

## Critical elements for local Indigenous water security in Canada: a narrative review

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### ABSTRACT

Indigenous communities in Canada are over-represented with respect to poor water quality and water advisories. To date, approaches to solve this water crisis have been founded in the Western Science (WS) context with little to no consultation or dialogue with those communities most impacted, and without regard for culture. A literature review was undertaken to: (i) document Indigenous Knowledge (IK), and perspectives regarding water and (ii) to identify current local water security tools utilized by Indigenous communities. The aim is to provide sound evidence regarding the value of ownership and leadership by Indigenous communities in the context of current and appropriate resources available to (re)claim these roles. Solutions must remain consistent with, and founded upon, traditional Indigenous worldviews and cultural values to ensure sustainable water security. Literature reviewed from the past ten years revealed one overarching creation theme with three water-specific themes in Indigenous communities; namely, water from natural sources, water as a life-giving entity, and water and gender. Ultimately, there needs to be a new framing of local water security with the development of tools which engage IK and WS in order to assess local water security and appropriately inform interventions, policies, regulations and legislation.

**Key words** | community-based research partnership, Indigenous Knowledge, water is life, water security, water stewardship

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### INTRODUCTION

Access to a reliable supply of safe drinking water is recognized as a basic human right ([United Nations Declaration on the Rights of Indigenous Peoples 2008](#); [World Health Organization 2017](#)), and a powerful environmental determinant of health ([Gorchev & Ozolins 2011](#)). Moreover, all nations agreed in 2015 to a unifying agenda for global sustainable development. Within this agenda is a commitment to universal access to drinking water; potable water in every house, school, public building, and place of work ([United Nations Department of Economic and Social Affairs 2015](#)). Despite this, 884 million people globally continue to lack basic access (defined as 'an improved source within 30 minutes' round trip to collect water') to drinking water at home ([WHO & UNICEF 2017](#)), and thus risk

exposure to a number of waterborne pathogens such as *Escherichia coli* O157:H7 and *Giardia lamblia*.

Indigenous communities around the world, particularly those in rural and remote areas, represent a highly impacted, yet often overlooked and isolated, population. These communities are particularly vulnerable to water insecurities due to exposure to industrial and naturally occurring contaminants and toxins, and a chronic lack of resources and infrastructure to manage or maintain secure water systems ([White et al. 2012](#)). In addition, drinking water in Canada is under provincial/territorial jurisdiction, while First Nations communities are under federal jurisdiction. The lack of access to government decision-making processes, specifically on a policy level, results in a lack of consultation

and participation, with the outcome being that Treaty and Indigenous rights are ignored. Bill S-11, an Act proposed in 2010, meant to respect safety of drinking water on First Nations land (Phare 2009; McGregor 2012) is one such example and was subsequently rejected by the Chiefs of Ontario due to lack of opportunity for Indigenous peoples to collaborate. The need for federal legislation to protect and provide drinking water was finally acknowledged in November 2013, when the Safe Drinking Water for First Nations Act came into force, authorizing the Canadian Government, in collaboration with First Nations communities, to develop regulations that better support ‘access to safe, clean, and reliable drinking water’ (Health Canada 2014). Notwithstanding these regulations, as of July 30, 2018, there were 72 long-term drinking water advisories (DWA) in effect and 41 short-term, some of which have been in place for decades to months, respectively (Aboriginal and Northern Development Canada 2018); long-term DWAs indicate advisories that have been in place for more than one year, whereas short-term DWA warn residents of a short-term quality issue on a certain water system (Health Canada 2017). It is clear that solutions for water security are beyond the scope of legislative tools and/or policy in isolation, and thus require both an inter-disciplinary and a localized approach.

Local water (in)security is the result of myriad complex interactions between water resources, drinking water and sanitation (including wastewater) infrastructure and management, community health and wellbeing, access and equity, food security, economic activities, energy, and the environment (Schuster-Wallace & Dickson 2017). Given the inherent complexities present at the intersect between these natural and anthropogenic systems, relevant, and temporally appropriate water security assessments are of critical importance, whether at the local or watershed scale, to effectively support decision-making, management, and stewardship solutions. The current study sought to: (i) synthesize documented Indigenous perspectives, attitudes, and knowledge(s) with respect to water across Canada; (ii) identify existing local water security tools and regulations which incorporate Indigenous-specific values used in Canada (with reference to the United States and Australia); and (iii) provide recommendations for developing an Integrated Research Strategy (IRS) and a path forward for the transferable

inclusion of Indigenous values and Indigenous Knowledge (IK) in current local water security assessment approaches. IK is defined as ‘a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living things (including humans)’ (Berkes 2012).

## METHODS

A systematic literature review was undertaken in Academic Search Premier, Environment Complete, and SocINDEX using specific keyword combinations (Table 1). Search results were initially constrained to documents published in the English language between 2006 and 2016 and focused on Canada. The search for tools was subsequently expanded to include publications focused on the United States and Australia given relevance and similarities to the Canadian context. The search was conducted using various combinations of terms and phrases (Table 1). Articles were selected for review based on their specific inclusion of Indigenous values, attitudes toward water, and/or the presentation of a tool(s) for water security based on title and article abstract. Articles were excluded if Indigenous values were not the main theme and/or framework and if water was not the primary focus. Results were separated into documents which provided insight into the unique relationships between Indigenous people and water, and water assessment tools which incorporated any aspect of these relationships.

**Table 1** | Search strategy

Keywords	Number of articles	Number of relevant articles
2006–2016 Academic Search Premier		
Indigenous Knowledge AND water	212	16
Indigenous perspectives AND water	110	11
Indigenous women AND water	43	9
2006–2016 SocINDEX		
Traditional water knowledge	17	1
Water AND indigenous AND insecurity	17	2
2006–2016 Environment Complete		
Water AND Indigenous AND tools	228	9

The academic literature was augmented by a grey literature search undertaken through Google.ca. Search terms included 'boil water advisories', 'First Nation water legislation' and 'policies', and 'water security in Indigenous communities'. A total of 13 documents and reports met these criteria and provided additional context to the academic literature.

## EMERGING THEMES (RESULTS)

The findings presented here are reflective of the number of relevant documents found within each database and the grey literature search. Each theme represents Indigenous perspectives, attitudes, and IK regarding water usage within communities. Methods in the papers assessed included in-depth case studies and interviews with community leaders. The literature to date offers many insights into water usage and values in Indigenous communities as well as IK about water. It is recognized that Indigenous communities across the world are diverse in terms of cultural practices, traditions, and governance, making it difficult to convey key attitudes, knowledge, and traditions regarding water without making general and potentially erroneous assumptions. However, the literature has demonstrated that many Indigenous communities share similar traditional beliefs and attitudes toward water (Swain *et al.* 2006; McGregor 2014). Moreover, process tools that support people posing the right questions to the right people can provide insight to socio-cultural water security elements that may otherwise be overlooked. This is especially true in the Canadian context where IK has been historically devalued and Indigenous people are now reclaiming IK and the inherent importance of such knowledge (Kulnieks *et al.* 2013).

### Water as life, water for life

Many Indigenous oral traditions, often taking the form of stories and traditional teachings, speak of the great significance of the spiritual connection that Indigenous communities express between land, water, and animals and support Indigenous ways of knowing (McGregor 2012). The majority of information regarding perspectives, attitudes, and IK surrounding water is conveyed through traditional knowledge foundations such as Creation or

Origin Stories as it is the center of Indigenous interconnectedness to the natural world for many Nations (McGregor 2004; Lavalley 2006; Sanderson *et al.* 2015). In an effort to highlight the Indigenous perspective of water, Blackstock (2001) utilized ethnographic research methods to document the IK of three Elders in Canada. The Elders explained that water is alive, so it has a living spirit, and is viewed at the heart of the Indigenous ecosystem. Similarly, Indigenous First Nations in Ontario described water as a living entity, and that in order to stop the continuous and future threats to water, societal perceptions about water need to change (Lavalley 2006). Not only is water essential to wellbeing, but important places in communities are also often located and are culturally and traditionally connected to water; for example, through local river systems that surround the land (Barber & Jackson 2011). Similarly, McGregor (2014) and Anderson (2010) documented, through interviews with Elders across different regions and different Indigenous nations in Canada, that water is the equivalent or essence of 'life', and that the relationship between water and health and wellbeing is rudimentary and direct.

As such, the pollution, overuse, and lack of a holistic appreciation of water in Western society diametrically opposes the relationship between Indigenous people and water, thereby having a significant impact upon Indigenous rights and ways of life. Industrial development, such as mining and hydroelectric generation, alongside commercial agriculture, not only consume water for profit, but generate chemical by-products that significantly damage waterways utilized by Indigenous communities for both sustenance and traditional practices (Phare 2012; Matsui 2015). Indigenous communities often acknowledge water as the lifeblood of Mother Earth, thus describing the deep cultural and spiritual significance of water, which must be recognized and understood as more than a resource to be exploited (Blackstock 2001; LaValley 2006; Basdeo & Bharadwaj 2013). Thus, one component of being water secure is recognizing that water is more than a commodity (McGregor 2012). Indigenous traditions have taught individuals how to take from the land, while still respecting the interaction of the non-human world (Burrows 2005); these traditions have the opportunity to play a significant role in water stewardship today, and therefore must be integrated into both qualitative and quantitative water security tools, knowledge, and skills.

## Water from natural sources

Collection and consumption of water from natural sources, such as local springs, creeks, rivers, lakes, springs and aquifers, is a common practice among Indigenous people that dates back to the pre-colonial contact era (Daley *et al.* 2015; Jung & Skinner 2017). However, industrialization, forestry, agroindustry, urbanization, land cover and land use change, poor wastewater management and infrastructure, as well as changes in precipitation patterns as a result of climate change, have resulted in a global decrease in water quality, and increased risk of acquiring waterborne pathogens (Harper *et al.* 2011; Schuster-Wallace & Sandford 2015). Regardless of potential risk of exposure to harmful pathogens, Indigenous communities in Canada are required to continue to retrieve and consume water from natural, untreated sources for reasons related to culture, community perspectives, and lack of alternative water sources.

The reasons for the consumption (or non-consumption) of untreated water must be thoroughly understood in order to be properly addressed in context and with consideration of traditional ways. For example, chemical water treatment processes are often described by Indigenous communities as killing the spirit of water, essentially leaving the water lifeless and undrinkable (Lawless *et al.* 2015). Consuming bottled water is similarly frowned upon, as described by Anderson (2010) consequent to interviews from eleven Elders in Indigenous communities across Canada. It was noted that bottled water ‘taste(s) dead’ and one Elder in particular spoke of teaching others in the community that ‘anything wrapped in plastic dies’.

Hanrahan *et al.* (2016) sought to understand the multiple dimensions of local long-term water insecurity through an extensive case-study comprised of open-ended and semi-structured interviews with Elders and community leaders in the remote area of Black Tickle, Labrador. Findings included a preference for drinking water from natural sources, as it was considered more ‘trustworthy’ and thus safer than treated water, reflecting practices that people have held for millennia prior to colonial settlement and development impacts (Anderson 2010; Harper *et al.* 2011; Daley *et al.* 2015). However, not all-natural drinking water sources are considered trustworthy; ‘trustworthy’ water comes from fast moving sources such as springs, streams, and rivers. The use of trustworthy water is especially important for traditional purposes,

such as practices related to pregnancy, birth, and newborn care (Anderson 2010). Further, convenience when living in a remote location was documented as a reason for consumption of untreated, naturally sourced water (McClymont Peace & Myers 2012; Sarkar *et al.* 2015).

## Water and gender

Indigenous women play a significant and fundamental role in water resource protection and are considered the primary holders of water knowledge in Indigenous communities (Anderson *et al.* 2013). The parallels between the life-giving abilities of both women and water have been well documented across the literature (Anderson 2010; Anderson *et al.* 2013; Baird *et al.* 2015; Longboat 2015). It is because of these commonalities that women assume primary responsibility for overseeing the wellbeing of community water supplies (Lawless *et al.* 2015). However, colonization, including residential schools and imposed (male dominated) systems of governance, have resulted in a significant disconnect between many women and their water stewardship roles (Cave & McKay 2016).

To understand the extent to which women and water are connected, Longboat (2015) conducted interviews with five Anishinaabe Elders in communities surrounding the Great Lakes in Ontario. These women are described as caring, praying, and speaking for the water, holding the title of ‘Keepers of the Water’. In (re)claiming their traditional roles they are responsible for restoring the traditional ceremonies that honour water. Baird *et al.* (2015) realized similar findings when employing a multiple case study design in three different Indigenous communities across southern Ontario aimed at understanding perceptions concerning water quality, water management, and water governance. Across the three communities, women rated the importance of water significantly higher than men and cultural roles of water were recognized as important not only for individual men and women, but also for communities as a whole.

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## EXISTING WATER SECURITY TOOLS

Incorporation of IK into current water security tools is not without challenges. Misinterpretation of oral histories and IK by both government and science is a recognized threat

that may impede Elders' willingness to share their experiences and cultural knowledge, particularly given the long history of colonization in Canada. Doubt and mistrust can also arise from acquiring information through a knowledge system that is unfamiliar or not customary (Houde 2007). Nonetheless, equitable and mutually beneficial collaboration between Western Science (WS) (defined as 'system of knowledge which relies on certain laws that have been established through the application of the scientific method to phenomena in the world around us'), Social Sciences, and IK are essential for assessing and ensuring local water security.

The constant insecurity faced by Indigenous communities brings into question the effectiveness and overall performance of current regulations, practices, and tools currently employed in Canada for the management of water resources in Indigenous communities. Recognizing the limitations and gaps of current practice, as well as opportunities for improvement, is critical for successful development in the future.

## Regulations

Water governance and water safety in Indigenous communities are under the purview of federal government agencies including Health Canada, Aboriginal Affairs and Northern Development (INAC), and Environment Canada. Each of these agencies is responsible for different aspects of water management in Indigenous communities in Canada (Table 2).

In spite of the regulations, the Status Report of the Auditor General indicated that none of these agencies were fully implementing all of their required duties (Auditor General 2011). In 2011, for example, INAC had only conducted 25 of 80 annual inspections, and 47 of 80 risk evaluations. Furthermore, Health Canada found that only 40% of

community sites were conducting bacteriological sampling (a responsibility of the community itself) and even these were below the recommended frequency of current Canadian Drinking Water Guidelines. Moreover, not only did testing occur infrequently, but Health Canada and INAC failed to communicate water testing results, which is both an ethical and legal obligation (Simeone 2010; Auditor General 2011). Clearly a significant gap exists in water quality monitoring in Indigenous communities as well as a disconnect between the agencies responsible for monitoring water quality and the communities, contributing to poor communication and misunderstanding, leading to a lack of knowledge of water quality in the community itself.

As with most communities in Canada, Indigenous communities are encouraged to employ the multi-barrier approach (MBA) to safe drinking water (Health Canada 2013), which addresses the drinking water system at three different points; namely, the water source, the treatment system, and the distribution system. MBA employs procedures, processes, or tools at each point as a preventative measure (Health Canada 2013). The MBA also requires ongoing monitoring throughout the system, and preparedness plans in case of an adverse event(s); however, these are not in place in many First Nation communities. Walters *et al.* (2012) compared Indigenous and non-Indigenous drinking water systems using the MBA and found that the gaps in the safety of the drinking water in Indigenous communities remained significant compared to non-Indigenous communities, even with technical and financial investments, with 83 out of 140 First Nation drinking water systems ranking medium to high risk compared with only four municipal drinking water systems in Ontario. Further, with the exception of source water protection (SWP), the MBA offers few opportunities for alignment with Indigenous ways of life. As such, more attention must be allocated to the

**Table 2** | Institution and description

First Nation	Health Canada	Environment Canada	INAC <sup>a</sup>
Own, design, construct, manage and operate water and wastewater systems	Ensures appropriate drinking water quality monitoring programs are in place on reserves south of the 60th parallel <sup>b</sup>	Ensures guidelines are followed and provides guidance on source water protection and sustainable water use	Provides appropriate funding for services and infrastructure (i.e. training of personnel and system upgrades)

<sup>a</sup>It should be noted that INAC has been dissolved as of December 2017.

<sup>b</sup>South of 60° represents the 60th parallel which constitutes the mainland boundary between the Northern Territories. South of 60° is therefore the provinces located south of the parallel such as Alberta, Saskatchewan, Manitoba and Ontario.

socio-cultural determinants of drinking water in these communities and incorporated into innovative MBAs.

### Tools for monitoring and assessment

Unlike the many resources available in large communities or urban centers, which are managed by municipalities, the necessary tools to support understanding and assessment of local water security, including communication and engagement, in Indigenous communities are scarce. Even in comparison to rural or remote communities, Indigenous communities have little or no indicators in place, and those developed are often derived from non-Indigenous frameworks and are therefore arguably non-transferable, as there is no 'one-size fits all' approach (Morrison *et al.* 2015). Efforts at improving or developing tools are hindered by the absence of a comprehensive national survey of water systems in Indigenous communities, making the issue difficult to quantify with inadequate evidence for action (Hanrahan *et al.* 2016).

Cultural practices in Indigenous communities are often supported by logical and dependable knowledge that has been developed through connections with the land and water, and subsequently passed on to future generations (Mauro & Hardison 2000). To Indigenous communities, this dependable understanding of the land and all interaction between humans and the earth is recognized as Indigenous Traditional Knowledge (ITK), Traditional Environmental Knowledge (TEK), or IK. A preliminary understanding of IK as it pertains to Indigenous practices is fundamental when addressing perspectives and attitudes of Indigenous people's relationship with water, as 'ceremonies, customary fishing, [gathering] and hunting practices and ways of teaching children and sharing [IK] are impacted when water is contaminated' (Human Rights Watch 2016).

The use of qualitative research in particular has been demonstrated to contribute to a holistic understanding through in-depth narratives provided by community experts, often cited as Elders and knowledge holders. For instance, Wilson *et al.* (2015) conducted semi-structured interviews with Elders in the community surrounding climate change and subsequent effects on water quality and distribution in the Yukon River, Alaska. They found that IK from Elders, in addition to quantitative methods, resulted in numerous beneficial contributions to the scientific understanding.

Specifically, in observations overlooked by scientific methods, Elder observations tended to precede changes in the environment as well as weather patterns (Sanderson *et al.* 2015). For example, in Nechako River Basin in British Columbia, Elders anticipated changes to river flow, overall water level, and prediction of a subsequent drought through observing water, rain, and snowfall patterns over several years. It was also found that IK offered new areas of inquiry previously not considered by WS and offered a sustainable complementary method for long-term observation of water quality patterns (Woo *et al.* 2007). However, historically, research methods have been constrained within WS, and even more so with an emphasis on the physical rather than social sciences that are embedded within positivism, hypothesis testing, and quantitative methods.

Due to the close relationship and spiritual connection Indigenous peoples experience with water and the land, incorporating IK as indicators for water security has the ability to benefit both researchers and communities (McGregor 2012; Sanderson *et al.* 2015). Many studies have been undertaken linking IK with various aspects of climate change in conjunction with WS to develop a deeper understanding. For example, Gearheard *et al.* (2010) sought to better understand changing wind patterns in Nunavut by successfully linking Inuit knowledge on the subject with historic meteorological station observations. Despite the value of IK, validation of this type of knowledge in WS is challenging, as some IK is sacred and not to be shared outside of communities (Matsui 2015).

Successful integration of IK has occurred in assessment of individual elements of water security. For example, two Indigenous communities in Saskatchewan were surveyed on key water quality indicators which were derived from conversations with community Elders (Sardarli 2013). Likert scale responses were converted to numeric values and used to develop a mathematical model. The model outputs, which included a formula for measuring water quality over time, were acknowledged and accepted by the community because of their significant inputs to the process. The successful model of water quality was reported to the administration of participating communities who pledged to refer to it in their negotiations with governmental institutions.

Similarly, Alessa *et al.* (2008) sought to develop the Arctic Water Resource Vulnerability Index (AWRVI) to

assess Indigenous community vulnerability and/or resilience to changes in their water resources. Recognizing that traditional values associated with water could be used as a strong indicator, they developed a single index based on IK, in addition to WS indicators. The authors quantified this as the number of Indigenous people 50 years of age or older in the community per capita. However, simply quantifying the number of Elders in the community does not capture their deep understanding of, and connection to, the land and waters and thus does not utilize the full potential of IK. Additionally, it does not take into account gender roles associated with IK, even though Indigenous women are fundamental to positive water stewardship (see above under 'Water and gender'). Sub-indices highlighting these gender roles would not only significantly strengthen water security tools, but foster support and engagement within participating communities.

Incorporation of IK is not the only indicator lacking in current community water security tools. Smith *et al.* (2006) conducted an extensive public health risk evaluation of 56 drinking water systems for Indigenous communities in Alberta. The evaluation components were developed in harmony with the WHO risk assessment categories. In addition to the fact that 50 out of 56 drinking water systems were found to be at high risk (defined as low quality drinking water system translating into higher public health risks), major challenges were identified with respect to the provision of meaningful training to Indigenous water management personnel. These personnel documented that the training often opposed their cultural beliefs, making it difficult to assume ownership or responsibility for the protection of water and health in the community, highlighting the significance of culturally specific and appropriate training for, and by, respected community members as well as the overall importance of true and equitable Indigenous partnership.

As previously identified (see above under 'Water from natural sources'), collection and consumption of water from natural sources has forever been, and continues to be, a common practice among Indigenous communities. Therefore, conservation of these natural sources is imperative to the Indigenous way of life. As such, tools that address SWP are critical in Indigenous communities and provide an opportunity to re-connect Indigenous people to their health and to the land, while protecting water quality

(Patrick 2011). Upon the realization in 2011 that 80% of Indigenous communities in Canada were not implementing a SWP plan because they do not fall within the boundaries of a Conservation Authority managing a watershed, INAC developed the On-Reserve SWP Guide and Template, informally referred to as 'the Guide', in an attempt to provide Indigenous communities with the tools needed to develop their own community-based SWP plan. While the template is detailed and allows a role for community leadership, broad adoption of the Guide is not feasible given communities are poorly resourced, often without the financial or technical capacity for implementation. Furthermore, to be as effective as possible, SWP plans should be basin wide rather than assuming political boundaries. However, this cannot happen effectively where Indigenous people do not fall under jurisdictional boundaries or have a voice at the table for discussion regarding water, water governance, and water safety and protection.

### Understanding, awareness, and action

Indigenous communities and agencies are pivotal to ensuring the appropriateness of tools and mechanisms in collaboration with government, for assessing, monitoring, and ensuring local water security. As such, they need to be assured of the capacity to assess and monitor local water security status and to maintain local infrastructure. It is critical to recognize that water security goes beyond providing guidelines and policies, as White *et al.* (2012) noted, '... standards are only as good as their implementation', highlighting the importance of enhancing social and human resources in Indigenous communities to enable sustainable water management for water security in a way that remains consistent with cultural principles, values, or practices. Moreover, it is the *act* of stewardship that realizes the responsibilities associated with rights, a practice that is strongly embedded in Indigenous cultures, as rights enable responsibility.

In recognition of the importance of strong community capacity for successful water management, Rizvi *et al.* (2013) developed a conceptual framework to assess the capacity of Indigenous communities to practice effective water management strategies. The authors address six different capacity types: actor network, information management, human resources, technical, financial, and institutional, each with

varying sub-indices. Evaluation was completed using qualitative interviews with community members and subjectively categorizing responses as 'capacity present' or 'capacity absent'. However, the indicators employed were not identified and/or developed by Indigenous communities, and thus neither individuals nor communities are properly represented in the outcome(s). This is a significant limitation of this research, and speaks of the need for co-creation and collaboration.

Similar research by [Lebel & Reed \(2010\)](#) sought to evaluate the capacity to provide safe drinking water of an Indigenous community in Montreal Lake, Saskatchewan. Six dimensions of capacity similar to those explored by [Rizvi \*et al.\* \(2013\)](#) were assessed: financial, human resource, institutional, social/political, and two forms of technical (piped distribution system or truck haul system). The authors then developed indicators for each capacity element and formulated questions based on these indicators for evaluation purposes. For instance, financial capacity was assessed by the question 'funding is available for operation and maintenance' and all indices were answered by a simple dichotomous scale. Likewise, the framework applied was derived from non-Indigenous communities and lacked key elements such as IK, community attitudes and beliefs surrounding water, and the recognition and protection of First Nations water rights, all of which impact water security.

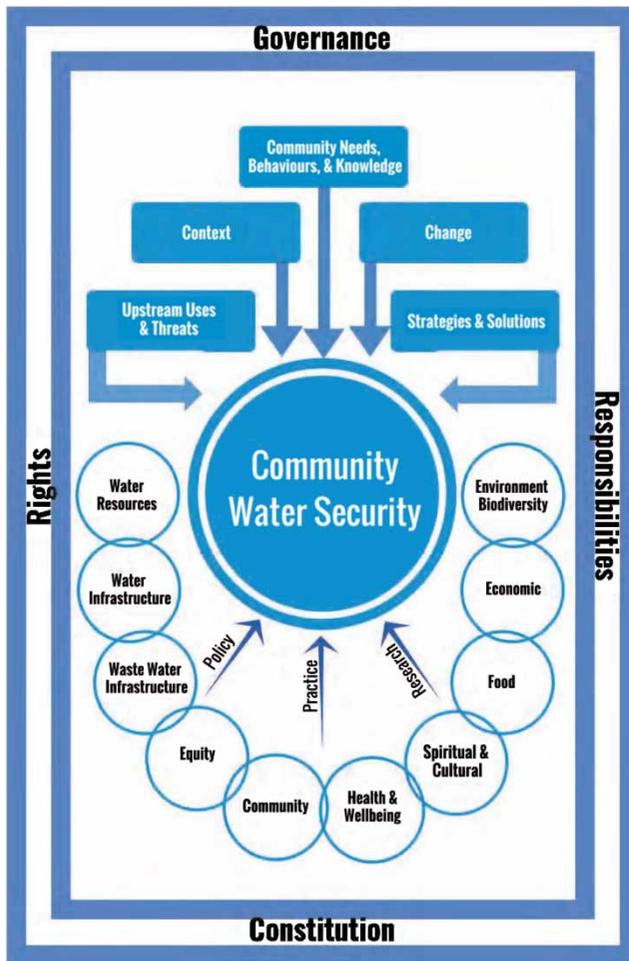
Building on the construct that social determinants and human capacity are strong indicators of local water security status ([White \*et al.\* 2012](#)), [Maxim \*et al.\* \(2001\)](#) developed the Community Capacity Index (CCI) for evaluation of these capacities within Indigenous communities. The purpose of the CCI is to predict whether programs developed in non-Indigenous communities will be successful in Indigenous communities. Overall, the CCI was able to predict the kind of shortfall that would exist and also indicate what preparatory action may be necessary. The CCI recognizes diverse characteristics of Indigenous communities by breaking down human and social components into sub-indices that hold a point value. This type of index has the ability to predict the failures that may occur when programs or policies, which were not developed primarily for Indigenous communities, are implemented. These indicators are extremely relevant in the current context where the majority of water-related policies and programs in Indigenous communities were originally developed for non-Indigenous counterparts.

From a process perspective, water security tools need to incorporate an assessment of community capacity to implement, operate, and maintain procedures, processes, and tools designed to enhance water security and therefore better enable the realization of local water security. To prevent misrepresentation, community engagement is required during essential stages of discussion and identification of issues, as well as through tool development, such as primary indicator development and knowledge sharing. It is only when community capacity increases that sustainable water management can be achieved. The solutions to the water crises faced by Indigenous communities are not straightforward; that is, there are no 'quick fix' approaches. Investing adequate time and resources into ensuring that Indigenous communities are engaged, their voices are heard, and a sustainable solution is achieved, is pivotal to success. This type of long-term engagement is echoed in the federal government's pledge to end all DWA by March 2021, acknowledging that a sustainable solution requires several years of collaboration and capacity building.

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## A PATH FORWARD

Local community water security is considered a comprehensive concept that examines and integrates direct and indirect physical, social, economic, and health and wellbeing elements ([Schuster-Wallace & Dickson 2017](#)). An IRS ([Figure 1](#)) is presented that outlines the interconnected and multidimensional factors that influence, and ultimately determine, a water secure community. The IRS should be an essential step towards a comprehensive understanding of water challenges in order to move beyond a WS approach and allow for more appropriate and effective strategies and tools to be developed. For example, water has both direct and indirect impacts on health, while climate change, land development, population dynamics and migration, agriculture, industry, and unsustainable economic growth are increasingly contributing to the global degradation of water resources and therefore water insecurity. Access to potable water is a key element for safeguarding health and wellbeing, and water and waste water infrastructure are critical features in the provision of safe drinking water. Proper treatment, maintenance and regulations are measures to decrease the



**Figure 1** | Integrated Research Strategy (Source: Tools for Water Security in Indigenous Communities Workshop).

likelihood of waterborne illness and thus a water secure community. Additionally, sustainable water-related economic activities can provide significant benefits to communities as well as support local water and food security.

It is crucial to engage in co-created research that is meaningful to Indigenous community members and the entire society in which they live. Elements of water security are all heavily influenced by external factors, which include upstream uses and threats, the current and historical contexts that have shaped water perceptions, community needs, behaviour and knowledge, and strategies and solutions that have been implemented to date (Figure 1). Each must be considered in the framing of local water insecurity and therefore the development of tools and metrics to understand and assess water status. In doing so, the reactive

approach of treating the end product, i.e. DWA in response to adverse water quality, remains grossly inadequate and new tactics must be undertaken.

Finally, constitution and governance represent the multi-level (through local to international) structures overarching the process of achieving a water secure community (Figure 1). Rights and responsibilities represent the fundamental human and cultural needs to be met and the recognition that these rights also confer obligations to respect and steward water. Indigenous rights have been at the center of national, regional, and international decisions over the past several decades. Realization of local water security will only be found through woven knowledge systems, partnerships, dialogue, and collaboration that begin and end with Indigenous communities themselves. Without SWP and appropriate resources, proper construction, maintenance, and operation of water infrastructure in Indigenous communities and the integrity of the ecosystems that we all depend on will not be achieved or sustained.

In order to achieve local water security in any community, it is essential to understand the status of, threats to, resources for, and opportunities existing for local water security investments. It is clear from the literature reviewed that most, if not all, Indigenous communities in Canada fall short in at least one of these aspects. Therefore, addressing these complexities must be predicated on the following:

- The equitable engagement of both IK and WS through complementary multi-disciplinary research methods, participatory approaches, scientific methods, and cultural approaches that build upon a strong community-based research partnership.
- Weaving evidence from both knowledge systems into a comprehensive solution for local water security. This calls for a re-framing of important elements for local water security that moves beyond WS-identified elements (i.e. status of water resources and infrastructure).
- The development of new community-based Indigenous assessment tools that allow for the articulation and prioritization of indicators and tool elements by communities themselves to reflect both IK and WS perspectives local water (in)security.
- Appropriate technologies and other solutions that address local water insecurity.

These are fundamental to creating sustainable and meaningful change that can be owned by communities and which enables them to (re)claim their water stewardship roles through the incorporation of Indigenous values that have historically driven community decisions and actions. Building on this cohesive and integrative understanding and assessment of water security at the local scale, it should be possible to: (i) identify and understand the entities that directly contribute to local water (in)security; (ii) collaborate across parties; and (iii) prioritize, develop, and implement appropriate actions to improve Indigenous local water security. In doing so, it is possible to help provide a deeper, more meaningful understanding of the critical importance of water for Canadian society in general.

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