Water Security on First Nations Reserves in Ontario: Exploring the impact of source water protection, community location, and fiscal capacity

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Abstract

Chronic water insecurity on First Nations reserves is embedded in flawed and fragmented governance and chronic underfunding. These structural issues affect all First Nations communities yet some communities have access to clean drinking water and some do not. In this work, I ask: How can variation in First Nations communities' access to clean drinking water in Ontario be explained? Through a mixed-methods approach, using expert interviews and statistical analysis, the insight that emerges most clearly is that remoteness matters. The research also reveals differences in the way water security is framed, ranging from a protecting against water-threats lens to a service provision lens. When assessed with a water-threats lens, there is qualitative support for a relationship between environmental protections and availability of clean drinking water. When assessed with a service provision lens, there is no statistically significant association between environmental protections and availability of clean drinking water. The statistical modelling offers the surprising finding of support for a positive relationship between proximity to active mines and access to clean drinking water, the inverse of my expectation. Finally, the research findings do not suggest statistical support for a relationship between on-reserve availability of clean drinking water and fiscal management capacity of First Nations. The evidence suggests that First Nations fiscal capacity is unrelated to access to clean drinking water.

Résumé

L'insécurité chronique de l'eau dans les réserves des Premières Nations est ancrée dans un système de gouvernance coloniale défectueuse et fragmentée et un sous-financement chronique. Ces problèmes structurels touchent toutes les communautés des Premières Nations, pourtant certaines communautés ont accès à l'eau potable et d'autres non. Dans ce travail, je pose la question suivante : comment expliquer les variations dans l'accès des communautés des Premières Nations à l'eau potable en Ontario? Grâce à une approche à méthodes mixtes, utilisant des entrevues avec des experts et des analyses statistiques, l'idée qui ressort le plus clairement est que l'éloignement est important. La recherche révèle également des différences dans la façon de concevoir la sécurité de l'eau, allant d'une optique de protection contre les menaces pour l'eau à une optique de prestation de services. Lorsqu'elle est évaluée sous le prisme des menaces pour l'eau, la relation entre les protections environnementales et la disponibilité de l'eau potable bénéficie d'un soutien qualitatif. Lorsqu'elle est évaluée dans l'optique de la prestation de services, il n'y a pas d'association statistiquement significative entre les protections environnementales et la disponibilité de l'eau potable. Les modèles présentent également une conclusion surprenante, à savoir qu'ils soutiennent une relation positive entre la proximité des mines en activité et l'accès à l'eau potable, ce qui est l'inverse de mes attentes. Enfin, les résultats de la recherche ne suggèrent pas de soutien statistique pour une relation entre la disponibilité de l'eau potable dans les réserves et la capacité de gestion financière des Premières Nations. Les preuves suggèrent que la capacité fiscale des Premières Nations n'est pas liée à l'accès à l'eau potable.

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Introduction:

Water security gaps persist for First Nations communities despite urgent demands for water security, consensus that water security is essential, evidence of the detrimental effects of the lack of clean water, availability of technological know-how, and commitments from the Government of Canada that the problem will be resolved. The problem festers despite assurances of funding and political will (Government of Canada 2015, McCullough and Farahbakhsh 2015). As of May 17, 2021, there are 53 long-term drinking water advisories[1] on 34 First Nation reserves in Canada.[2] Some of these drinking water advisories have been in place for over a decade (Government of Canada 2021).

First Nations communities' lack of access to clean drinking water is not a problem that begins and ends on reserves. It is embedded in the larger issue of water security, which is in turn embedded in the larger issue of settler colonialism.[3] Many scholars and stakeholders argue that access to clean drinking water is impeded by fragmented government policies (Swain et al. 2006, McCullough and Farahbakhsh 2012); chronic underfunding (Assembly of First Nations 2018, Palmater 2012); and a fundamentally flawed relationship based on the *Indian Act* between the Canadian government and First Nations (Joseph 2018, White et al. 2012, p. 19, Baijius et al. 2020, p. 2). These structural issues affect all First Nations communities and point to a chronic problem, yet some communities have access to clean drinking water and some do not.

My research question is: *How can variation in First Nations communities' access to clean drinking water in Ontario be explained?* With this approach, I wish to gain insights on how water insecurity can be explained and in turn, factors that can improve water security in First Nations

[1] Indigenous Services Canada (ISC) drinking water advisories include: Boil water advisories (BWA), Do not consume (DNC) advisories and/or Do not use (DNU) advisories; "long-term" is an advisory that has been in place for more than 12 consecutive months.
[2] I use *First Nation reserves* and *First Nation communities* interchangeably in this work.
[3] Settler colonialism is understood as a specific structure rather than an event (Wolfe 2006, p. 390). According to Baijius and Patrick (2019),"Vestiges of colonialism, stemming from the *Indian Act*, remain in place today and include an array of government controls and institutional mechanisms. Territoriality drives settler colonialism, which must be recognized as a structure instead of characterized as an event. Institutions and laws perpetuate settler colonialism, reproducing the social relations and inequalities that are at the root of many 'water problems'"(p. 2).

communities. The objective of this research is to better understand the puzzle of this persistent water insecurity. I add my thesis to a growing body of work undertaking research at the intersection of political science and environmental studies. In this work, I hone-in on the variation of water security across First Nations' communities in the province of Ontario. I adopt a mixed-methods approach, presenting qualitative evidence from expert interviews. I pair this with a statistical analysis of both publicly available data and data I gathered through the official Access to Information process.

From this analysis, my findings are mixed. The insight that emerges most clearly is that remoteness matters. The interview evidence supports the argument that capital investments are important to ensure clean drinking water in First Nations communities. Interview findings also point to size and location as major factors contributing to the persistence of water insecurity in First Nations communities.

The modelling exercise does not offer support for my expectation of a measurable relationship between financial capacity and availability of clean drinking water on First Nations reserves. In addition, the modelling exercise does not provide support for my expectation of a measurable relationship between environmental protections and availability of clean drinking water. The interviews reveal differences in the way water security is framed, ranging from a protecting against water-threats lens to a service provision lens. When assessed with a water-threats lens, there is support for a relationship between environmental protections and availability of clean drinking water. The models also offer the surprising finding of correlation of proximity to active mines and access to clean drinking water, the inverse of my expectation.

In the sections that follow, I explain the scope of my research and justify the decision to focus on First Nations communities in Ontario. Next, I review the literature and present my hypotheses. Following this, I outline my positionality, qualitative approach, and findings from the interviews. Thereafter, I present the quantitative approach, setting out the regression modelling technique, the

variables and their data sources, and the statistical results. Finally, I discuss the implications of my research, linking the findings back to the existing literature.

Research scope and case selection

Water security has been defined by the United Nations as "The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water […]" (UN-Water 2013). In this thesis, I limit the scope to focus on water *quality*. Beyond the purview of this research, there are many opportunities to examine issues around *quantity* (see, for example, Barlow 2013). For the purpose of exploring the persistence of water insecurity on reserves and variation in its measures, I operationalize water insecurity using drinking water advisory data for the availability of clean drinking water.[4] Unavailability of clean drinking water serves as a measure of water insecurity and drinking water advisories are used as indicators. The approach of using drinking water advisories as a proxy for water insecurity is prevalent in the growing body of work which examines water security through an environmental justice lens (see, for example, Galway 2016).

This thesis is designed to investigate why some First Nations communities have short-term or long-term drinking water advisories, and others do not. I focus on cases in Ontario because the province has both the largest First Nations population in a single province or territory and the largest number of long-term drinking water advisories (McCullough and Farahbakhsh 2012, p. 5, Government of Canada 2021). In addition, there is a reasonable sample size of First Nation reserves in Ontario and visible variation in availability of clean drinking water. Ontario is also a large province with variation on population densities and variation on sub-regions such as industrial south, north, and remote communities with very limited access. Finally, I was able to obtain robust data dealing with the availability of clean drinking water on reserves in Ontario. By limiting the scope of the research to

[4] I use *access to* clean drinking water and *availability of* clean drinking water interchangeably in this work. There is no evidence of user fees or other structures that would impede access despite availability.

Ontario, some external validity is lost but the generalizability of the findings to other provinces and territories is inherently limited by the nature of the federal system. Likewise, by limiting my scope to First Nations reserves, I am excluding self-identifying communities, non-status communities and disputed communities.[5] This choice was made in order to harmonize the research design with best available data.

Literature Review:

This section focuses on three important issues that emerge from reviewing the body of literature on water security and First Nations populations in Canada. Firstly, water governance on First Nation reserves is a contested area and is complicated by both federalism and settler colonialism. Secondly, government strategies to combat water insecurity focus overwhelmingly on water treatment infrastructure capacity. Finally, environmental protections such as source water protection may lead to cleaner drinking water in First Nations communities. After setting out these three issues I will outline how my research responds to the existing literature.

Much of the literature points to flaws and barriers in the institutional governance framework. Bakker and Cook (2011) argue that the structure of Canadian federalism impedes unified water policy and necessitates "the development of a federal water strategy that is integrated and coordinated with provincial, territorial and First Nations' interests and that allows for true participation by engaged citizens" (p. 286). At this time, there is little evidence of such a strategy in place. Babie et al. 2020 argue that federalism is ill-suited for water governance because water inherently rejects the boundaries placed on it by units or branches of government (p. 5). They maintain that the way federalism fragments power makes it is impossible for federal or state governments to effectively and comprehensively manage the whole of a water resource since a water resource is by its nature incapable

[5] The following communities were excluded because they do not have Federal registered band numbers and therefore I was unable to gather reliable data: Ardoch Algonquin, Beaverhouse, Hornepayne, Koocheching, Namaygoosisagagun and Whitewater Lake. I was able to obtain data for 127 of the 133 First Nations communities with registered band numbers in Ontario (95%) (Collins et al. 2017, p. 3).

of fragmentation (p. 6, p. 10, p. 19). This work is important for my research because it candidly demonstrates how good water governance is inherently complicated by federalism. This is particularly salient since most water governance is dominated by the provinces and on-reserve water governance is dominated by the federal government.

Water security is increasingly being explored in terms of questions of good governance (McFarlane and Harris 2018, Wilson et al. 2019, Alcantara et al. 2020). However, evidence of good water governance is lacking, especially considering the ways in which the governance arrangements reinforce existing colonial relationships (Simms et al., 2016, Wilson 2020). Increasingly scholars, especially Indigenous scholars, are exposing the flaws in assuming colonial governments' legitimacy and authority, both in their exertion of power through policy interventions and their framing of water and water security (Linton 2010, McGregor 2012, Barlow 2013, Longboat 2013, McGregor 2014, Whyte 2016, Arsenault et al., 2018, Joseph 2018, Meisch 2019, Wilson et al. 2019). Considering the compounding complications of federalism and settler colonialism in providing good water governance, the chronic water security problems in First Nations communities are not surprising. The literature highlights the underlying issues of social justice and decolonization and portrays water insecurity as an embedded issue. The fact that water insecurity is considered an embedded issue is significant for this research because it points to the importance of considering the complexity of the overall system.

Another major theme that emerges from the literature is water treatment infrastructure capacity as the solution for water security problems. There is evidence that finance and funding are important for ensuring water security (McFarlane and Harris 2018, p. 381, Lipka and Deaton 2015). Palmater argues, "The crisis is a predictable outcome resulting from conscious choices made by federal officials to underfund critical infrastructure" (2019, n.p.).[6] According to Palmater, infrastructure funding is a

[6] It is important to note that Palmater points to the deficits in financial investments in First Nations infrastructure as purposeful. Also see Baijius and Patrick 2019, p. 2. Palmater advocates for funds to be "transferred directly to First Nations to manage their own programs and services — including the funding owed from treaty obligations not yet honoured" (Palmater 2019, n.p.).

necessary condition of water security. Much of the gray literature emphasizes funding as well as technical fixes to address the water security gap in First Nations communities (Government of Canada 2018, Ontario First Nations Technical Services Corporation 2018). Focusing on water treatment as the solution to water insecurity rests on the premise that capital investment is the chief barrier to availability of clean drinking water. In a related vein, lack of clean drinking water on reserves is frequently framed as a socio-economic problem. It is often approached as connected to the larger problem of a significant socio-economic gap between First Nations living on-reserve and people living off-reserve and as such, an issue that can be resolved with increases in funding.[7] Overall, it seems reasonable to expect financial problems to impact availability of clean drinking water and this way of thinking is aligned with current policy approaches. However, investigations into relationships between funding for infrastructure, socio-economic improvements and water security are underdeveloped in the literature. In general, the literature that focuses on technical and funding fixes for water insecurity rests on a paradigm of development. Brown et al. (2016) test whether socio-economic factors can explain access to safe drinking water in First Nations communities. They find that socio-economic factors are not statistically significant in explaining why some First Nations communities in Canada have safe drinking water and other First Nations communities do not.[8] Brown et al. investigate this relationship using the Community Well-Being Index dataset from 2006 with measures such as labour force, education, income and housing to represent socio-economic well-being. Their work focuses on national data for drinking water security and recommends studies be conducted at the provincial level to further investigate causes of safe and unsafe water (p. 105). Further investigation around relationships between availability of clean drinking water and socio-economic factors is called for given the findings of

[7] For more information on socio-economic gaps on First Nations reserves see the 2018 Spring Reports of the Auditor General of Canada *Socio-economic Gaps on First Nations Reserves—Indigenous Services Canada*, https://www.oag-bvg.gc.ca/internet/English/parl_oag_201805_05_e_43037.html#hd3b, accessed April 20, 2021.

[8] Note that Brown et al. 2016 use water risk as their dependent variable. This conceptualization is more comprehensive than availability of clean drinking water as a proxy for water security.

Brown et al., and to bridge the gap between arguments that water treatment infrastructure capacity is paramount, and arguments that water insecurity is embedded in underlying issues of social justice and decolonization.

There is a growing body of literature exploring environmental protections such as source water protection as important in ensuring clean drinking water. The idea of source water protection is to protect water from contamination. It often involves defining and delineating intake zones to protect sensitive areas for drinking water supply. The Government of Ontario describes source water protection as: "protecting the surface or ground water that supplies municipal drinking water systems" (2006). Source water protection emerged as a policy priority in Ontario twenty years ago to address the failures that caused seven deaths and left thousands seriously ill from contaminated water in Walkerton. In response, Justice O'Connor's report recommended adopting a multiple-barrier approach to ensure the safety of drinking water. Source water protection is the first step in this multiple-barrier approach, followed by treatment and distribution, monitoring programs, and finally, ongoing communication about potential threats with responses to adverse conditions (O'Connor 2002, p. 73, Walters et al. 2012, p. 5). According to Ontario, local source protection committees are formed with representatives from municipalities, First Nations, industry, the farming community, and the general public. The committees then identify local activities that could pose a risk to their municipal water supplies and develop plans to manage those risks (2018). The 2006 *Clean Water Act* codifies this approach to preventing drinking water contamination. Ontario's water governance changes have greatly improved the quality of drinking water in the province.[9] However, it is not clear if the environmental protections designed and implemented by the settler state lead to cleaner drinking water in First Nations communities. Patrick (2011) investigates why, despite substantial financial investments from the federal government, First

[9] 2019 data show that "99.9 per cent of more than 522,000 drinking water tests from municipal residential drinking water systems met Ontario's strict, health-based drinking water standards" (Government of Ontario 2019). Detailed information on drinking water quality test are available at: https://data.ontario.ca/dataset/drinking-water-quality-and-enforcement/resource/63bdba9f-c4f2-4b2c-a605-3e9751e31c2f, accessed May 31, 2021.

Nations communities have unequal access to clean drinking water. Patrick points to the need for "a more holistic approach […] that endorses watershed and groundwater protection as part of a multi-barrier approach to safe drinking water" (p. 3). In their 2011 drinking water report card, Ecojustice assigned an F grade to Canada's federal government for its poor drinking water protection record and an A grade to the province of Ontario for implementing an ambitious source water protection program, strong treatment, testing, operator training and public reporting standards (Christensen and Parfitt 2011, p. 3).

The literature shows that source water protection may have potential to improve availability of clean drinking water both as an environmental protection and as part of a larger shift in institutional governance as seen in Ontario post Walkerton. However, First Nation participation in source water protection is very limited (Walters et al. 2012, p. 5, Marshall et al. 2020, p. 1). Scholars point to both opportunities and barriers to First Nation participation in the institutional governance framework. Scholars such as Marshall et al., Patrick et al., McGregor, de Loë, and Collins et al. point to the potential source water protection has for improving water security on First Nations reserves. Marshall et al., building off of Collins et al. (2017), note that barriers to First Nation participation in source water protection include issues with scale, jurisdiction, the concept of source water protection, representation, funding, and capacity (2020, p. 1). There is evidence that nearly half of the 27 First Nations located inside source water protection regions do not participate in the protection committees (Collins et al. 2017, p. 3, Walters et al. 2012, p. 13). Many First Nations oppose participating in source water committees because provincial governments are not signatories to treaties and therefore do not support their treaty rights; and First Nations are often "lumped in with other 'stakeholders' in providing comments on the legislation" (Walters et al. 2012, Simms et al. 2016, p. 9, Collins et al. 2017, p. 3). There is a gap in the literature demonstrating the benefits, if any, First Nations communities derive in terms of increased water security through measures of source water protection.

As highlighted in the literature review, access to clean drinking water is a complex and embedded issue and there is evidence of flaws and barriers in the institutional governance framework. Government strategies to combat water insecurity are incomplete, at best, and indicative of settler colonial structures, at worst. Structural impediments feed into and perpetuate water insecurity. As such, the persistent problem of water insecurity is most comprehensively assessed as embedded in larger systemic problems. However, measuring the effects of federalism and settler colonialism is difficult and beyond the scope of this thesis. Opportunities for future research include investigating water insecurity as a wicked problem, linking with overlapping spheres of decolonization and social justice. For the purpose of my research, I advance that these structural problems are present but are not likely to significantly vary within the province of Ontario.[10] The fragmented jurisdiction where First Nations communities rely on federal or own funding for water protections and infrastructure is seen in reserves across the province and yet, the availability of clean drinking water varies across the province.

Building off information gleamed from the literature review, I create three hypotheses:

H1: ***Greater financial capacity is correlated with availability clean drinking water on First Nations reserves, in province of Ontario.***

H2: ***Environmental pollutions are correlated with unavailability of clean drinking water on First Nations reserves, in the province of Ontario.***

H3: ***Environmental protections are correlated with availability clean drinking water on First Nations reserves, in the province of Ontario.***

[10] In this work, I aim to hold constant the structural issues affecting all First Nations communities. In doing so, I do not wish to imply that there is a lack of political, cultural and historical diversity among First Nations communities in Ontario. Rather, I point to the Canadian constitutional order, the *Indian Act* and the current gap in legislation for on-reserve water regulations. I test for both the influence of treaties and tribal councils and do not find correlation in the models. For the purposes of this exercise, I examine variation within the settler structure of the province.

Research Approach

I seek to leverage some explanation of variation in water security by comparing reserves that all experience these systemic problems and testing for measures that are likely to influence water security. For the purposes of this research, I assess availability of clean drinking water in terms of drinking water advisories.[11] I make this choice based on the availability of data. For a more comprehensive approach, I defer to experts in a growing body of work that focuses on Indigenous methodologies and First Nations understandings of water security (Arsenault 2021, Longboat 2013, McGregor 2012, McGregor 2014).

I am interested in exploring why there is variation in water security among First Nations communities in Ontario, with some communities experiencing greater levels of water security and others experiencing chronic insecurity, while under similar institutional governance frameworks.[12] My thesis contributes to the discussion around the persistence of water insecurity in First Nations communities, testing whether financial capacity, in conjunction with population size, location and environmental considerations, explains the variation of water security on reserves. I expect to contribute to the literature by exploring these important and underdeveloped factors both through models and interviews with water experts. I build off insights from the case studies reported in Collins et al. 2017, that despite numerous barriers, source water protection has potential to increase water security in First Nations communities. My research is novel in comprehensively evaluating the relationship between on-reserve source water protection and drinking water advisories in the province of Ontario. In light of the information from the literature on the importance of environmental protections for water security, I expect participation in source water protection, taken as an environmental protection measure, to positively correlate with availability of clean drinking water on reserves. I also test to see if proximity to point source pollution correlates with availability of clean

[11] Drinking water advisory data is only collected for public systems. As such, water from private wells falls outside the scope of this research.
[12] For a description of the institutional governance framework, please see Patrick et al. 2019, p. 2.

drinking water on reserves. This research is novel in bringing together these data sources in this time frame.

Justification of mixed-methods approach

To test the hypotheses laid out above, I undertake a mixed-methods approach to examine variation in water security on First Nations reserves in Ontario. It is a cross sectional analysis across space. Structural problems are not expected to vary across the time frame of the data I use (2018-2020). I employ a two-pronged approach, using expert interviews and multi-variate regression analysis. The mixed-method approach is chosen to draw from the strengths of quantitative and qualitative methods and minimize possible weaknesses (Johnson and Onwuegbuzie 2004, p. 14). In addition, the mixed-methods approach allows for data and methods triangulation. I will present the qualitative research first, followed by the statistical modelling.

Positionality and Ethics

The research was conducted within the broader context of suffering and injustice surrounding settler colonialism and lack of clean drinking water in First Nations communities. I recognize that Universities and researchers have historically been part of a processes of imperialism that values Western knowledge (Tuhiwai Smith 1999, p. 127, p. 222). This is especially important given I am undertaking research that involves the well-being of First Nations communities and I have a settler background. I have undergone training in cultural awareness and sensitivity and I acknowledge my positionality at all steps of the research process. Fortunately, there is a rigorous Ethics Framework in Indigenous Contexts in place meant to establish an ethical space for researchers and Indigenous communities engaged in research. My research was reviewed and approved by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (approval number 21-01-027).

Qualitative

Qualitative methods

I include qualitative methods to allow for openness to other ways of understanding water protection and water security (Mason 1996, p. 6-7). I conducted four semi-structured expert interviews and undertook thematic analysis. This allows for the inclusion of subjective viewpoints (Flick 2009, p. 168). The interviews with water experts helped inform my selection of variables and served as a check on my conceptualization of water security. They helped fill in gaps and answer questions that arose while undertaking empirical analysis. Interviewees were chosen because they are considered experts in the field and to speak from both sides of settler/Indigenous paradigms of understanding water security. Speaking with experts who are working on the ground to improve water security on First Nations reserves provided critical information that could not be gained from published materials. With REB approval, I conducted the interviews by phone, and with participant permission, I audio-recorded and subsequently transcribed the conversations. For participants who chose not to be audio-recorded, I took detailed notes. I coded the transcriptions and notes in themes relevant to my research question. All interviewees chose to have their names and titles divulged in this thesis. I interviewed two Director Generals of Indigenous Services Canada's Strategic Water Management Team Directorate, Chad Westmacott and Jennifer Esdaile; and Indigenous Services Canada's Ontario Regional Program Manager, Ken Kokanie. I also interviewed Debbie King, the Environmental Technician and water plant operator for Pays Plat First Nation, who helped develop and implement a community-based Source Water protection plan for the community. The guiding questions I used in the semi-structured interviews are included in Appendix 1. Before conducting the interviews, I reviewed and analysed primary and secondary data to inform my questions including 5,914 pages of information from ATIP requests and a narrative account of the source protection experience of Pays Plat First Nation from the Canadian Environmental Law Association (Waffle 2014).

Qualitative findings

The qualitative data provide insights that help build theories to explain variation in access to clean drinking water in First Nations communities in Ontario. All four water experts mentioned costs and funding as a barrier to having clean drinking water. In terms of environmental protections and pollutions, interviewee answers varied. Some of the experts spoke of gaps and vulnerabilities. Two of the interviewees referred to water in Northern Ontario as pristine. One expert spoke of the technological ability to clean any polluted water. In the following section, I report these findings.

All the federal government experts point to the importance of funding dollars. They frame their role primarily in terms of funding agents (this finding is consistent with Scholtz 2013, p. 107). Westmacott describes First Nations as the "decision makers, owners and operators". He depicts Indigenous Services Canada's role as providing funding and providing advice for First Nations to make decisions.[13] Esdaile states, "if the community is not on board we don't push for it, in the past we would have, but moving toward a world now, if not accepted by the community it doesn't help anybody."[14] According to Esdaile, "the community makes the decisions". In terms of who the important actors on the water security on First Nations reserves in Ontario file, Kokanie explains:

> The most important actors are First Nations themselves. Each individual First Nation is an actor on that stage, if you will. They're the most important ones. At the department, at ISC I mean, we're funding agent first and foremost, right, so I mean, we don't dictate what gets done. In order to be eligible for funding there are certain check boxes, that must be checked.[15]

While federal government experts identify First Nations governments as critical actors, these experts also recognize that the federal funding role is important. Indigenous Services Canada decides what

[13] Phone interview with Chad Westmacott, Director General of Indigenous Services Canada's Strategic Water Management Team Directorate, March 8, 2019.
[14] Phone interview with Jennifer Esdaile, Director General of Indigenous Services Canada's Strategic Water Management Team Directorate, February 26, 2021.
[15] Phone interview with Ken Kokanie, Ontario Regional Program Manager, February 17, 2021. Kokanie was tasked with leading an action and investment plan to address long term drinking water advisories on First Nation reserves in Ontario.

projects get funding. Westmacott frames the work Indigenous Services Canada is doing in terms of "what the best way to move the file forward is". Esdaile explains that projects are assessed based on lifecycle costing standpoint. Information from a federal ATIP request specifies that "the policy is to take the most cost-effective option over a 20-year life span".

Esdaile explains that "historically low levels of funding" is a major factor contributing to the persistence of water insecurity in First Nations communities. A related important factor that emerged from the interviews as well as the ATIP information is funding formula issues. Two main issues come up: deficiencies in the funding formula and problems with shared operations and maintenance costs. Kokanie explains:

> [The] formula that dates back to the mid-nineties, as we could calculate what the theoretical cost to operate and maintain, have a facility would be and then we provide 80 percent of that calculation to the First Nation and it's their responsibility to identify the remaining 20 percent, of funding from either user fees or own source revenues or wherever to operate the facility. That, that formula quite obviously is out-dated in the mid two thousands.

Kokanie says Indigenous Services Canada is working with the Assembly of First Nations, regional, and local chiefs to come up with a plan for a new funding formula. According to Westmacott, the long term-goal is a new fiscal relationship and to "get ourselves out of the business". Esdaile and Kokanie state that in 2021, operations and maintenance funding will be topped up from 80% to 100% of the current funding formula. Providing 20% of operations and maintenance capital has been problematic for some communities. According to Kokanie, First Nations need to "make wise budgetary decisions on an annual basis".

In addition to historically low levels of funding and deficiencies in the funding formula, Esdaile points to the cycles of funding as an impediment for ensuring clean drinking water on reserves. She describes a scenario where shorter-term cycles of funding causes problems. In some cases, she explains, funding is only committed for feasibility or design phases. The feasibility study can take over

12 months to complete. Communities need to spend time updating previous feasibility or design studies in order to move forward when they get the next bit of funding.

Kokanie explains that funding for source water protection is not considered a priority at this time. There has been preliminary work done but due to the complexity of the issue, and the large price tag, there is still a gap. Kokanie states: “We have identified it as a thing to tackle, but it's been kind of put on the bottom of the priority list if you will, for the time being”. Kokanie says some minor investments have been made and some preliminary work undertaken, but source water protection is extremely expensive.

> It is a bit of a gap I would say right now in what work we do with our First Nations partners, we have done some preliminary stuff but source water protection is a huge, huge, huge envelope. I believe the numbers that were bounced around by the province of Ontario when they pursued it, was around $200 million dollars or something in that ballpark to do source water protection. And I think that was mostly for the southern part of the province.

King describes piecing together funding from a number of sources to implement a community-based source water protection plan.[16] Initially the source water protection funding came from the Canadian Environmental Law Association and subsequently, the Great Lakes Guardians Community Fund through the Ontario Ministry of the Environment, Conservation and Parks. King explains they are still working on piecing together funding and it is “all about funding”. King says, “it's hard for a smaller community like ours to get these funds”. She states: “we kind of get overlooked because you know, we only have 80 people in our community. So, we're really small, we get, we kind of get missed a lot. We just kind of go under the radar, and we don't seem to get those funds. But as of late, we've been doing really well getting funding.” King says, “seems lately that there's a lot more opportunities for funding for environmental, like water and environment”. She explains that whenever another bit of money comes in, the community can do a little more. King was successful in getting funding for four

[16] Phone interview with Debbie King, Environmental Technician and water plant operator for Pays Plat First Nation, January 29, 2021.

consecutive years with the Great Lakes Guardians Community Fund for keeping wetlands pristine and keeping source water clean. She explains:

> It also enabled us to do water sampling to start a baseline database with water quality monitoring. We've got it really good baseline setup now so that we can notice changes over time quicker now. Like now we've got seven years of data. You know, if something strange were to happen, we'd be able to notice that really quickly, because the numbers would just shoot out at the page at us.

King also provides insight that the provincial Ministry of Environment Conservation and Parks used to sample water near Pays Plat but they no longer do. Because of this information, I looked into what samples of rivers and streams Ontario is currently undertaking. I found that there are significant gaps in water monitoring for remote parts of Ontario. Appendix 2 illustrates the active and closed sampling stations in Ontario.

One of King's biggest concerns is getting signs put up on the highway with emergency response numbers and numbers for the Band office for people to call in case of accidents. King explains that there was a truck accident on the TransCanada highway that goes through the community and the truck went into the river, spilling diesel fuel. Luckily, she says, the previous water plant operator witnessed the event and was able to get the water plant shut down in time so nothing got into the water intake. King clarifies that they had to get water brought in from another community for a month or two while it was cleaned up. I ask King what she thinks the biggest threat to clean drinking water is and she replies her biggest concern is rail derailments. King says:

> CP rail runs right along Lake Superior, through our community right along Lake Superior for miles. And you don't even know what CP rail is hauling. You can't get that information 'til a year after they've gone through. They don't have to tell you what they're hauling. But it's pretty easy to tell because you know, you see those block Procore cars going by and I know because I worked in the pulp mill in Terrace Bay. I know that's Bunker C. It's a really heavy oil. Yeah, what if that was to ever… If a train derailment happened and that Bunker C got into Lake Superior, we'd be pooched. Yeah, so I'd say CP rail, you know?

This evidence touches on the theme of funding as well as environmental protections. It also teases out a water-threats lens that focuses on vulnerabilities. According to King, it is very important to establish

and monitor the water quality baseline, continuously sample the water, and protect the community's drinking water supply from threats.

Two of the interviewees use the word pristine when talking about water quality. Kokanie refers to much of the water in the north as pristine. King also refers to the source water for Pays Plat as pristine. King says her community is very lucky that Lake Superior doesn't have very many problems, that there is not a lot of industry nearby. Some northern communities, she says, are not so lucky. This points to an association between pristine water and being distant to threats. Following from this is support for the idea that clean lakes, distant from threats, may lead to clean drinking water.

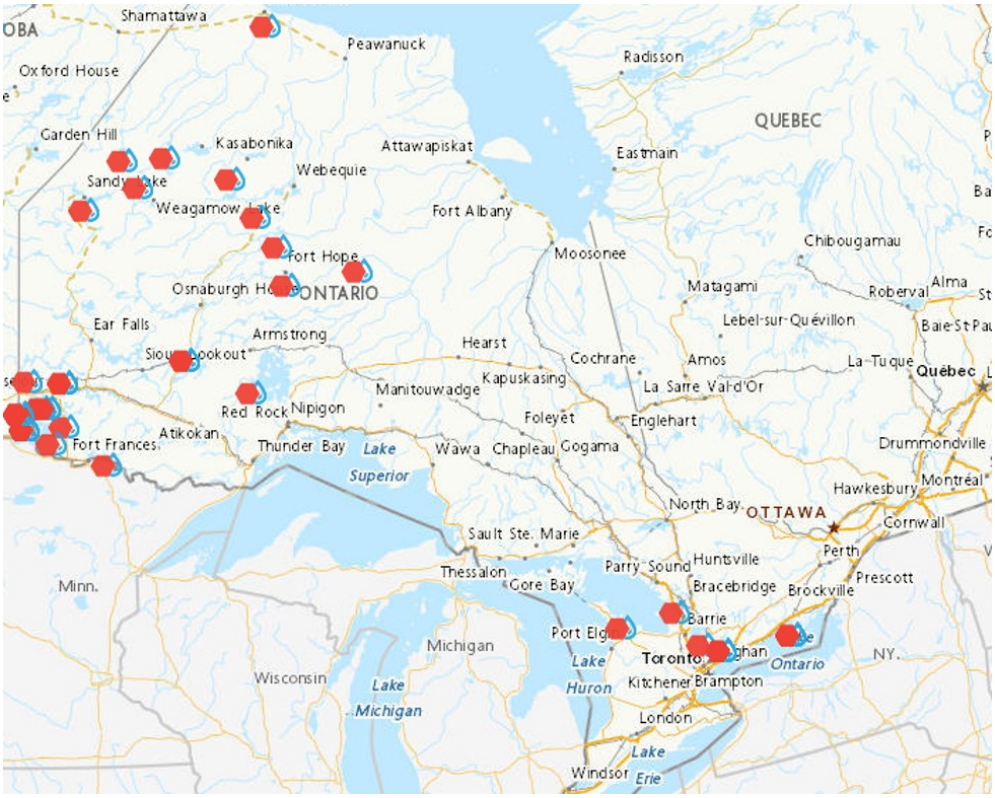
In terms of environmental protections, Esdaile acknowledges that Indigenous Services Canada hears concerns about source water in terms of cultural and traditional perspectives. Esdaile states that source water protection is addressed on a case-by-case basis, but in terms of clean drinking water, the focus is on water treatment. She explains, Indigenous Services Canada may take a look at source water studies, to decide that it is better to pull from one source over another but source water can be treated, there are amazing technologies.

Summary of Interview evidence

Findings from the interviews provide support for the theory that financial capacity will impact water security. As King explains, funding is key. Funding applications and reporting obligations are arduous and require capacity. It is reasonable to suppose some First Nations are able to obtain additional funding and others are not. In addition, communities who struggled to provide the 20% operation and maintenance costs may have water security issues if they are unable to pay competitive operator salaries, purchase water treatment chemicals and pay insurance. All four interviewees mention costs and funding as a barrier to having clean drinking water, however, the question remains whether financial capacity variation among First Nations explains variation in First Nations communities' access to clean drinking water in Ontario.

In terms of explaining variation First Nations communities' access to clean drinking water, financial capacity may be related to questions of location and population size. King states it is harder for small communities to get funding and because Pays Plat is so small, it often goes under the radar. Considering this, and the geographic locations of First Nations communities with long-term drinking water advisories in Ontario as illustrated in Figure 1, there is support for the theory that small, remote First Nations may have less access to clean drinking water. According to Esdaile, size and location are major factors contributing to the persistence of water insecurity in First Nations communities. Modelling exercises can help shed light on possible interplay between remoteness, population size and financial capacity.

Figure 1
Geographic locations First Nations communities with long-term drinking water advisories in Ontario[17]



[17] Retrieved from Government of Canada, Indigenous Services Canada, *Ending long-term drinking water advisories.* https://www.sac-isc.gc.ca/eng/1506514143353/1533317130660#dataset-filter, accessed October 6, 2020.

In terms of environmental pollutions and protections, interviewee responses varied. In general, federal officials signaled that their approach to ensuring clean drinking water is largely focused on financial investments and infrastructure. There is acknowledgement of the importance of protecting source water, but it is not prioritized. There is some support for an association between pristine water, distance from threats and clean drinking water. This may signal that protecting source water is not prioritized because there are few imminent pollution threats. However, information from the interviews points to differing viewpoints on the relationships between source water and drinking water. Another viewpoint that was expressed is that technological fixes can provide clean drinking water, independent of the quality of the source water. Given these ambiguous findings, the modelling exercise may help shed light on whether there is a relationship between environmental protections and pollutions and variation in access to clean drinking water. In the following section, I turn to multi-variate regression modelling.

Quantitative

Quantitative methods

Inclusion of quantitative methods allows me to model the relationship between water insecurity and explanatory variables. I follow lessons from Collier et al. 2004 and Goertz 2008 for concept formation and construction of my variables. I operationalize levels of water insecurity, my dependent variable, using drinking water advisory data for the 2018 to 2020 time period to create an ordinal response variable. I retrieved the drinking water advisory data online from Indigenous Services Canada publications[18] and from a provincial Freedom of Information and Protection of Privacy Act (FIPPA)

[18] Drinking water advisory data is available at https://www.sac-isc.gc.ca/eng/1506514143353/1533317130660, however, short-term advisories are removed from this site as they are lifted. Therefore, I cross-referenced the information with *Monthly progress updates* retrieved from https://www.canada.ca/en/indigenous-services-canada/search.html?_charset_=UTF-8&idx=0&q=monthly%20progress%20update%20on%20drinking%20water%20advisories%20on%20public%20systems%20on%20reserves#wb-land, accessed May 31, 2021. Please note, as of 2020, drinking water advisory data is also available at the Government of Canada Open Data Portal https://open.canada.ca/data/en/dataset/5f73fff7-2011-48b9-af52-ffb31e68539c, accessed May 31, 2021.

request.[19] I code communities with no drinking water advisories as 0, communities with short-term drinking water advisories as 1, and communities with long-term drinking water advisories as 2. If a community had a single instance of a drinking-water advisory, or multiple instances of drinking-water advisories that do not extend beyond one year, it is classified as having a short-term drinking-water advisory. If a drinking-water advisory is in place for over a year it is considered long-term, in line with the government of Canada definition. I label the dependent variable *waterproblems* to make clear that as the number increases clean drinking water is more scarce. I refer to this as availability and unavailability of drinking water throughout my discussion. Please see Appendix 3 for Tables detailing metrics, indicators and sources for the dependent and independent variables.

I model the relationship between measures of financial capacity, population size, location, environmental pollution and environmental protections with availability of clean drinking water. I chose these variables based on information that emerged from the literature review, the best available data and the feasibility of the study. I compiled and classified information from the sources listed below, to create an original dataset (N=127) which I then used to run multiple models in *Stata,* testing each of my independent variables:

Financial capacity

Following from Brown et al. 2016, I test the relationship between a financial indicator and availability of clean drinking water but I am unable to use the per capita community income indicator because I find irreconcilable gaps in data.[20] I conducted primary research to create additional indicators

[19] I submitted a FIPPA request (2020-004) to Ontario's Ministry of Indigenous Affairs for: "The most current, final versions of Excel spreadsheets, created by the Performance Measures and Data Unit of Ministry of Indigenous Affairs using data from Indigenous Services Canada's public websites each quarter, showing drinking water advisories (DWAs) in Ontario First Nations communities".

[20] There is a data gap for 31 First Nations communities in the 2016 Canadian Census of Population data. This translates into a 24% gap for the aggregate community income indicator in my dataset. This gap is problematic because the restricted data do not appear to be random. The data gap exists because StatsCan supresses the data to preserve confidentiality for 18 communities (due to population size less than 40 inhabitants); 7 communities chose not to participate; and there are data quality issues for 6 communities. Gaps for the 2011 census data are even larger. This information is retrieved from Statistics Canada: https://www12.statcan.gc.ca/census-recensement/2016/ref/sup/index-eng.cfm and https://www12.statcan.gc.ca/census-recensement/2016/ref/98-304/app-ann1-2-eng.cfm, accessed June 8, 2021.

for financial capacity from data from First Nation Band financial statements. Under the *First Nations Financial Transparency Act,* First Nations are required to publish their audited consolidated financial statements online.[21] Using this financial data, I address the gap in the Canadian Census of Population data, for smaller communities and communities that were not enumerated by the census. However, it is important to acknowledge that Band's wealth and or financial capacity is different from individual residents' wealth and or financial capacity. The First Nation Band financial statements gets at a measure of First Nation's government capacity. I include two measures: 1) accumulated surplus as reported on the financial statements, and 2) financial risk, which I calculate by dividing the number for accumulated surplus by the reported long-term debt (var: *accsurplus* and *finrisk)*. I also include a control variable for communities that have received land claim settlements within the last fifteen years (var: *settlement*).[22] I code *settlement* as a dummy variable, *yes* as 1 and *no* as 0.

Location

I include data from the Index of Remoteness of communities from Statistics Canada to account for the influence of location in availability of clean drinking water (var: *remote*). The Index of Remoteness of communities is a continuous measure from zero to one. One corresponds to the maximum value of remoteness. The index is calculated based on geographic proximity to service centres and population centres. The distance to population centres in a given travel radius, and the population size of these population centres are considered in the calculation.[23]

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[21] Although the *First Nations Financial Transparency Act* requires First Nations to publish their audited consolidated financial statements online, the legislation is no longer enforced. However, many First Nations continue to publish their financial statements online. I was able to obtain 2019 data for most First Nation bands, however, I used 2018 data for Fort Severn, Nibinamik, and Wabaseemoong First Nations; and 2017 data for Marten Falls, and Gull Bay (Kiashke Zaaging Anishinaabek) First Nations, since 2019 data were not available. The *First Nations Financial Transparency Act* is available at https://laws-lois.justice.gc.ca/eng/acts/f-11.66/page-1.html, accessed May 31, 2021.

[22] For information on the land claim settlements included as a control variable, see: https://www.canada.ca/en/news/archive/2010/10/canada-mississaugas-new-credit-first-nation-celebrate-historic-claim-settlement.html; https://www.canada.ca/en/indigenous-northern-affairs/news/2018/03/canada-ontario-and-mitaanjigamiing-first-nation-celebrate-land-claim-settlement.html; https://www.canada.ca/en/news/archive/2011/03/canada-caldwell-first-nation-achieve-win-win-solution-conclude-longstanding-claim.html; https://www.mykawartha.com/community-story/3699250--71-million-land-settlement-for-first-nations-community/, accessed May 2, 2021.

[23] Index of remoteness from Statistics Canada is available at https://www150.statcan.gc.ca/n1/pub/17-26-0001/172600012020001-eng.htm, accessed May 31, 2021.

Population size

I retrieved population data from the Indigenous Services Canada Community Well-Being (CWB) Index which is compiled by First Nation based on Statistics Canadian Census of Population data (var: *cwbcensus2016*). I address gaps in the 2016 census data, notably the lack of information for communities with less than 40 residents, by collecting data from additional sources. Since I wanted to see if population size is a significant factor impacting access to clean drinking water, it was important to include the communities with 40 individuals or less. To address this, I create an additional population indicator by manually extracting data from Indigenous Services Canada websites (var: *population*). The majority of information was pulled from each First Nation's profile on Indigenous Services Canada websites.[24] I test the confidence of the two population indicators by correlating *censuspopulation2016* and *population.* I find they are highly correlated (0.96). Therefore, I choose to use the *population* indicator in the models since it allows for the examination of variation in water security across 127 First Nations reserves, whereas use of census data restricts the models to 71 observations.

Environmental Protections

I collected data from provincial Source Water Protection Plans and ATIP requests using source

[24] First Nation profile information can be retrieved from https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNListGrid.aspx?lang=eng. For 13 First Nations, there was no recent statistic information available. The best, most recent data came from the 2013 *Archived - Connectivity for Aboriginal and Northern Communities in Canada* and I was able to use this information for 12 of the remaining First Nations. Registered Band numbers are listed after First Nation names in parentheses below. I used the "Total Population on Reserve" number (as opposed to the "Total Registered Population" number).

1. Animbiigoo Zaagi'igan Anishinaabek (194): https://www.aadnc-aandc.gc.ca/eng/1357840942029/136016344468
2. Bingwi Neyaashi Anishinaabek (196): https://www.aadnc-aandc.gc.ca/eng/1357840942042/1360163607384
3. Chapleau Ojibway (229): https://www.aadnc-aandc.gc.ca/eng/1357840942047/1360163670961
4. Flying Post (227): https://www.aadnc-aandc.gc.ca/eng/1357840942061/1360163846193
5. Lac Des Mille Lacs (189): https://www.aadnc-aandc.gc.ca/eng/1357840942077/1360164048159
6. McDowell Lake (326): https://www.aadnc-aandc.gc.ca/eng/1357840942087/1360164173283
7. Missanabie Cree (223): https://www.aadnc-aandc.gc.ca/eng/1357840942091/1360164223485
8. Obashkaandagaang (235): https://www.aadnc-aandc.gc.ca/eng/1357840942113/1360164503763
9. Oneida Nation of the Thames (169): https://www.aadnc-aandc.gc.ca/eng/1357840942119/1360164581121
10. Pikangikum (208): https://www.aadnc-aandc.gc.ca/eng/1357840942123/1360164634277
11. Wahta Mohawk (134): https://www.aadnc-aandc.gc.ca/eng/1357840942151/1360164991350
12. Wawakapewin (234): https://www.aadnc-aandc.gc.ca/eng/1357840942156/1360165055693

For one remaining First Nation, the best available data was from 2006. Batchewana First Nation (198): https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNPopulation.aspx?BAND_NUMBER=198&lang=eng

water protection as a proxy for environmental protections. I used publicly available GIS data to map First Nation reserves with Conservation Authority boundaries using *Google Earth.*[25] I classify First Nations communities categorically based on whether they are in a geographical region where there is a Conservation Authority and Source Protection Plan in place. I use the category *yes* for reserves located within the geographic region of Ontario's 19 Conservation Authorities, and *no* for reserves located outside Conservation Authority boundaries.[26] For the purpose of using this data in my models, I code as a dummy variable *yes* as 1, and *no* as 0 (var: *cons*). I also gather data to address how many First Nations, who are located within these areas, choose to participate in the provincially mandated Source Protection framework. I systematically reviewed the regions' 38 Source Protection Plans to establish if there is evidence of First Nations who have opted into the provincially mandated framework, beyond the three First Nations identified in the literature. Again, I use the categories *yes* and *no,* and code, as a dummy variable, *yes* as 1 and *no* as 0 (var: *ontarioswp*). I also mined the Source Protection Plans and Source Protection Area websites for any mention of First Nations communities. I gathered data on whether Conservation Authority Committees have First Nations representatives or if the seats remain vacant (var: *swpcom*).

I systematically reviewed 2019 Annual Performance Inspection (API) Results Reports from ATIP requests to collect and classify additional data on First Nation participation in source protection plans (var: *swp*). For *swp* I code as *yes* any implemented source water protection plan, community-based, provincial or other, but exclude "generic protection plans" as reported on question R 1.4 of the API Result Risk responses. I include generic protection plans as a separate variable (var: *swp_gen_inc*).[27]

[25] Appendix 5 illustrates the results. First Nations geographic locations were retrieved from https://open.canada.ca/data/en/dataset/b6567c5c-8339-4055-99fa-63f92114d9e4, accessed May 31, 2021.
[26] To calculate the dichotomous variable representing location in area where there is a provincial Conservation Authority, I retrieved GIS data from Ontario Geohub: https://geohub.lio.gov.on.ca/datasets/conservation-authority-administrative-area?geometry=-144.107%2C38.917%2C-25.367%2C58.786, accessed May 31, 2021.
[27] A personal communication from Indigenous Services Canada, received August 22, 2019, outlines the four categories: "1-Implemented Protection Plan: An appropriate site-specific protection plan exists for the source water and is being properly implemented; 2- Generic Protection Plan: The community does not have a site-specified protection plan for the source water, but is

Environmental Pollution

I collected most of the environmental pollutant data from government open data sources. I focus on point source pollution since data for nonpoint source pollution is unavailable. The National Pollutant Release Inventory (NPRI) and Federal Contaminated Sites data were collected from federal government open data sites.[28] NPRI data are published to meet requirements of the *Canadian Environmental Protection Act.* NPRI data include pollution released to air, water and land from facilities that are required to submit reports. Federal Contaminated Sites data include all federal sites with potential contamination that could pose a risk to human health or the environment. I include measures for proximity to NPRI sites (var: *closest_npri, km_to_closest_npri*) and Federal Contaminated Sites (var: *closest_csite, km_to_closest_csite*).[29]

I include two additional pollution source metrics: abandoned mines (var: *closest_abmine, km_to_closest_abmine*) and active mines (var: *closest_activemine, km_to_closest_activemine*). I retrieved data for active mines from Natural Resources Canada, in the form of a shapefile.[30] I retrieved data for orphaned and abandoned mines from the National Abandoned and Orphaned Mines Initiative (NOAMI) which provides information regarding mines for which the owner cannot be found or is unable or unwilling to carry out environmental clean-up.[31]

implementing a generic water protection plan; 3- Non-implemented Protection Plan: An appropriate site-specific protection plan for the source water exists, but the community is not implementing it; 4- No Protection Plan: No protection plan exists for this community's source water."

[28] National Pollutant Release Inventory: https://www.canada.ca/en/services/environment/pollution-waste-management/national-pollutant-release-inventory.html, and Federal Contaminated Sites Inventory: https://open.canada.ca/data/en/dataset/1d42f7b9-1549-40aa-8ac6-0e0302ff2902, accessed May 31, 2021.

[29] The *closest_npri* variable value is simply the ID number npri pollution release site therefore km_to_closest npri site is used in the models. I used the geonear package, in *Stata*, to calculate the kilometres to nearest site. I installed the package by typing *ssc install geonear* (Picard 2010). I repeat the same process for the variables *closest_abmine (*km_to_closest_abmine) and *closest_activemine (km_to_closest_activemine).*

[30] Appendix 6 illustrates the geographic locations of active mines in relation to First Nation communities. I retrieved the active mine data from Natural Resources Canada, *The Atlas of Canada - Minerals and Mining*: https://atlas.gc.ca/mins/en/index.html. I downloaded the shapefile and used "producing mines": https://ftp.maps.canada.ca/pub/nrcan_rncan/Mining-industry_Industrie-miniere/900A_and_top_100/900A_69th_shape.zip, accessed June 7, 2021.

[31] National Orphaned/Abandoned Mines Initiative: http://www.noami.org/php/NOAMI_2012_search.php?language=English, accessed June 7, 2021.

Quantitative findings

I use multi-variate regression modelling to test whether financial capacity, population size, location, environmental pollution, and environmental protections explain *variation in First Nations communities' access to clean drinking water in Ontario.* Because my dependent variable is categorical and ordinal, I use an ordered logistical model with robust standard errors. I also ran the data using ordered probit regression and found the results are not sensitive to the modelling choice. I perform the model in *Stata* through the command: *ologit*. Figure 2 illustrates the model output (rounded to two decimal points).

Figure 2

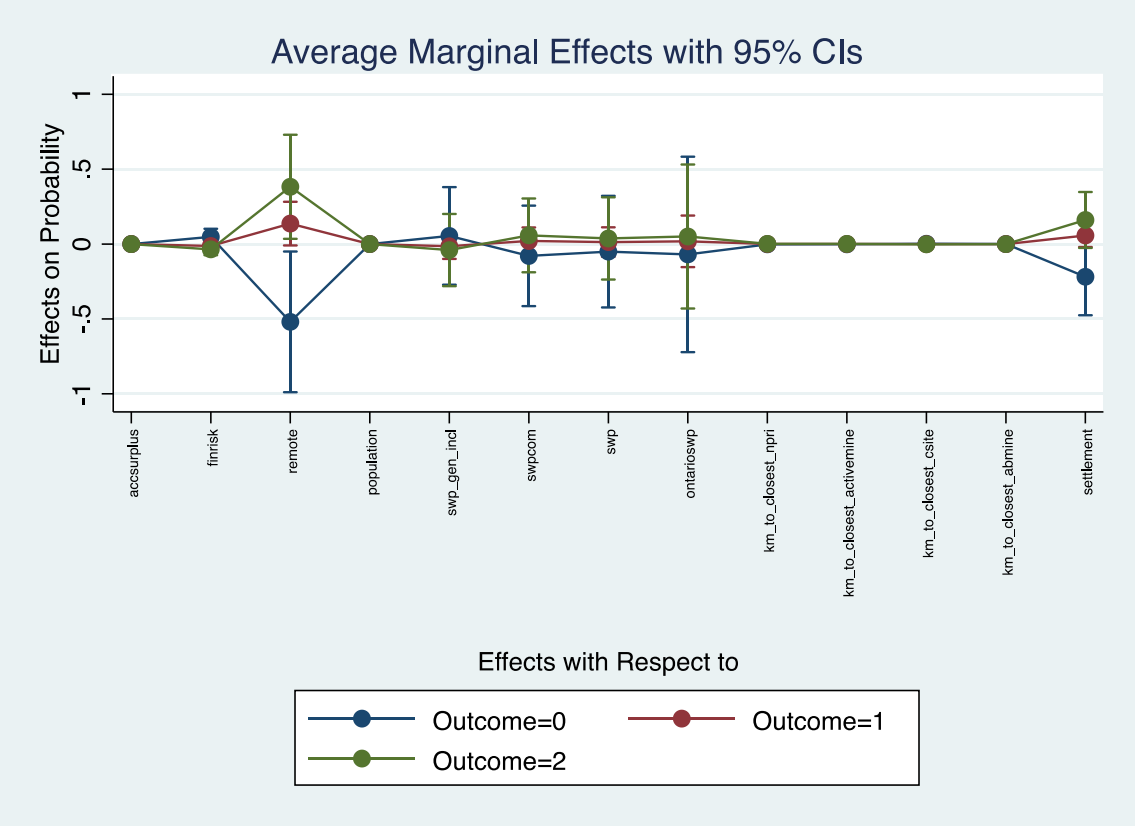
Ordered logistic regression — Number of obs = 127
Wald chi2(13) = 28.80
Prob > chi2 = 0.0070
Log pseudolikelihood = -116.49119 — Pseudo R2 = 0.0997

waterproblems	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
accsurplus	0.00	0.00	0.63	0.53	-0.00	0.00
finrisk	-0.23	0.14	-1.67	0.09	-0.50	0.04
remote	2.48	1.21	2.05	0.04	0.11	4.85
population	0.00	0.00	0.19	0.85	-0.00	0.00
swp_gen_incl	-0.26	0.79	-0.33	0.74	-1.82	1.30
swpcom	0.38	0.82	0.46	0.64	-1.22	1.98
swp	0.24	0.91	0.27	0.79	-1.54	2.02
ontarioswp	0.33	1.59	0.21	0.84	-2.78	3.44
km_to_closest_npri	0.01	0.01	0.86	0.39	-0.01	0.03
km_to_closest_activemine	0.01	0.00	2.13	0.03	0.00	0.01
km_to_closest_csite	-0.01	0.01	-1.51	0.13	-0.02	0.00
km_to_closest_abmine	-0.00	0.00	-0.77	0.44	-0.01	0.00
settlement	1.04	0.64	1.62	0.10	-0.22	2.30
/cut1	2.24	0.75			0.77	3.70
/cut2	3.45	0.82			1.86	5.05

Figure 3 demonstrates the average marginal effects on probability for the selected independent variables. Appendix 4 shows the full results.

There are two statistically significant findings of note, one intuitive, the other non-intuitive. I explain each in turn. The intuitive result pertains to remoteness. The output shows a statistically significant positive relationship between remoteness and drinking water advisories. Figure 3 shows that as a First Nations community's remoteness increases, it becomes more likely that community finds itself in the drinking water advisory categories, either short-term (labelled outcome 1) or long-term (labelled outcome 2). This finding is robust while controlling for population size.

Figure 3



The non-intuitive result is that as the kilometres to the closest active mine increases (i.e., the farther away a First Nation community is to the closest active mine), the more likely the community is to have drinking water advisories. That means the closer a community is to an active mine, the more

likely that the community has available clean drinking water on-reserve. This is a counter-intuitive result from a pollution threat standpoint, but it is consistent with the idea that being closer to a mine correlates with better water infrastructure on-reserve. While this is not directly testable using my dataset, it points to mining-related investment in First Nations water infrastructure.

The results suggest that financial capacity, population size, and environmental protections are not sufficiently correlated with variation in First Nations communities' access to clean drinking water in Ontario to reject the null hypotheses. I do not find evidence to support H1, my expectation that greater financial capacity is correlated with availability of clean drinking water. Although there is evidence elsewhere that financial capacity can explain discrepancies between First Nations and non-First Nation in terms of availability of clean drinking water (see, for example, Auditor General of Canada 2018), it does not appear from my analysis to explain the variation in availability of clean drinking water among First Nations reserves, in Ontario. In terms of the results that population size is non-significant, it is important to qualify that the largest population size represented in the model is 6,213.

The models do not provide statistical support for H2, my expectation that measures of pollution are negatively correlated with availability of clean drinking water on First Nations reserves in the province of Ontario. Three pollutant variables were non-significant at the 95% and 90% confidence levels. As mentioned, there is evidence at the 95% confidence level that proximity to active mines and access to clean drinking water are positively correlated, the inverse of my expectation.

The models also do not provide statistical support for H3, my expectation of a positive correlation between environmental protections and availability of clean drinking water on First Nations reserves, in the province of Ontario.

Discussion:

Combining the qualitative and quantitative evidence, I find there are mixed results. In this section, I outline the findings in broad brush strokes and subsequently unpack and discuss implications and links to the existing literature. Figure 4 and 5 illustrate the qualitative and quantitative results.

Figure 4: Hypotheses results. Evidence to accept the alternative (rejecting the null hypothesis)

	Qualitative	Quantitative
H1: Greater financial capacity is correlated with availability clean drinking water on First Nations reserves, in province of Ontario.	Yes	No
H2: Environmental pollutions are correlated with unavailability of clean drinking water on First Nations reserves, in the province of Ontario.	Mixed	No
H3: Environmental protections are positively correlated with availability of clean drinking water on First Nations reserves, in the province of Ontario.	Mixed	No

In terms of the modelling exercise, I find that socio-economic factors, in conjunction with location and environmental considerations do not explain the variation of water security on reserves in Ontario. From the interviews, I find that there is support for the theory that financial capacity is associated with availability of clean drinking water. In terms of findings from the interviews for a link between environmental pollutants, environmental protections and availability of clean drinking water, the results are unclear. There are differing interpretations of the relationship between environmental protections and availability of clean drinking water.

Figure 5: Other factors results (control variables)

	Qualitative	Quantitative
Remoteness	Yes	Yes
Population size	Yes	No

The modelling exercise reveals support for a negative relationship between remoteness and availability of clean drinking water. There is some support for this relationship from interview evidence in terms of the logistical challenges of infrastructure in remote areas and in terms of remote communities flying under the radar. The models also present support for an association between proximity to active mines and access to clean drinking water which also points to an infrastructure story.

Implications of findings and links to the existing literature

As illustrated above, the investigation yields mixed results. It is not surprising that the results are a little fuzzy given the embedded nature of the on-reserve water security problem, as illustrated in the literature review. In general, the interview evidence supports the argument that capital investments are important to ensure clean drinking water in First Nations communities.

The models do not provide support for an association between financial capacity and access to clean drinking water. This finding sheds light on an important governance point. First Nations communities experience water insecurity independent of financial health. That means there is no evidence that First Nations with balanced books are better off when it comes to having clean drinking water. It also means that there is no evidence of an association between large surpluses, from own-source revenue for example, and availability of clean drinking water. These findings stand in contrast to scholars who argue that dysfunctional First Nation governance is at the root of First Nation problems (see, for example, Graham 2012 and Flanagan 2000). My findings do not support an association between good fiscal management and access to clean drinking water.

The importance of funding dollars for ensuring clean drinking water emerges as a central theme in the interviews. This finding is consistent with arguments in the literature that funding dollars is a key piece of the puzzle (Walters et al. 2012, p. 5, Klasing et al. 2016). Examining interview evidence in conjunction with modelling results raises the point that funding cycles may be an important part of the

story, but one that the modelling is not capturing. According to Klasing et al., funding dollars are unpredictable and frequently insufficient (p. 14). Esdaile says that shorter-term funding cycles are part of the problem since First Nations may need to spend time and money updating feasibility studies if funding is piecemeal. The funding mechanism Indigenous Services Canada currently uses to fund drinking water services is inappropriate for a number of reasons. These contribution agreements lead to uncertainty about funding levels because it is not certain whether funding levels provided one year will be available the following year. Funding agreements generally involve significant reporting burden which can strain First Nation capacity (Office of the Auditor General of Canada 2011).

There are mixed results regarding a link between environmental protections, pollutions and availability of clean drinking water. Part of the fuzziness around this issue is that there are different ways of understanding access to clean drinking water that as highlighted in the interview evidence. Water security is framed through a protecting against water-threats lens by King, focusing on overall systems including risks, vulnerabilities and monitoring. Alternatively, the federal officials frame water security in terms of service provision. When water security is framed as ensuring treated, piped water, it follows that this is achieved through infrastructure. The mixed-methods approach successfully allowed for other ways of understanding water protection and water security. Although assessing this difference is beyond the scope of my work, it is aligned with the argument made elsewhere that there are fundamental differences between First Nation conceptualizations and provincial and federal government understanding of water security in the province of Ontario (Arsenault 2021, p. 3). Interestingly, the water-threats lens is also aligned with off-reserve water governance in the province of Ontario. Post-Walkerton, Ontario shifted to this multiple-barrier approach with intentional system redundancies to reduce risks (O'Connor 2002).

The other issue that provides some fuzziness around the relationship between drinking water advisories and environmental protections and pollutions is the idea of an association between pristine

water and being distant to threats. This points to an additional layer of complexity. In theory, if lakes and streams are distant from threats this may lead to clean drinking water. However, if lakes and streams are distant from threats, there may not be environmental protection measures in place.

The models are able to provide some insights in terms of a lack of correlation between drinking water advisories and environmental protections while controlling for financial capacity, remoteness, population size and environmental pollutions. I find only 15% First Nations communities have fully-developed, implemented source water protection plans in place (var: *swp*). While 28% have some measure of source water protection in place (including well-head protection and generic protection plans)(var: *swp_gen_inc*). I explore source water protection in terms of inclusion in provincial source water protection plans, community-based source water protection plans and "generic protection plans". The models do not suggest a difference in terms of whether communities have drinking water advisories while comparing communities in the industrial south (with its provincial source water protection framework) and the north (with community-based source water protection plans or "generic protection plans"). The finding that relatively few communities undertake source water protection is consistent with arguments in Collins et al. 2017 that First Nations communities face lack of funding to implement source water protection (p. 6). The lack of evidence from the modelling exercise supporting a relationship between drinking water advisories and environmental protections is surprising. There is no existing clear linkage between environmental projections and access to clean drinking water. As such, I am unable to confirm any benefits, First Nations communities derive in terms of increased water security through their inclusion in source water protection regions.

The models suggest a positive correlation between proximity to active mines and access to clean drinking water. This finding lends support to mining-related investment in First Nations water infrastructure. Because large quantities of water are vital to the mining process, it follows that there would be studies and plans for water systems near mines. In addition, because pollution is a known

hazard in mining operations, mitigations including environmental assessment and monitoring are likely taken to control for this risk. According to Daigle, mining companies issue Impact and Benefits Agreements to First Nations communities but they contain confidentiality clauses that prevent disclosure of the conditions (2018, p. 167). There is evidence that mining companies in the Ring of Fire, in Northern Ontario, have signed Regional Framework Agreements with the nine Mattawa First Nations. These agreements include environmental assessment and monitoring, developing regional community infrastructure and resource revenue sharing (Slowey 2013, p. 180). These findings suggest proximity to active mines may be linked to investments in infrastructure.

Interview findings point to size and location as major factors contributing to the persistence of water insecurity in First Nations communities. This is consistent with the idea that infrastructure is a key factor in ensuring clean drinking water. Results from the modelling exercise also point to remoteness. Surprisingly, the models do not point to population size in terms of explaining variation among First Nations in the province of Ontario. There is a lack of consensus in the literature about what constitutes a small drinking water system (McFarlane & Harris 2018, p. 379). If we take small systems to be systems serving 5,000 people or less, 99% of the communities in this study are small systems. If we take small systems to be systems serving 500 people or less 65% of the communities in this study are small (Moffat and Struck 2011).

In terms of remoteness, results from the models and interviews are aligned regarding the salience of this point. First Nations communities further from population centres of at least 1,000 people are more likely to have drinking water advisories. The literature provides evidence of abhorrent conditions in many First Nations communities with long-term drinking water advisories (Baijius and Patrick 2019, p. 1, Klasing et al. 2016, p. 40-54). Indigenous Services Canada funding formulas contain supplements to account for remoteness, however, as seen in the interview evidence, there are still shortfalls. Does remoteness simply exasperate funding shortfalls? This is part of the story, however, if

the relationship was this simple, I would expect to see some correlation with deficits in the financial capacity indicators.

The model results do not provide evidence to help with a link between lack of access to clean drinking water, remoteness and lack of financial capacity. Brown et al. 2016 investigate socio-economic indicators and water security but I find the gaps in the census data are too great and skewed to extrapolate conclusions. Evidence from the interviews offer some clues as to why remoteness may be linked to water insecurity. According to the federal officials, it difficult to retain well-trained water systems operators in smaller communities. Indigenous Services Canada reports that salaries of water system operators in First Nations communities are 30% lower than operators off-reserve. In addition, 26% of public water systems on First Nations reserves lack a fully trained and certified operator while 56% lack a fully trained and certified back-up operator (Office of the Auditor General of Canada 2021). The literature also points to a correlation between lack of operator training and certification and drinking water advisories (Harvey et al. 2015, p. 5138).

Conclusion:

This work teases apart some factors that can help explain variation in water insecurity among First Nations in Ontario. By combining expert interviews with regression analysis, I am able to approach the puzzle of water insecurity from multiple angles. I was fortunate to be able to interview experts who are directly involved, working on the ground. I approach the research question at the intersection of political science and environmental studies, building off a body of work that points to flaws and barriers in the institutional governance framework that exasperate and perpetuate water insecurity. I focus on the variation of water security across First Nations' communities in the province of Ontario and find evidence that remoteness is an important factor in perpetuating water insecurity. There is tension between this finding and the idea of pristine remote areas. I reason that this can be explained because a lack of drinking water advisories does not imply protected source water. This

thesis is unique in its approach, including publicly available data, data I gathered through the official Access to Information process and interviews with water experts. With this information, I am able to fill a gap in terms of systematically assessing on-reserve source water protection and drinking water advisories in the province of Ontario. I am also able to explore relationships using socio-economic indicators and contribute to discussions of financial governance. Finally, the models uncover an intriguing finding lending support to mining-related investment in First Nations water infrastructure. Although this finding was not the focus on my study, it raises possibilities for future studies on relationships between private sector infrastructure investments, environmental assessment and monitoring practises and access to clean drinking water on reserves.

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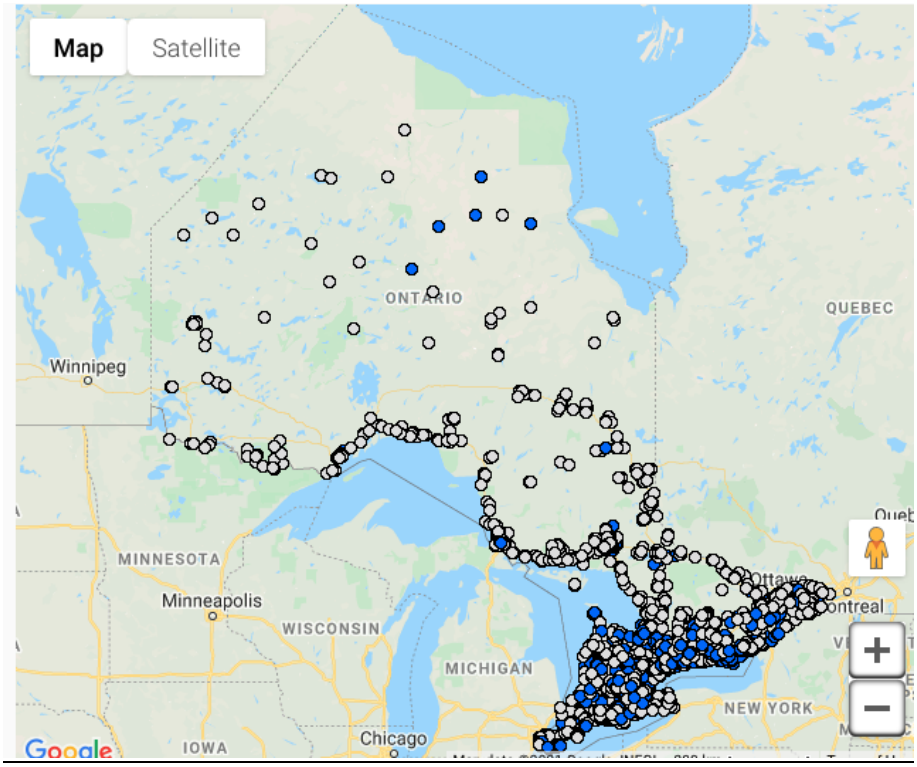
Appendices

Appendix 1
List of Questions for semi-structured interviews

1. How long have you been working at [X]? What interested you about this work? Can you tell me a little about what brought you here?
2. What factors do you think contribute to the persistence of water insecurity in First Nations communities?
3. In your opinion, are there environmental protections in place to protect the water supply? Can you tell me a little about any experience you may have with these protections?
4. Who would you say are the main political actors in ensuring there is clean drinking water on First Nations reservations?
5. Do you have any examples of best practices when it comes to environmental protections and water security on First Nations reserves?
6. Are you aware of any participation in source water protection planning by First Nations in Ontario, either provincially mandated protections or own reserve protections? If yes, what can you tell me about successes and barriers? Can you shed light on how funding is secured?

Appendix 2
Map of Ontario's Provincial (Stream) Water Quality Monitoring Network



The blue dots indicate active stations and the grey dots are inactive stations
Retrieved from the Ministry of Environment, Conservation and Parks.[32]

[32] Provincial Water Quality Monitoring Network (PWQMN)
https://www.ontario.ca/environment-and-energy/map-provincial-stream-water-quality-monitoring-network, accessed May 31, 2021.

Appendix 3

Table 1: Water security operationalized as access to clean drinking water, indicator and source

		Indicator	*Variable name*	*Source*
Dependent Variable	Water insecurity	0, 1, 2 ordinal response variable represents lack of clean drinking water, represented by drinking water advisories.	*waterproblems*	DWA data from Indigenous Services Canada, from *Ending long-term drinking water advisories*: https://www.sac-isc.gc.ca/eng/1506514143353/1533317130660#dataset-filter, and data from an Ontario Ministry of Indigenous Affairs FIPPA request.

Table 2: Independent Variables, indicators and sources

		Indicator	*Variable name*	*Source*
Independent Variables	Financial capacity	First Nation accumulated surplus measured in dollars	*accsurplus*	First Nation Band financial statements, from *First Nation Profiles*: https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FFListGrid.aspx?lang=eng
		First Nation financial risk measured in dollars (accumulated surplus divided by long-term debt)	*finrisk*	First Nation Band financial statements, from *First Nation Profiles*: https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FFListGrid.aspx?lang=eng
		Per capita community income score (single numbers that range from 0 to 100)	*cwbincome2016*	Per capita community income from score from 2016 Community Well-Being (CWB) data: https://open.canada.ca/data/en/dataset/56578f58-a775-44ea-9cc5-9bf7c78410e6
		CWB score (single numbers that range from 0 to 100)	*cwbindex2016*	Socio-economic index score from 2016 CWB data: https://open.canada.ca/data/en/dataset/56578f58-a775-44ea-9cc5-9bf7c78410e6
	Location	Index of Remoteness of communities (continuous measure from zero to one, one corresponds to the maximum value of remoteness)	*remote*	Index of Remoteness of communities from 2016 data, released 2020: https://www150.statcan.gc.ca/n1/pub/17-26-0001/172600012020001-eng.htm
	Population size	Population numbers from CWB Index and 2016 Census	*cwbcensus2016*	2016 Census population data from the CWB Index: https://open.canada.ca/data/en/dataset

				/56578f58-a775-44ea-9cc5-9bf7c78410e6 and https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E
		Population data retrieved from Indigenous Services Canada First Nation Profiles and Indigenous Services Canada sites.	*population*	Indigenous Services Canada, *First Nation Profiles*: https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNListGrid.aspx?lang=eng Indigenous Services Canada 2013 *Connectivity for Aboriginal and Northern Communities in Canada* and *First Nation Profiles* 2006 data: https://www.aadnc-aandc.gc.ca/eng/1352214337612/1353504776242 https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNPopulation.aspx?BAND_NUMBER=198&lang=eng
	Environmental Protections	Dichotomous variable representing participation in Provincial source protection committee, yes or no.	*pswp*	Conservation Ontario, *Source Protection Plans and Resources*: https://conservationontario.ca/conservation-authorities/source-water-protection/source-protection-plans-and-resources
		Dichotomous variable representing location in area where there is a provincial Conservation Authority and provincial Source Protection Plan in place, yes or no.	*cons*	Ontario Geohub, *Conservation Authority Administrative Area*: https://geohub.lio.gov.on.ca/datasets/conservation-authority-administrative-area?geometry=-144.107%2C38.917%2C-25.367%2C58.786 First Nations geographic location: https://open.canada.ca/data/en/dataset/b6567c5c-8339-4055-99fa-63f92114d9e4
		Dichotomous variable representing participation on provincial Source Protection Plan Committee, yes or no.	*swpcom*	Ontario Geohub, *Conservation Authority Administrative Area*: https://geohub.lio.gov.on.ca/datasets/source-protection-area-generalized?geometry=-144.107%2C38.917%2C-25.367%2C58.786

		Dichotomous variable representing presence of implemented source water protection plan, yes or no.	*swp*	ATIP, interviews
		Dichotomous variable representing presence of a SWP plan, yes or no. For this metric SWP plan includes any source water protection plan, community-based, provincial or other, including "generic" as reported on water source risk (question R 1.4) for Annual Performance Inspection Result Risk responses 2019.	*swp_gen_inc*	ATIP, interviews
	Environmental Pollutions	National Pollutant Release Inventory (NPRI) Pollution release sites	*closest_npri*	NPRI: https://www.canada.ca/en/services/environment/pollution-waste-management/national-pollutant-release-inventory.html
		Federal contaminated sites	*closest_csite*	Treasury Board of Canada Secretariat, *The Federal Contaminated Sites Inventory*: https://www.tbs-sct.gc.ca/fcsi-rscf/rfi-rpf-eng.aspx
		Proximity to Closest active mine	*closest_activemine*	Data from Natural Resources Canada The Atlas of Canada - Minerals and Mining: https://atlas.gc.ca/mins/en/index.html File downloaded: https://ftp.maps.canada.ca/pub/nrcan_rncan/Mining-industry_Industrie-miniere/900A_and_top_100/900A_69th_shape.zip
		Proximity to Orphaned/Abandoned Mines	*closest_abmine*	National Orphaned/Abandoned Mines Initiative (NOAMI): http://www.noami.org/php/NOAMI_2012_search.php?language=English

Appendix 4:
Average marginal probability for the selected independent variables

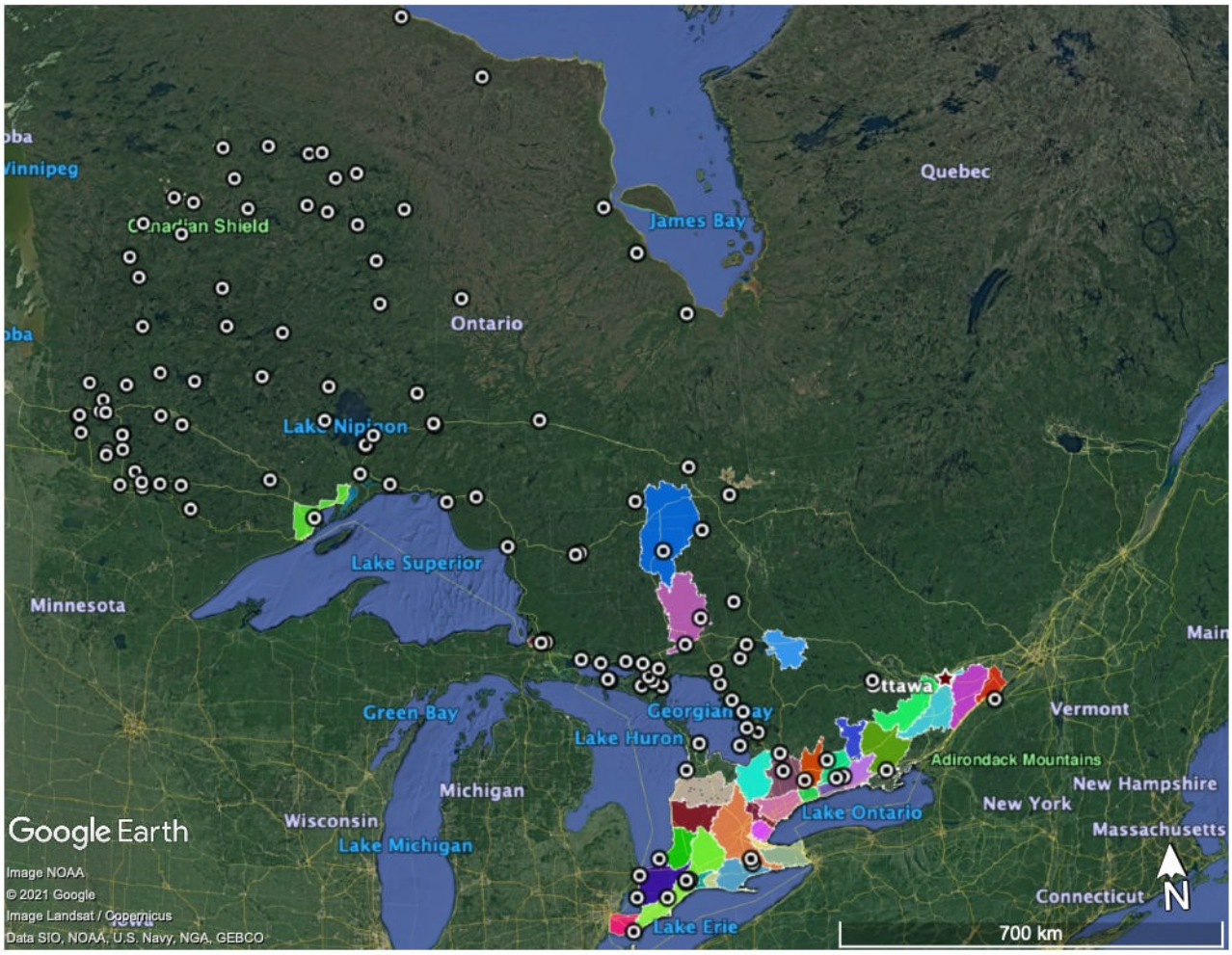
```
Average marginal effects                        Number of obs     =        127
Model VCE    : Robust

dy/dx w.r.t. : accsurplus finrisk remote population swp_gen_incl swpcom swp ontarioswp km_to_closest_npr
               km_to_closest_activemine km_to_closest_csite km_to_closest_abmine settlement
1._predict   : Pr(waterproblems==0), predict(pr outcome(0))
2._predict   : Pr(waterproblems==1), predict(pr outcome(1))
3._predict   : Pr(waterproblems==2), predict(pr outcome(2))
```

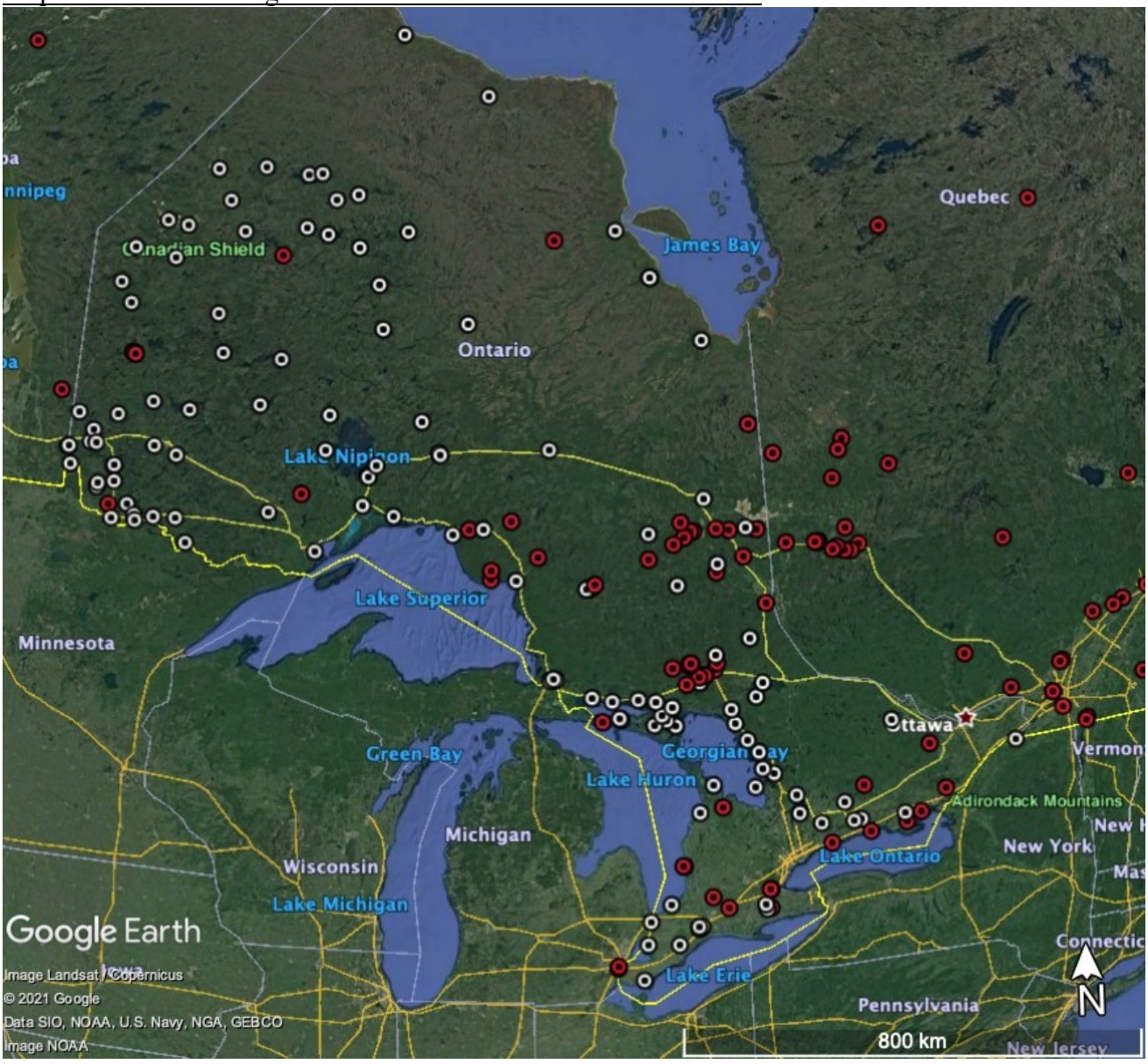
		Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
accsurplus							
	_predict						
	1	-8.70e-10	1.36e-09	-0.64	0.523	-3.54e-09	1.80e-09
	2	2.29e-10	3.52e-10	0.65	0.515	-4.60e-10	9.19e-10
	3	6.41e-10	1.02e-09	0.63	0.528	-1.35e-09	2.63e-09
finrisk							
	_predict						
	1	.0478307	.0278772	1.72	0.086	-.0068077	.1024691
	2	-.0125982	.0084876	-1.48	0.138	-.0292336	.0040373
	3	-.0352325	.020226	-1.74	0.082	-.0748748	.0044097
remote							
	_predict						
	1	-.5194918	.2397287	-2.17	0.030	-.9893515	-.0496321
	2	.1368292	.0742651	1.84	0.065	-.0087278	.2823862
	3	.3826625	.1772128	2.16	0.031	.0353318	.7299933
population							
	_predict						
	1	-.0000115	.0000591	-0.19	0.846	-.0001273	.0001043
	2	3.03e-06	.0000158	0.19	0.848	-.0000279	.0000339
	3	8.47e-06	.0000433	0.20	0.845	-.0000765	.0000934
swp_gen_incl							
	_predict						
	1	.0544072	.166314	0.33	0.744	-.2715623	.3803766
	2	-.0143303	.0434756	-0.33	0.742	-.099541	.0708804
	3	-.0400768	.1230372	-0.33	0.745	-.2812253	.2010717

swpcom						
_predict						
1	-.0790907	.1711974	-0.46	0.644	-.4146315	.25645
2	.0208317	.0458738	0.45	0.650	-.0690792	.1107427
3	.058259	.1257295	0.46	0.643	-.1881663	.3046842
swp						
_predict						
1	-.0507825	.1900401	-0.27	0.789	-.4232542	.3216892
2	.0133756	.050175	0.27	0.790	-.0849657	.1117169
3	.0374069	.1400183	0.27	0.789	-.237024	.3118377
ontarioswp						
_predict						
1	-.0689287	.3328827	-0.21	0.836	-.7213668	.5835095
2	.0181552	.0878143	0.21	0.836	-.1539577	.190268
3	.0507735	.2452297	0.21	0.836	-.429868	.531415
km_to_closest_npri						
_predict						
1	-.0019725	.0022437	-0.88	0.379	-.00637	.0024249
2	.0005195	.0006094	0.85	0.394	-.0006749	.001714
3	.001453	.0016535	0.88	0.380	-.0017879	.0046939
km_to_closest_activemine						
_predict						
1	-.0015337	.0007047	-2.18	0.030	-.0029149	-.0001525
2	.000404	.0002158	1.87	0.061	-.000019	.0008269
3	.0011297	.0005242	2.16	0.031	.0001024	.0021571
km_to_closest_csite						
_predict						
1	.0022092	.0014647	1.51	0.131	-.0006616	.00508
2	-.0005819	.0003544	-1.64	0.101	-.0012764	.0001127
3	-.0016273	.0011447	-1.42	0.155	-.003871	.0006163
km_to_closest_abmine						
_predict						
1	.0004639	.0005988	0.77	0.439	-.0007098	.0016376
2	-.0001222	.0001555	-0.79	0.432	-.000427	.0001827
3	-.0003417	.0004473	-0.76	0.445	-.0012184	.000535
settlement						
_predict						
1	-.2182536	.1310508	-1.67	0.096	-.4751084	.0386013
2	.0574859	.0394203	1.46	0.145	-.0197765	.1347483
3	.1607676	.0953858	1.69	0.092	-.0261851	.3477204

Appendix 5:
Map of Ontario showing First Nation reserves and Conservation Authority boundaries



Appendix 6:
Map of Ontario showing First Nation reserves and active mine sites



The grey dots indicate First Nation reserves and the red dots indicate active mine sites.