ontario over the past decade (Ogden, 2017; Cheng et al., 2017). Temperature and precipitation have a direct effect on the incubation period of the mosquito population and thus affect the transmission cycle (Yusa et al., 2015; Ogden, 2017; Hoover & Barker, 2016). The warmer temperatures and higher precipitation amounts accelerate the mosquitoes' physiological process and lead to quicker larval development, frequent mosquito biting, and shorter incubation period for the vector pathogen (Yusa et al., 2015; Hoover & Barker, 2016). These risk factors lead to more surviving vectors and a higher rate of contact between mosquito and host (Hoover & Barker, 2016).

## **2. Materials and Methods**

### *2.1 Research Area*

The study was conducted in Middlesex County, a central location in southern Ontario, Canada, which has several rural communities with eight townships in its county boundaries. This region provides a good representation of southern Ontario's rural communities.

### *2.2 Study Participants*

Eligibility for participation in this study stipulated that focus group members had to be Middlesex County residents. The study participants were recruited through convenience sampling. This was achieved via promotional materials disseminated by the Middlesex County Library at various locations in the county and through social media. Forty participants attended the five focus groups offered in February and March 2020 at Middlesex County Library

community rooms. Twenty-nine participants were women, and 11 participants were men. Eighty-five percent of the participants were living with family, and all participants had either a secondary or a post-secondary degree. A \$20 Tim Hortons gift card was given to each participant as an incentive. The research was approved by the Ryerson University Research Ethics Board (REB#2019-449).

**3. Data Collection and Analysis**

The research data included transcripts from the focus groups. Focus group discussions were recorded with an audio recorder with participant consent. Thematic analysis was used to identify common discussion points and summarize the information. Clarke & Braun (2017) stated that Thematic Analysis brings flexibility and accessibility, which results in generating useful results from the data collected.

The data were analyzed by a qualitative data analysis software, NVivo 10 (QSR International Pty Ltd, 2012). To increase rigour, the member checking process was used (Baxter & Eyles, 1997). Three research team members independently reviewed the transcripts and identified the key themes. Study findings were discussed and compared when complete. The study participants had the opportunity to review the themes and provide feedback. Quotation marks were used to highlight the verbatim remarks from the participants.

**4. Results**

The analysis of the data from the five focus groups yielded four main themes and addressed the purpose of the study. The key themes that emerged from the focus groups are summarized in Table 1.

Table 1. Key themes from the interviews

Key themes from the interviews
Frequent extreme weather events
Access to food and safe drinking water
Protection from vector-borne diseases
Living in a rural community

*4.1 Theme 1: Frequent Extreme Weather Events*

Focus group participants had been observing different weather patterns in Middlesex County that were consistent with the established effects of climate change. Two major weather-related events, namely flooding and freezing rain, were noted in all focus group discussions.

Participants observed increased flood frequency in recent years. This was a concern for both living spaces and regarding crop yields and quality. When participants were asked which extreme weather event they could most closely relate to climate change, 73% of the participants agreed that flooding was the most significant concern. A participant explained how flooding affected crops by noting: *If the fields are flooded, you can't seed.* Another participant expressed her concern by stating: *"... [W]e experienced a lot of flooding that we never had. And it does really delay that planting in the spring."*

Freezing rain was the second major concern discussed by the participants as they felt there was an increase in the frequency of freezing rain events in Middlesex County. This observation is a concern to the participants due to the immense impact of freezing rain on their day-to-day lives. Icy road conditions are hazardous and result in reduced service accessibility and an increase in accidents. In addition, freezing rain causes crop damage with significant economic and food security effects.

Another participant felt that the area in which he resided has become more vulnerable in recent years due to climate change. He revealed: *They talk about the cutting down of trees and the effect of that on climate change. There is an abundance of trees in the area, and some are being cut down by the municipality which contributes to harsher winter climate conditions."*

Warmer winters were a concerning weather event mentioned by the participants when asked about the changes in temperatures. Leisure activities such as snowmobiling and ice skating have been negatively impacted. One participant explained: *"...[F]or example, normally in the winter we were able to skate on the pond and we have not been able to skate once this winter."* Another participant agreed and responded by stating: *It has been a few years now [since the pond has frozen]."*

#### 4.2 Theme 2: Access to Food and Safe Drinking Water

Participants stated that they experienced unique barriers to food access when compared to their urban counterparts. Focus group participants who were farmers expressed deep concerns about how climate change had been affecting crop yields. One farmer revealed: *Crops are not getting tall and growing enough or to their full potential - plants budding early from warm winter weather get damaged and killed when normal frost returns; late frost is damaging and killing regularly scheduled crops.* Another farmer participant commented on the same topic and gave the growth of corn as an example to better inform the challenges he had been facing: *There is a difference...a lot of corn did not go in until about the first week of June.* This planting delay causes a ripple effect. Less crop growth or delayed crop growth may result in reduced harvest quantities and an increased need for crop insurance with higher premiums, which consequently results in significantly higher operating costs. Another participant commented: *The less product that gets into the store, the more expensive the crops can get.* The financial challenges noted by the participants were twofold: there was insufficient crop produced to provide monetary compensation, and crop insurance had been subsequently increasing due to reduced harvest. Another participant commented: *... [F]armers' markets, I like to try and support them because it's local and it's grown here but I also know I spend more money there.* These remarks indicate that due to a decrease in food security as a result of varying climate change weather patterns, the increased food prices can be a major concern for the rural residents living on a budget. Focus group discussions demonstrated a strong connection between climate change effects and food insecurity in rural communities related to the amount and variety of crops. Reduced crop yields, increasing farming costs, and financial constraints to buy fresh and local produce result in food insecurity. Participants felt the constraints in accessing a variety of fresh produce as the items mostly come from far distances and do not end up in their local grocery stores. The participants repeatedly highlighted the need for government incentives to ensure that affordable healthy food options reach rural communities.

The effects of climate change on water quality and quantity have been discussed in detail during the focus groups. Participants mainly relied on private wells as their water source, and all participants agreed that there was a variation in quality and quantity in recent years. Not all participants tested their well water regularly. A participant explained: *We check our well every once in a while, just to see how deep it is.* Some participants had concerns about their well water source, potential contamination sources nearby, and not having enough information about maintaining their water systems.

One participant was concerned about the quality of her water: *...[F]or sure, it's a concern. We used to have safe water, but you just do not feel like it's necessarily as secure a supply as it used to be.* Another participant commented that there was a change in the smell of the water as the year progresses, and she described the smell as *probably algae at times in the year.* Most of the participants were using filtering systems in their private water systems, such as reverse osmosis. The participants felt that this was an adequate water treatment to remove pathogens. A few participants were using municipal water systems and they raised no concerns regarding the quality and quantity of their potable water. Overall, the participants felt that more guidance from government agencies was needed to operate their private water systems and to keep the systems safe considering the effects of extreme weather events such as flooding.

#### 4.3 Theme 3: Protection from Vector-Borne Diseases

Participants across the five focus groups indicated that they observed an increase in the number of vector animals that could cause diseases such as Lyme disease and West Nile virus in their area in recent years. Participants were asked if they had an awareness of how to protect themselves and their families from vector animals such as ticks and mosquitos. The majority of participants did not seem to be very concerned about the potential health ramifications of vector-borne diseases, although they were in agreement that they did not have sufficient knowledge. One participant stated: *I guess I do not personally worry about ticks too much, but I probably should more...and West Nile, I have never really worried about it.*

Another focus group participant mentioned a recent conversation with her veterinarian friend who was deeply concerned about the increased number of ticks and Lyme disease cases occurring in the region recently. Study participants gave several examples of their encounters with ticks compared to a decade ago when they had never seen one.

In addition to Lyme disease, West Nile virus (WNV) was another major concern for participants. A participant who was a teacher stated that: *... [I]n the summer even when it's really hot - I just never remember the mosquitoes being like that when I was younger.* She further explains that she *used to spend a ton of time outside and now [she] is inside more...because of the mosquitos and [her] WNV concern.* There was also an overwhelming concern of increased invasive species in the region. Overall, the participants were concerned about the vector-borne activity

not only for themselves but for their families and pets as well.

#### 4.4 Theme 4: Living in a Rural Community

Research participants collectively agreed that there was a lack of initiative by the government and other officials to spread awareness regarding climate change. This has exacerbated a climate change knowledge deficiency within the population resulting in a decreased understanding of the climate crisis. This has created obstacles to generating initiatives and solutions to combat the adverse climate effects.

A participant who was a healthcare provider stated: "... [P]olitically, I do not think there has been enough done on any level. There has been lots of lip service. I think locally they've taken some steps but not as many as they should. There should be a more proactive approach." Participants showed a strong interest in gaining more knowledge regarding climate change. Furthering their knowledge would allow them the opportunity to understand and engage in climate change mitigation strategies and possibly help them to impede the adverse outcomes. Another participant revealed that *Both provincial and federal representatives are not engaged.* The frustration regarding the lack of initiatives from policymakers is evident in the testimonies of the residents of Middlesex County. Insufficient policies for climate change mitigation were a great concern for the participants in terms of preventing communicable diseases and increasing adaptation capacity.

The lack of bike lanes and public transit were mentioned by the participants to discuss the limitations of active transportation in their communities. There is a strong will in rural populations to use active modes of transportation but limitations such as inadequate bike lanes create barriers.

Lastly, an increase in invasive species, non-native plants and animals, had been identified during the discussions with the example of invasive frogs. The frogs also cause noise pollution to the residents and thus was a growing concern.

### 5. Discussion

Our study explores the climate change-related vulnerabilities of rural residents and identifies the opportunities for developing adaptation strategies for rural communities. Our study results indicate key parameters to address the climate change issues for rural residents and lead to a series of recommendations we make in this article to revamp climate change policy at local, provincial and federal levels.

Focus group discussions yielded four main themes and provided valuable insights on several climate change-related topics. The four themes are frequent extreme weather events, access to food and safe drinking water, protection from vector-borne diseases, and living in a rural community.

As a result of the changing climate, rural populations are being affected by extreme temperatures and more frequent, intense weather events such as flooding and freezing rain (Center for Climate and Energy Solutions, 2019; Field et al., 2012). Flooding, freezing rain and extreme hot or cold days not only affect the daily activities of rural residents but also can also negatively affect crops which causes a significant financial burden to both the agriculture sector and consumers (Lobell et al., 2011). Study results reveal an emerging concern among rural residents regarding insufficient social networks and financial capacity in responding to extreme weather events, which are in alignment with many established study findings (Vasseur et al., 2017; Manuel et al., 2015; Higginbottom et al., 2016). Flooding events may damage their houses, causing property damage (Curtis et al., 2017; Vasseur et al., 2017) and also may affect their water sources and livestock (Kipp et al., 2019; Yusa et al., 2015). Warmer winters were identified as a considerable concern for the residents both for recreational activities such as ice skating and snowmobiling and agricultural aspects. Not only were crop growing and harvesting cycles fluctuating, but at times it had become nearly impossible to maintain certain farm animals such as horses. Overall, the direct and indirect effects of extreme weather events on rural populations are significant and require local assessments to explore ways to address the specific vulnerabilities of each community.

Food security had been a recurring theme of the discussions. With the climate change effects, rural residents feel a significant challenge regarding food security based on three major concerns: 1. The variety of food for the rural populations is limited compared to urban communities as they mainly shop at local stores and farmers' markets, 2. The food prices, especially items not locally produced, have increased significantly, therefore affordability has become a significant issue (Yusa et al., 2015), and 3. Agriculture production has decreased significantly as a result of frequent extreme weather events (Lesk, Rowhani, & Ramankutty, 2016).

Drinking water safety has also been a concern for rural residents. Well water testing is not a common practice among rural residents, but there is a concern that water quality might be compromised. Flooding increases the risk of water contamination (Kipp et al., 2019). There is an identified need for increased awareness regarding water quality and testing in rural communities. Rural populations raise concerns in regard to a lack of institutional support

from government agencies to ensure safe drinking water, and access to affordable and healthy food options.

Rural residents have demonstrated an interest in reducing their carbon footprint but are unable to participate in many initiatives due to insufficient or non-existent infrastructure. As an example, there is a strong car dependency as opposed to other modes of community or active transportation.

The next theme explored was vector-borne diseases and climate change in rural communities. Although participants had general knowledge regarding vector-borne diseases such as Lyme disease and West Nile virus in the area, some of them were not keen on taking preventative measures. Rural areas offer convenient habitats such as tall grass and stagnant water for many vectors that may cause disease in humans. Increasing knowledge of disease prevalence and prevention can be administered through local library seminars and infographics delivered via the internet or newspapers, as the majority of study participants identified those media as their primary source of information.

Although focus group participants discussed various topics, the conversations revolved around the present challenges of climate change and the pessimism for future generations. The overall economic viability of living and work in rural areas poses a significant challenge for many residents. There is an overwhelming interest to keep climate change-related issues on the agenda of elected officials. There is also recognition that adaptation strategies should be planned at various levels, namely, individual, local, provincial, national, and successful implementation will require multi-level support. Involving all stakeholders in adaptation planning will ensure sustainable community development, which is key to address the current and future climate change effects.

Participants commented on the need for adaptation skills concerning the physical and mental health aspects of increased indoor activity (avoiding natural spaces/pollution). This could also be an indicator/opportunity for future health programming and funding to support new and emerging realities.

A limitation of this study is the use of convenience sampling. Our recruitment strategy may not have reached every eligible individual in Middlesex County's population. This may have resulted in limiting or omitting different perspectives from other appropriate sources.

## 6. Conclusion

Our study explored the vulnerabilities of rural populations within the context of climate change. We utilized a qualitative approach with focus group discussions which yielded fruitful results. Rural populations experience a lack of institutional support from various levels of government agencies to address the effects of climate change in their communities.

Future research is needed to develop effective local solutions with collaboration among government, business sectors, and rural residents. Although the research area was representative of southern Ontario's rural communities, researchers need to examine challenges in remote communities located in northern Ontario and other parts of Canada. Focus group discussions had representatives from different professions and age groups; however, having more farmer participants could bring valuable insight to the discussions. The study results should be utilized to facilitate future research in other parts of Canada and globally to further identify vulnerabilities and develop adaptation strategies.

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## Conflicts of interest

The authors do not have any conflicts of interest to declare.

## References

- Baxter, J., & Eyles, J. (1997). Evaluating Qualitative Research in Social Geography: Establishing 'Rigour' in Interview Analysis. *Transactions of the Institute of British Geographers*, 22(4), 505-525. <https://doi.org/10.1111/j.0020-2754.1997.00505.x>
- Bollman, R. (2017). Focus on Rural Ontario: 2016 Fact Sheet Series. *Rural Ontario Institute*. Retrieved from <https://www.ruralontarioinstitute.ca/uploads/userfiles/files/2016%20FOCUS%20ON%20RURAL%20ONTARIO%20BOOK%20-%20FINAL.pdf>
- Centre for Climate and Energy Solutions. (2019). *Climate Essentials, Science and Impacts*. Retrieved from <https://www.c2es.org/document/science-and-impacts/>
- Chen, C., Achdari, G., Majkut, K., & Sheu, J. (2017). Balancing equity and cost in rural transportation management

- with multi-objective utility analysis and data envelopment analysis: A case of Quinte West. *Transportation Research Part A*, 95, 148-165. <https://doi.org/10.1016/j.tra.2016.10.015>
- Cheng, A., Chen, D., Woodstock, K., Ogden, N., Wu, X., & Wu, J. (2017). Analyzing the potential risk of climate change on Lyme disease in eastern Ontario, Canada using time series remotely sensed temperature data and tick population modelling. *Remote Sensing (Basel, Switzerland)*, 9(6), 609. <https://doi.org/10.3390/rs9060609>
- Christ, A., & Niles, M. (2018). The role of community social capital for food security following an extreme weather event. *Journal of Rural Studies*, 64, 80-90. <https://doi.org/10.1016/j.jrurstud.2018.09.019>
- Clarke, V., & Braun, V. (2017). Thematic analysis. *The Journal of Positive Psychology*, 3(12), 297-298. <https://doi.org/10.1080/17439760.2016.1262613>
- Curtis, S., Fair, A., Wistow, J., Val, D. V., & Oven, K. (2017). Impact of extreme weather events and climate change for health and social care systems. *Environmental Health*, 16(S1), 128-32. <https://doi.org/10.1186/s12940-017-0324-3>
- Drolet, J. L., & Sampson, T. (2017). Addressing climate change from a social development approach: Small cities and rural communities' adaptation and response to climate change in British Columbia, Canada. *International Social Work*, 60(1), 61-73. <https://doi.org/10.1177/0020872814539984>
- Ebi, K. L., Ogden, N. H., Semenza, J. C., & Woodward, A. (2017). Detecting and attributing health burdens to climate change. *Environmental Health Perspectives*, 125(8). <https://doi.org/10.1289/EHP1509>
- Field, C. B., Barros, V., Stocker, T. F., Dahe, Q., Dokken, D. J., Ebi, K. ... Midgley, M. P. (Eds.). (2012). *IPCC, 2012: Managing the risks of extreme events and disasters to advance climate. Change Adaptation*. Cambridge University Press.
- Fleet, R., Bussi eres, S., Tounkara, F. K., Turcotte, S., L egar e, F., Plant, J., ... Dupuis, G. (2018). Rural versus urban academic hospital mortality following stroke in Canada. *PloS One*, 13(1), e0191151. <https://doi.org/10.1371/journal.pone.0191151>
- Fleet, R., Dupuis, G., Fortin, J., Gravel, J., Ouimet, M., Poitras, J., & L egar e, F. (2017). Rural emergency care 360 : mobilising healthcare professionals, decision-makers, patients and citizens to improve rural emergency care in the province of Quebec, Canada: A qualitative study protocol. *BMJ Open*, 7(8), e016039. <https://doi.org/10.1136/bmjopen-2017-016039>
- Fleet, R., Pelletier, C., Marcoux, J., Maltais-Gigu ere, J., Archambault, P., Audette, L. D., ... Poitras, J. (2015). Differences in access to services in rural emergency departments of Quebec and Ontario. *PloS One*, 10(4), e0123746. <https://doi.org/10.1371/journal.pone.0123746>
- Ford, J. D., Labb e, J., Flynn, M., Araos, M., & IHACC Research Team. (2017). Readiness for climate change adaptation in the arctic: A case study from Nunavut, Canada. *Climatic Change*, 145(1), 85-100. <https://doi.org/10.1007/s10584-017-2071-4>
- Higginbottom, G. M., Safipour, J., Yohani, S., O'Brien, B., Mumtaz, Z., Paton, P., ... Barolia, R. (2016). An ethnographic investigation of the maternity healthcare experience of immigrants in rural and urban Alberta, Canada. *BMC Pregnancy and Childbirth*, 16(1), 20. <https://doi.org/10.1186/s12884-015-0773-z>
- Hoover, K. C., & Barker, C. M. (2016). West Nile virus, climate change, and circumpolar vulnerability. *Wiley Interdisciplinary Reviews: Climate Change*, 7(2), 283-300. <https://doi.org/10.1002/wcc.382>
- Insurance claims for hail damage to crops rise in W Canada. (2008). *Dow Jones Institutional News*. Retrieved from <http://ezproxy.lib.ryerson.ca/login?url=https://www-proquest-com.ezproxy.lib.ryerson.ca/wire-feeds/insurance-claims-hail-damage-crops-rise-w-canada/docview/2245946892/se-2?accountid=13631>
- Kipp, A., Cunsolo, A., Vodden, K., King, N., Manners, S., & Harper, S. L. (2019). At-a-glance – Climate change impacts on health and wellbeing in rural and remote regions across Canada: A synthesis of the literature. *Health Promotion and Chronic Disease Prevention in Canada*, 39(4), 122-126. <https://doi.org/10.24095/hpcdp.39.4.02>
- Krawchenko, T., Keefe, J., Manuel, P., & Rapaport, E. (2016). Coastal climate change, vulnerability and age friendly communities: Linking planning for climate change to the age friendly communities agenda. *Journal of Rural Studies*, 44, 55-62. <https://doi.org/10.1016/j.jrurstud.2015.12.013>
- Lauckner, H. M., & Hutchinson, S. L. (2016). Peer support for people with chronic conditions in rural areas: A scoping review. *Rural and Remote Health*, 16(1), 3601. <https://doi.org/10.22605/RRH3601>

- Lavoie, J. G., Wong, S., Katz, A., & Sinclair, S. (2016). Opportunities and barriers to rural, remote and first nation health services research in Canada: Comparing access to administrative claims data in Manitoba and British Columbia. *Healthcare Policy/Politiques De Santé*, 12(1), 52-58. <https://doi.org/10.12927/hcpol.2016.24775>
- Laycock, K. E., & Caldwell, W. (2018). Exploring community cohesion in rural Canada post-extreme weather: Planning ahead for unknown stresses. *Social Indicators Research*, 139(1), 77-97. <https://doi.org/10.1007/s11205-017-1706-1>
- Lesk, C., Rowhani, P., & Ramankutty, N. (2016). Influence of extreme weather disasters on global crop production. *Nature (London)*, 529(7584), 84-87. <https://doi.org/10.1038/nature16467>
- Lobell, D. B., Torney, A., & Field, C. B. (2011). Climate extremes in California agriculture. *Climatic Change*, 109(S1), 355-363. <https://doi.org/10.1007/s10584-011-0304-5>
- MacLeod, M. L. P., Stewart, N. J., Kulig, J. C., Anguish, P., Andrews, M. E., Banner, D., ... Zimmer, L. (2017). Nurses who work in rural and remote communities in Canada: A national survey. *Human Resources for Health*, 15(1), 34-11. <https://doi.org/10.1186/s12960-017-0209-0>
- Manuel, P., Rapaport, E., Keefe, J., & Krawchenko, T. (2015). Coastal climate change and aging communities in Atlantic Canada: A methodological overview of community asset and social vulnerability mapping. *The Canadian Geographer*, 59(4), 433-446. <https://doi.org/10.1111/cag.12203>
- Martin, A., O'Meara, P., & Farmer, J. (2016). Consumer perspectives of a community paramedicine program in rural Ontario. *The Australian Journal of Rural Health*, 24(4), 278-283. <https://doi.org/10.1111/ajr.12259>
- McMartin, D. W., Hernani Merino, B. H., Bonsal, B., Hurlbert, M., Villalba, R., Ocampo, O. L., ... Sauchyn, D. J. (2018). Limitations of water resources infrastructure for reducing community vulnerabilities to extremes and uncertainty of flood and drought. *Environmental Management*, 62(6), 1038-1047. <https://doi.org/10.1007/s00267-018-1104-8>
- Ogden, N. H. (2017). Climate change and vector-borne diseases of public health significance. *FEMS Microbiology Letters*, 364(19). <https://doi.org/10.1007/s00267-018-1104-8>
- Picketts, I. M., Picketts, I. M., Andrey, J., Andrey, J., Matthews, L., Matthews, L., ... Tighe, S. (2016). Climate change adaptation strategies for transportation infrastructure in Prince George, Canada. *Regional Environmental Change*, 16(4), 1109-1120. <https://doi.org/10.1007/s10113-015-0828-8>
- Schleussner, C., Deryng, D., D'haen, S., Hare, W., Lissner, T., Ly, M., ... O., Thomas, A. (2018). 1.5°C Hotspots: Climate hazards, vulnerabilities, and impacts. *Annual Review of Environment and Resources*, 43(1), 135-163. <https://doi.org/10.1146/annurev-environ-102017-025835>
- Statistics Canada. (2020). *Table 17-10-0005-01 Population estimates on July 1st, by age and sex*. Retrieved from <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501&pickMembers%5B0%5D=1.7&pickMembers%5B1%5D=2.1&cubeTimeFrame.startYear=2016&cubeTimeFrame.endYear=2020&referencePeriods=20160101%2C20200101>. Doi: <https://doi.org/10.25318/1710000501-eng>
- Thornton, T. F., & Combetti, C. (2017). Synergies and trade-offs between adaptation, mitigation and development. *Climatic Change*, 140(1), 5-18. <https://doi.org/10.1007/s10584-013-0884-3>
- Vasseur, L., Thornbush, M., & Plante, S. (2017). Climatic and environmental changes affecting communities in Atlantic Canada. *Sustainability (Basel, Switzerland)*, 9(8), 1293. <https://doi.org/10.3390/su9081293>
- Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. I. (2012). Climate change and food systems. *Annual Review of Environment and Resources*, 37(1), 195-222. <https://doi.org/10.1146/annurev-environ-020411-130608>
- Waldie, P. (2011). Flooding causes farming disaster: More than six million acres of prairie farmland will go unplanted because of constant rain. *The Globe and Mail*. (1936-2016).
- Yonge, O., Jackman, D., Luhanga, F., Myrick, F., Oosterbroek, T., & Foley, V. (2019). 'We have to drive everywhere': Rural nurses and their precepted students. *Rural and Remote Health*, 19(3), 5347. <https://doi.org/10.22605/RRH5347>
- Yusa, A., Berry, P., J Cheng, J., Ogden, N., Bonsal, B., Stewart, R., & Waldick, R. (2015). Climate change, drought and human health in Canada. *International Journal of Environmental Research and Public Health*, 12(7), 8359-8412. <https://doi.org/10.3390/ijerph120708359>



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