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Canadian Water Contamination: An Analysis of Agricultural Impacts on First Nations' Water in British Columbia

Kimberly N. Hill-Tout

Embedded in the stereotypes of Canada is the myth of an abundant and accessible freshwater source to all its citizens. While Canada is home to one fifth of the world's freshwater supply, recent critiques have surfaced regarding the 'Third World' conditions many First Nation communities have been living in within the country. The water contamination effects on some of the most vulnerable populations within Canada have been previously overlooked for decades, and continue to result in very little attention and concern in both social and academic fields. This paper examines the effects and contributions of the agriculture industry on water contamination in British Colombian First Nation communities; what preventative measures are in place, and; what future holistic water management can be undertaken. Although British Colombia is seen as a progressive environmentally-friendly province, its agriculture and fishery sector is growing, bringing in a revenue of $12-$15 billion by the year 2020; First Nation communities are still 26 times higher to contract water borne infections, 2.5 times more frequently have water advisories issued, and to have the advisories last for years at a time. There are provincial Safe Drinking Water Regulation (SDWR) passed under the Health Act in 1992, Environmental Health Officers (EHO) and Community-based Drinking Water Quality Monitors (CBWMs) monitoring water quality, and pledges to invest more money into the protection of drinking water sources as recognized by the provincial government. Where the future may be headed for British Colombia is through Source Water Protection (SWP), the inclusion of women in governing councils to respect cultural knowledge shared in First Nation communities, and agricultural changes to decrease the farming wastes produced in the industry. By examining these effects in British Colombia, we can apply practical strategies to take charge of the water contamination crisis in First Nation communities in Canada.

Introduction

Canada has one fifth of the world's freshwater supply - home to thousands of lakes, rivers, streams and wetlands, with an estimated 9% of the world's renewable supply of fresh water and lakes accounting for roughly 7.5% of its inland surface area (Davies & Mazumder, 2003). However, there exists a myth about 'water abundance' in the country, because despite holding one of the largest amounts of freshwater in the world, the country has been under scrutiny for 'Third World' water conditions in First Nations communities. In the past decade two thirds of all First Nation communities in Canada have been under at least one drinking water advisory (Levasseur & Marcoux, 2015). As of July 32, 2015, 133 drinking water advisories were in effect for 93 First Nations communities across Canada, excluding British Columbia (BC), where as of August 31, 2015, 27 drinking water advisories were in effect in 23 First Nations communities (Figure 1) (Plotkin, 2015). BC is home to over 1500 businesses that produce foods and beverages, 200 agricultural commodities,

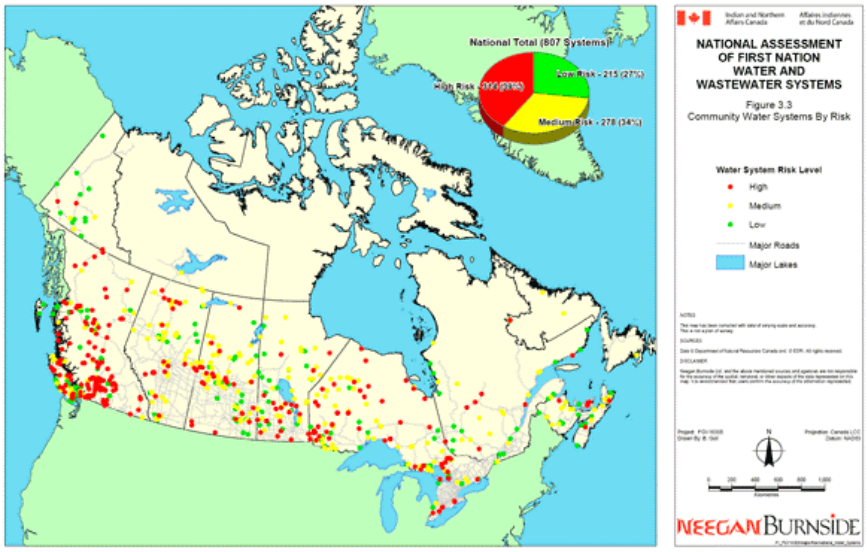

Figure 1: National Assessment of First Nation Water and Wastewater Systems (Neegan Burnside Ltd., 2011)

and 100 seafood species are harvested in the region (Wheatley, 1997). The business and agriculture industry contributes to water contamination in the province, and greatly affects the First Nations communities' water sources. With increasing freshwater consumption and the recent declaration of state of emergencies status in First Nations communities all across the country following decades of water crises (Harnum, 2010), research on source contamination is imperative for future water management and planning.

This paper will examine: (a) The effects and contribution of the agriculture industry on water contamination in First Nations communities by looking at BC's agriculture and fishery sector: the analysis will first have an overview of what the problem is regarding BC's water contamination by the agriculture and fishery sector, the contaminants found, their health implications, and a consideration of how these problems will exacerbate climate change; (b) What preventative measures are being taken in BC: the water treatment, agriculture and water management policies; (c) Factors of what can be done will be examined, such as source water protection, alternative agriculture methods, and involving women and traditional methods in future water management implementation planning. By examining these holistic effects in BC, one can apply practical implications and strategies to take charge of the water contamination crises in First Nations communities in Canada.

What the Problem Is

There are three types of drinking water advisories: boil water advisories, do not consume advisories, and do not use advisories. Advisories are issued after confirmation of water supply contamination with fecal pollution indicator organisms, and First Nation community water systems are 2.5 times more likely to have advisories issued. As part of the British Columbia Tripartite Framework Agreement on First Nations Health Governance on October 1st, 2013, Health Canada (2016) no longer reports drinking water advisories in BC First Nations communities. Provincial or territorial governments in non-First Nations Canadian communities are responsible for the issuing of drinking water advisories, especially those communities which are small, remote or isolated. Monitoring bacteriological contaminants in 2006 in water systems was only carried out at 29% of the recommended frequency by Health Canada. As

a result Health Canada concluded that drinking water quality monitoring in First Nations communities was not sufficient to protect public health. People living in First Nations communities are 90 times more likely to lack access to running water (Poulin, & Lévesque, 2013), and approximately 30% of First Nation community water systems are classified as high risk systems: the number of water borne infections in First Nation communities is 26 times higher than the Canadian National average (Patrick, 2011). Although Canadian cities experience boil water advisories they are shorter than those experienced in First Nations communities. In November 2006 Metro Vancouver experienced an advisory lasting 2 days, following landslides and water turbidity from winter rains. In contrast First Nation communities experience prolonged advisories lasting up to years at a time. Over time, the lands surrounding First Nations communities have become the used for urban development, recreation, forestry, mining, and agriculture which degrades their quality.

The twentieth century 'Green Revolution' transformed the food system from a local based production to a fossil fuel industrial system, causing food to become one of the key factors in water and other environmental crises. On the farm, fossil fuels are used to power machinery, and to create petroleum based chemicals for artificial fertilizers (e.g. Atharv Chemicals & Fertilizers, n.d.), to protect against pests and to stave off weeds. The BC agriculture and fisheries sector is of importance, and growing the economy is a key focus for the BC government - with a goal of building agriculture revenue from over $12 billion to $15 billion per year by 2020 (Climate Action Initiative BC Agriculture & Food, 2015). The majority of BC producers run a cow operation, and there is a small but important feedlot sector. Cattle are raised throughout BC for beef, and account for about 5% of the national beef herd (BC Environmental Farm Plan, Chapter 3). BC ranks first in Canada for the highest provincial herd at approximately 140 cows per herd, milk quality, and average milk production; most of BC dairy herds are located in the Lower Mainland, southwestern Vancouver Island, and north Okanagan Shuswap area (Chatwin, Jack, Wikeem, Wikeem, Colberg & Johnson, 2002). The province's hog industry is concentrated in the Fraser Valley, and is divided into two categories of hogs (Powell, 2015). Livestock that have free access to watercourses may impact both water quality and the land bordering the watercourse (the riparian area). Impacts can include direct deposit of animal excrement into the water, lowland that is seasonally flooded; spawning bed trampling, and removal of riparian vegetation. A consequence of overgrazing and monocrop production is soil erosion (the movement of soil by water, wind, or gravity). Although erosion occurs naturally, industrial farming practices such as irrigation, and tillage have increased the speed at which agricultural soils are eroded. Intensive tillage eliminates protective groundcover from the soil surface, and extensive irrigation salinates the soil. Erosion pollutes waterways with sediment, bacteria, excess nutrients, and chemicals, all of which degrade aquatic systems by reducing stream depth, increases turbidity, and alters pH balance downstream from the point source. Nutrient pollution damages aquatic ecosystems by increasing algae blooms, accelerating eutrophication of the water system, creating "Dead Zones". What is of concern regarding the agriculture sector is that in feedlots, manure storage areas leeches into groundwater and First Nations communal wells, carrying heavy metals and fertilizers (e.g. Arsenic, Nitrogen, Phosphorus, Copper, Zinc, Magnesium, Calcium, ammonia, nitrates, and Potassium), antibiotics, endotoxins, nutrients, and pathogens, which contaminates the groundwater, aquifers, and directly affect fish (Bor-

deleau, Asselin, Mazerolle, & Imbeau, 2016), and by consequence, affect human health as well. Manure affects fish habitats as it deposits bacteria, and it is a high oxygen demanding substance (measured as biochemical oxygen demand, 'BOD'), lowering oxygen levels in the water, increases the rate of eutrophication, and results in water sensitivity to temperature increases since warm water holds less oxygen than cool water.

Incidentally BC's coastline is ideal for its fishery industry because of its climate, water quality and sheltered bays; salmon, shellfish and marine phytoplankton are its three main cultured species (Brown, 2006). First Nations communities are traditional-food insecure as a result of Western industrial development, as seen with environmental Mercury pollution in the country's fish, and concern for traditional hunting and preservation of aquatic birds that reside in their waters (Wheatley, 1997). As traditional foods become contaminated, alternative foods are sought. A change in diet from high protein fish and meat to carbohydrate 'junk' foods, contributes to a prevalence of diabetes (Galloway, 2015). Heavy metals are found to have adverse effects in small quantity, and have been the cause of many of the drinking water advisories in First Nations communities (Grieder, 2016). Likewise, Nitrogen contaminants in the water can cause methemoglobinemia, baby blue syndrome, and spontaneous abortions in women (Wheatley, 1997); e-coli strains have had outbreaks in many First Nation communities, with increased popularity for documentation following the Walkerton, Ontario outbreak. Of the chemicals listed in the Canadian Drinking Water Guidelines in Health Canada (1996), most are used in agriculture or industry. Lack of trust for tap water has created dependency on expensive bottled water, and encouraged consumption of cola-based beverages. Furthermore, First Nations communities have higher rates of chronic illnesses, for example the rates of cancer are three times higher than in non First Nation communities (Table 1 Figure 2), and adverse health conditions can be attributed to poor water quality (Harnum, 2010).

As it is, Nazko First Nation, Alexis Creek First Nation and Lake Babine, all in BC are

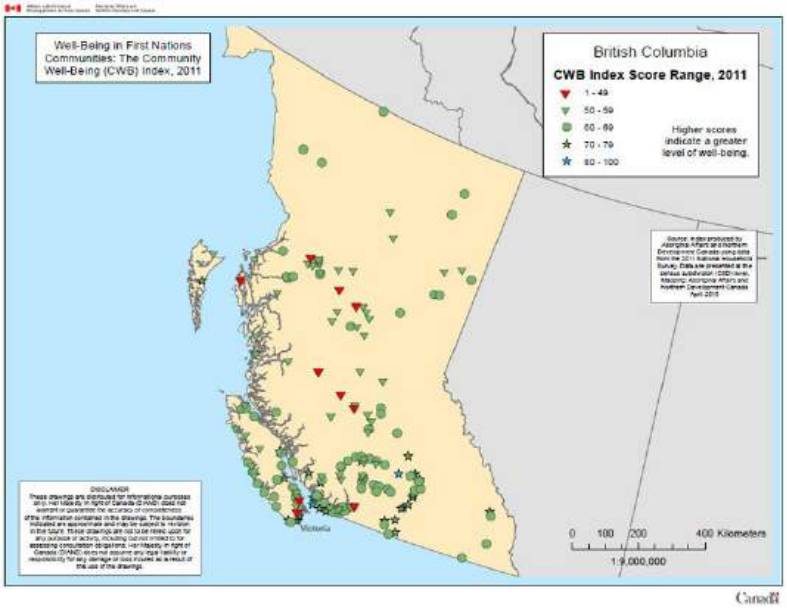

Figure 2: The Community Well-Being Index (AANDC, 2011)

Table 1: Concentration of heavy metals in soils of agricultural areas

centration of heavy metals in soils

Element	Target (A) value (mg/kg soil)	Intervention (C) value (mg/kg soil)
Arsenic	29	55
Barium	200	625
Cadmium	0.8	12
Chromium	100	380
Cobalt	20	240
Copper	36	190
Mercury	0.3	10
Lead	85	530
Molybdenum	10	200
Nickel	35	210
Zinc	140	720

Notes:
(1) Intervention value. This indicates serious contamination of soils where remediation is necessary.
(2) For heavy metals, the target and intervention values are dependent on the clay/silt and organic matter content of the soils. Standard soil values must be modified by the formula:
Ib = Is {(A + B% clay/silt + C% organic mater)}/(A + 25 B + 10 C)
Where Ib = Intervention values for a particular soil.
Is = Intervention values for a standard soil (10% organic matter and 25% clay)

Source: Food and Fertilizer Technology Center, n.d

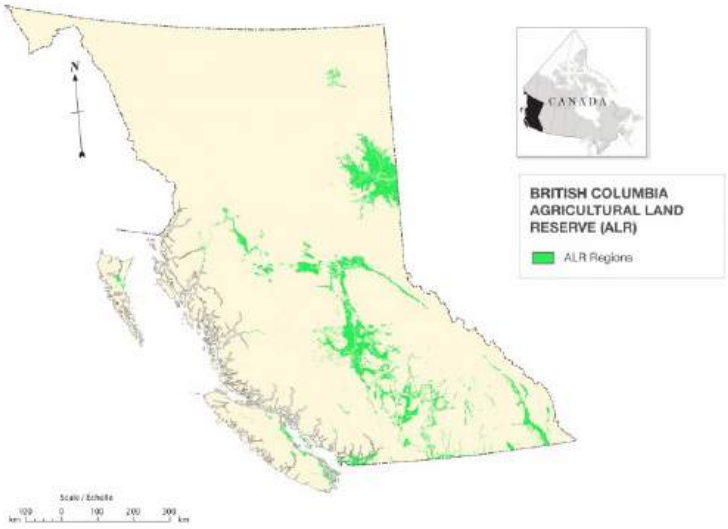

Figure 3: British Columbia Agricultural Land Reserve (Geography Open Textbook Collective, 2014)

all ranked second on the longest running water advisory- spanning 16 years. These areas are located in Northern Central Mainland BC, where it is becoming a hub for agriculture due to cheaper land prices. Where land goes for $55,000- $60,000/ acre in the lower Fraser Valley, Northern Mainland can be purchased for $2,000-$3,000$/ acre (Sandlos, & Keeling, 2016) (Figure 3). Regionally, the area specializes in fruits, vegetables, berries, hay, beef cattle, dairy, sheep, bison, and honey. Likewise the Northwest Central Interior, Bulkley Nechako Valley produces forage, oil seeds, and cattle ranching. Together along with the Peace River District, there are around 3050 farms generating $241 million in farm receipts (Tam, Findlay, & Dafna, 2014). Certainty of access to water is crucial for agricul-

tural development and food security in the province. Approximately 3% of water licensed in BC is for consumptive uses such as industrial, commercial, drinking water or agriculture. This includes reservoir water for the 4.7 million hectares of agricultural lands in BC (Doyle, Blais, & White, 2012). In some parts of BC, high levels of precipitation and seasonal runoff can cause the soil on which agricultural crops and livestock are being raised, to become water logged. With climate change comes further demand for irrigation of crops and animal watering. The heating of the earth removes moisture from the soil, and more surface freshwater and groundwater sources are exploited to irrigate the crops (McGregor, 2008). BC is already dependent on 75% of its surface water to provide water for their citizens (Doyle et al., 2012), and these bodies of water will become stressed, should lakes continue to disappear at alarming rates through cultural eutrophication, and groundwater depletion. More so impacted are the vulnerable and marginalized First Nations communities within the province whom already are dealing with water contamination and higher health risks, exacerbated by the agriculture industry.

What is Being Done

The link between human health and the environment manifests itself with our reliance on clean drinking water. Surface source water is defined as untreated (i.e raw) water from lakes, streams, and rivers that water utilities or individuals use for drinking (Davies & Mazumder, 2003). Quality drinking water has become to be defined as that which is safe for drinking and cooking: (1) free of disease causing organisms, (2) harmful chemicals below defined thresholds and physical parameters within acceptable ranges, and (3) with radioactive compounds below defined thresholds (Davies & Mazumder, 2003). Filtration is often used prior to disinfection to physically remove particles and pathogens, however users of surface-derived drinking water are at a higher risk for infection by Giardia and Cryptosporidium. The prevalence of surface water as a source may be a contributing factor to BC having higher reported enteric diseases compared to the rest of Canada (Davies & Mazumder, 2003).

In Canada there is a division between the federal and provincial governments' roles and jurisdictions in protecting drinking water. The provinces are responsible for use of water, flow regulations, development relating to water, and legislate pollution control and water supply (Davies & Mazumder, 2003). BC passed the Safe Drinking Water Regulation (SDWR) under the Health Act in 1992 (BC Gov., 1992). The SDWR replaced the responsibility of safe drinking water provision on water purveyors subject to approval of Medical Health Officers and set the micro-biological limits of bacteria in finished water. Prior to 2001, Health Canada was investing $5 million annually in its Drinking Water Safety Program for First Nations communities (Health Canada, 2016). From April 2001 to March 2003, Health Canada (2016) invested an additional $5 million to protect and enhance drinking water quality on reserves. In the 2003 budget, $600 million over five years was announced to support the implementation of the First Water Management Strategy, developed by Indigenous and Northern Affairs Canada (INAC) and Health Canada, to promote the safety of water supplies in First Nation communities from 2003-2008 (Health Canada, 2016). In First Nations communities, Environmental Health Officers (EHOs) and Community-based Drinking Water Quality Monitors (CBWMs) share responsibility for drinking water quality monitoring at tap (Poulin, & Lévesque, 2013). As part of the British Columbia Tripartite Framework Agreement on First Nations Health Governance, on October 1st, 2013, Health Canada transferred its role in the design, management,

and delivery of First Nations health programming in BC to the new First Nations Health Authority (FNHA) (Health Canada, 2016). Therefore, Health Canada no longer reports drinking water advisories in BC First Nations; Chief and Council in First Nation communities are responsible for planning and developing their capital facilities to provide for the basic infrastructure needs of the community, including drinking water. They are responsible for the day-to-day operation of water and wastewater systems on the reserves, including sampling and testing drinking water (Davies, & Mazumder, 2003). Still, First Nations peoples have also faced the threat of water privatization, and public-private partnerships (PPP) between companies and the government (Brunger, & Schiff, 2013). Furthermore, the federal government maintains jurisdiction involving navigation and fisheries (e.g. section 35 under the Fisheries Act), national parks, and aboriginal reservations (Harnum, 2010). The BC public wants enactment of strong legislation, including raw and finished water standards, public education, research on drinking water issues, and watershed protection. (Davies, & Mazumder, 2003).

In terms of agriculture, there are regulations and standards in place to protect streams and water quality. The Range Practice Regulation states that in community watersheds, "livestock use of riparian areas must not result in fecal deposits, trampling of vegetation, deposit of sediments or exposure of mineral soil to the extent that the district manager considers detrimental" (Houghton, & English, 2014). However, there is no absolute measure, for the amount of fecal deposits considered detrimental. The Agricultural Waste Control Regulation of the Environmental Management Act contains the Code of Agricultural Practice For Waste Management; the Code, administered by the Ministry of Environment, deals with agricultural wastes and pollution concerns (Bactawar, 2003). Direct access to a watercourse may be classified as either managed or unrestricted; restricting access will limit livestock impacts on water quality and sensitive streambank areas, but will concentrate impacts onto the access site. In January 2015, the Animal Health Act was updated to allow the province to better manage and respond to animal diseases that can spread between animals and humans, and ensure that BC farms remain competitive on the global market (Powell, 2015). In term of fisheries, BC is committed to ensuring that the conservation of the resource will be the basis of sustainable fisheries and seafood supply; the federal Fisheries Act and Species at Risk Act has sections to protect wildlife, fish, aquatic life, and their habitats (Brown, 2006). Impacts to habitat or the deposit of deleterious substances into watercourses are prohibited, both of which could occur from livestock access to watercourses (Brown, 2006).

The Auditor General of BC voiced concern of BC's lack of an effective and integrated approach to land-use management with respect to protection of drinking water sources in 1999, and the importance of non-point source pollution (e.g. agricultural runoff) is recognized by the BC government; BC is the only province in Canada to develop an action plan to address this issue (Davies & Mazumder, 2003). The Auditor General estimated that adding filtration systems to the smaller water systems outside Vancouver and Victoria would initially cost around $700 million with an additional $30 million for annual maintenance (Davies & Mazumder, 2003). Other estimates suggest initial cost may be as high as $2 million (BC Gov., 2001). There was previously a $5 billion deal signed with First Nations in 2005 by former Liberal Prime Minister, Paul Martin, that aimed to address a wide range of issues faced by Canada's First Nations, but was scrapped when the Conservatives came to

power (Galloway, 2015). This deal included a promise of $400 million to bring clean water to remote First Nations communities (Galloway, 2015). But some people say that the water problems faced by the First Nations are almost too big, broad, and cannot be solved by cash alone. To overcome the risk associated with water events in First Nation communities, INAC invests in expensive water treatment facilities. They provide funding for water services and infrastructures such as the construction, upgrading, operation and maintenance of water treatment facilities on First Nation reserves (Health Canada, 2016). This approach has been less than successful, in part because of the high unit cost of water treatment facilities and the relatively small population base of each reserve. It is also questionable to have a conventional water treatment facility in many of these communities because of inappropriate design specifications, dependency on chemical treatment, lack of trained operators, and high operation and management costs.

In BC, the Ministry of Health and the local Health Authorities are lead agencies for drinking water protection. The Drinking Water Officer (DWO), or Medical Health Officer designated in the Health Authority, has power to require expensive water treatment plants, requirements that medium and small water operators can ill afford such as in First Nation communities. Similarly, these health officials have power to order source water assessments, essentially the first stage of any source water protection plan and assessment response plans, as outlined in the BC Drinking Water Protection Act of 2001 (Patrick, 2011). Based on the 2008 Okanagan Basin study, watershed stakeholders typically do not communicate well across sectors, and First Nation water operators are rarely considered in land management decision-making of the provincial government. Health officials including DWO and Medical Health Officers in BC now have the legal instruments in place to "order" Source Water Protection (SWP) planning (Patrick, 2011). These powers have the potential to bring watershed stake-holders, including First Nation and non-First Nation land managers and water operators together to better coordinate land use activities in the interest of protecting all source waters.

What Can be Done:

We are faced with the need to adapt as well as to mitigate to the changing technologies around agriculture and water management. However, we also need to take action with what can be done in the present to reverse and prevent water contamination from agricultural factors, especially amongst the First Nations communities. For example, fully protected watersheds had lower Giardia, but not Cryptosporidium concentrations in watersheds of limited access, compared to those with recreational and agricultural activities, or those with sewage and industrial discharge (McGregor, 2008), proving we have areas we need to focus our concern.

Methods

A method proposed is the multi-barrier approach. The Canadian Council of Ministers of the Environment (CCME) define the multi-barrier approach as "an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water from 'source to tap; in order to reduce risk to public health" (Patrick, 2011). This method is to reduce the risk of drinking water contamination through the presence of system redundancies/ barriers built into the water system. There are three main components in the multi-barrier approach: source protection, drinking water treatment, and attention to the drinking water distribution system (Patrick, 2011). This holistic approach to safe drinking water has been

supported across Canada as it endorses watershed and groundwater protection.

Source water protection (SWP) is a safe, logical, and affordable means of protecting human health in First Nations communities, it involves delineation of watershed or groundwater recharge area, inventory of potential sources of contamination, assessment of vulnerability of water supply to contamination, and implementation of a source protection management plan (AANDC, 2014). It is watershed management programs with a specific goal of protecting drinking water supplies; it is a watershed specific planning process encompassing numerous potential initiatives and programs, and aims to reduce the risk of waterborne contamination at the water source. SWP makes economic sense for three principal reasons: it is reported to be several times less expensive to protect a water source from contamination than it is to remediate after contamination; it has been shown to be more cost effective to invest in natural capital, such as purchasing development rights or land acquisition within a watershed, rather than to invest in physical capital, such as water treatment technologies; SWP is the first barrier of defense for clean drinking water as it reduces water treatment challenges and costs (Houghton & English, 2014). Yet, for all its benefits, SWP has proven to be difficult to practice on the ground. Recent Canada-wide studies suggest that small and medium sized water operators lack sufficient financial, technical, human, and legal capacity to undertake SWP (Patrick, 2011). Many First Nation communities in Canada are classified as small water systems (less than 250 water connections), lacking sufficient financial and technical capacity when measured against medium-sized municipal water systems (Patrick, 2011). Research from British Columbia's Okanagan Basin has revealed constraining factors to attaining municipal water systems; ineffective watershed stakeholder communication, fragmented inter-agency relations, and competing resource interests have all been shown to constrain SWP at the local level. Current research suggests that factors constraining SWP tend to be institutional and jurisdictional rather than technical or scientific (Plotkin, 2015). With authority to order source water assessments public health officials have potential to act as catalyst to pull together all stakeholders involved in watershed activities, from forestry and mining to cattle range and recreation, meaning the obligation to reach a more effective solution lies heavily with them.

The Canadian government has spent about $2 billion on the issue between 2001 and 2013, but the problems are as severe as ever (Sandlos & Keeling, 2016). A more targeted approach is needed, along with better communication between the government and First Nations.

"Chronic government underfunding of water systems is to blame for the lack of progress; a national assessment commissioned by the federal government found $470 million was needed per year over 10 years."
- Emma Lui, Council of Canadians

Despite $3.5 million spent on fixing water systems in the last few years of that funding session, but water advisories persist.

"They took the easy route. They sent money but did not put someone on the ground."
- Alec, Council of Canadians

Health officials including Drinking Water Officers and Medical Health Officers in British Columbia have the legal instruments in place to "order" SWP planning (Patrick, 2011). These powers have potential to bring watershed stake- holders, including First Nation and non-First Nation land managers and water operators, together to better coordinate

land use activities in the interest of protecting all source waters. The result of expanded source water protection planning for First Nation communities is improved communication between all watershed stakeholders, with the goal of enhanced drinking water quality (Patrick, 2011). As proven elsewhere, greater attention to source water protection delivers cleaner, safer, and more affordable drinking water. Additionally, source water protection has the potential to reconnect health and place for First Nations in Canada; the rescaling of First Nations' place as a result of colonization continues to impact health: loss of access to traditional lands, the transference of resource management activities to the government, and the forced resettlement acted against land and water protection (Patrick, 2011). By introducing source water protection at the local level, it opens up new opportunities for not only enhanced water quality but also community engagement, intergenerational knowledge translation (Elder to youth), and the reconnection of health and place for First Nations in Canada (Sandlos, & Keeling, 2016).

Involve Women

Attention should turn to the role of First Nation women with water, and the impact they can have with water management. This opportunity will diversify and enrich the discourse on water management and contribute to improve water management strategies. Across time and culture, women are considered the holders of water knowledge and assume the primary role in the protection of water resources. Given that a high proportion of First Nation women live in poverty, they are amongst those least able to afford these kinds of short-term and individual responses to substandard water quality. The voices and experiences of First Nation women are seldom evident in dialog or policy development; concerns about water quality in First Nation com-

Figure 4: First Nation families preparing traditional foods and food sharing (left): (a) Sockeye salmon being butterflied and prepared for drying; (b) Sockeye salmon being dried on racks in the open air (right): (a) Moose meat being cut into thin strips and prepared for drying; (b) Moose meat being dried on racks in open air (COSEWIC, n.d.).

munities led to the formation of an Expert Panel on Safe Drinking Water for First Nations in 2006, but First Nation women were not invited (Anderson, Clow, & Hawthorn-Brockman, 2013). Stories offered by Grandmothers and other female elders provide insight on water management; more research is needed in this area, particularly research that invites Aboriginal women to share their knowledge about water and their recommendations for solving today's water quality and security issues. Although it is a small contribution to the discourse on water quality, it is a crucial one because it creates a forum for the voices of First Nation women to be heard.

Agriculture

Individual farming projects can be undertaken- promoting a change in individual behaviours to facilitate change. Along the theme of changing individual behaviours, one can help create a reduced meat diet dependent market. Food sharing between family members, and within the community and friends is practiced among First Nations people, and results in less food waste (Tam et al., 2014) (Figure 4). The adaptation and mitigation we will undergo provides an opportunity to better understand and practice sustainable agricultural practices, including but not limited to: windbreaks, crop rotation, rainfall irrigation, reducing number of livestock, sustainable fishing policies, waste recycling, animal diet manipulation. The ministry of agriculture has committed $900,000 this year to initiatives aimed at preparing BC farmers for climate change, funding for regional adaptation strategies in Cowichan Valley, Delta and Peace County; a five year federal-provincial farming risk management fund 'Growing Forward' also includes $110 million for programs promoting innovation, adaptation and sustainable agriculture (Climate Action Initiative BC Agriculture & Food, 2015).

Conclusions

In recent decades, a higher proportion of pollution has come from agricultural sources than the first two thirds of the twentieth century, as a result of industrial, agricultural, and human effluents into watercourses. Agricultural intensification impacts water quality through the release of nutrients, chemicals, biological waste, and via soil erosion washed off farmland into the water environment. Challenges for managing farming's impact on agricultural water pollution can originate from either a point source (e.g. from a slurry store) or diffusely as a non point source (e.g. run off from larger areas of farmland). As non point source pollution can arise from the contributions of many smaller sources, it is difficult to attribute it to a specific sector or activity and the impacts of pollution can occur some distance from the source. These effects are being seen in First Nations communities where 23 communities are at a health and safety risk, under 27 drinking water advisories, and are suffering adverse health consequences. As both the responsible and regulatory agency, the government needs to maintain incentive for implementing, improving, and managing these systems. It is in BC's interest to conduct studies examining source water supply on human health so that agricultural water contamination can be better understood. While short term costs may be lower, unchecked development can lead to increasing future costs and risks through environmental degradation. Prevention of water pollution, and source water protection may be our solutions for future water source sustainability. Methods such as: alternative farming techniques, waste management, and including women in the water management discussions can establish and sustain water quality in First Nations communities in BC.

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