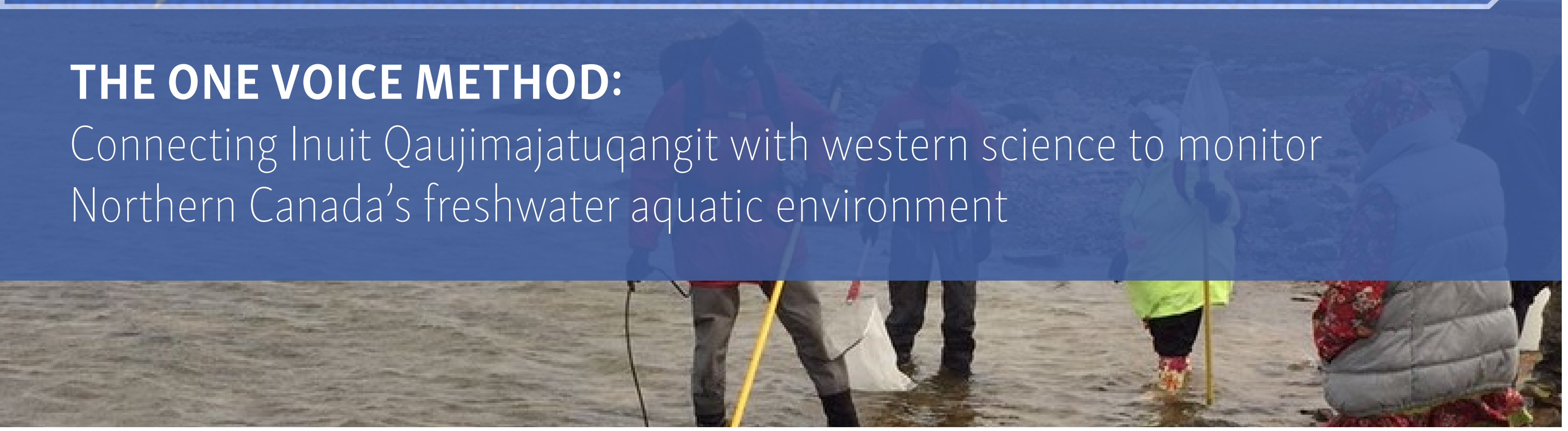

THE ONE VOICE METHOD:
Connecting Inuit Qaujimajatuqangit with western science to monitor Northern Canada's freshwater aquatic environment

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Abstract

Links between the Inuit Qaujimajatuqangit (IQ) and western science knowledge systems were explored through a series of modified semidirected interviews with knowledge holders, which were led by a "curious scientist" asking targeted questions to determine intersections for select water quality observations. Three iterative interviews were held, the last of which was on the land at sites identified by knowledge holders as having consistently high- or low-quality drinking water. Concurrent water quality sampling by the scientist helped establish a subset of analytes as common indicators that characterize the aquatic environment between the two knowledge systems. These common indicators can be used to establish baseline conditions, evaluate the impact of stressors, refine aquatic monitoring programs to better address community concerns, and produce a more holistic characterization of the aquatic environment, using both approaches.

Résumé

Les liens entre l'Inuit Qaujimajatuqangit (IQ) et les systèmes de connaissances scientifiques occidentaux ont été explorés au moyen d'une série d'entrevues semi-dirigées modifiées avec des détenteurs du savoir, menées par un « scientifique curieux » qui posait des questions ciblées pour déterminer les intersections pour certaines observations de la qualité de l'eau. Trois entrevues itératives ont été menées, la dernière ayant eu lieu au sol, à des endroits que les détenteurs du savoir considèrent comme ayant toujours de l'eau potable de qualité élevée ou faible. L'échantillonnage simultané de la qualité de l'eau par le scientifique a aidé à établir un sous-ensemble d'analytes comme indicateurs communs qui caractérisent l'environnement aquatique entre les deux systèmes de connaissances. Ces indicateurs communs peuvent être utilisés pour établir les conditions de référence, évaluer l'incidence des facteurs de stress, peaufiner les programmes de surveillance aquatique afin de mieux répondre aux préoccupations des collectivités et produire une caractérisation plus globale du milieu aquatique, à l'aide des deux approches.

Introduction

The livelihood of Canada's Indigenous populations is historically rooted in an intimate understanding of the natural environment. Recognition of that unique and comprehensive understanding of the local environment has been penetrating Canada's environmental legislation, policies, and practices for the past two decades (Usher 2000; CEAA 2012). For example, the Canadian Environmental Assessment Act requires the consideration and incorporation of Indigenous knowledge to facilitate a more complete characterization of large-scale development impacts (CEAA 2012). More recently, the Canadian federal government has introduced new environmental legislation that increases the obligation to consider the rights and knowledge of Indigenous people (i.e., Bill C-69 *An Act to enact the Impact Assessment Act and the Canadian Energy Regulator Act, to amend the Navigation Protection Act and to make consequential amendments to other Acts*).

While Indigenous knowledge is a required component of environmental impact assessments (EIAs), there is a wide but inconsistent variety of guidance on how it should be considered in conjunction with western science approaches that are the foundation of EIA (Bartlett et al. 2015). This problem is exacerbated by the typical framework through which the knowledge is collected. Semidirected interviews and consultations are relied on to gather the community's input on valued ecosystem components (VECs), but rarely do interviewers ask necessary follow-up questions to ensure the environmental information underlying the experiences and anecdotes offered by interviewees are adequately explored to provide details and context (Usher 2000). In addition, collecting information according to VECs is a western approach. Indigenous participants will repeatedly tell you that they do not see the world that way. Their view is holistic and cannot be separated into pieces (Legat 2012, Berkes 1998). VEC identification is embedded in practice and works somewhat effectively for wildlife, but falls short for less tangible VECs like water quality, which is rarely evaluated in its own right. In spite of the right to "no substantial alteration" accorded to water quality in Article 20 of the Nunavut Land Claims Agreement (NLCA 1993), EIAs on record frequently report impacts to water quality only in terms of implications to human health or effects on aquatic biota. The critical follow-up questions to explore water quality as an attribute in its own right have historically been left unasked, as interviews are led by IQ specialists or other professionals without a specific background in water quality. The lack of water discipline experience has allowed key descriptors of the aquatic environment to be overlooked, resulting in text akin to "no water quality information was specifically noted" (Sabina 2015), when in fact, the absence may reflect not the lack of information but the lack of appropriate questioning. Water quality is identified as a VEC through IQ, but without further detail its incorporation into environmental monitoring datasets and project design specifications is precluded. Western science has therefore remained the focus when evaluating project effects, even in jurisdictions like Nunavut where environmental co-management is integral to the assessment process, as mandated by the Nunavut Impact Review Board (NIRB 2016).

The overarching objective of this project was to address this deficit through the development of an approach to bring IQ and western science into One Voice to monitor the aquatic environment. This was accomplished through a series of semidirected interviews uniquely led by an aquatic environmental scientist with local experience around the community supported by Inuit researchers.

Methods

Three separate interviews were held from 2015 to 2017 with Inuit Elders[1] and hunters from Baker Lake, Nunavut, as part of the Innu'tuti program in the Baker Lake watershed. The study area was confined to the local watersheds near Baker Lake, as local Inuit engage in traditional land uses in proximity to the community. These watersheds are not pristine, but rather, are under some stress from operating gold mines, community sewage and garbage disposal, and climate change. Alterations

1 Elders were selected by the KIA and identified as respected members of Baker Lake with significant knowledge pertaining to the aquatic environment. They ranged in age from 41 to 90 years old. DOI: 10.xxx

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POLAR KNOWLEDGE Aqhaliat

Table 1: Iterative interviews with progressively focused objectives for One Voice study — water quality component.

	Year 1: 2015-2016	Year 2: 2016-2017	Year 3: 2017-2018
Objectives - Water Quality	Identify key VECs in the aquatic environment and traditional Inuit uses associated with each.	Confirm key Inuit uses associated with each VEC in the aquatic environment and the associated IQ measurement indicators.	Simultaneously collect visual and physicochemical measurements along with observations of IQ knowledge holders for each VEC associated with a key Inuit use of the aquatic environment.
	Determine IQ indicators used to evaluate the quality of each VEC in the aquatic environment.	Refine IQ measurement indicators of the aquatic environment and determine overlap with measurable western science – "common indicators" between the two knowledge systems.	Correlate measurements collected by each knowledge system to determine how measurements collected by one is represented by the other.
	Identify conceptual thresholds for continuation of each use.	Identify characteristics of water and fish that are desirable and undesirable, and the locations where they occur.	Define characteristics of water representing normal conditions, and those indicating degradation or a divergence from them. Identify the IQ thresholds for discontinuing traditional uses of the aquatic environment.

to these watersheds have been taking place since the advanced exploration stage for the Meadowbank Mine in the early 2000s and the onset of a warming climate in the 1950s (Medeiros et al. 2012).

The interview approach was modified from *Voices from the Bay*, following a semidirective style (McDonald et al. 1997). Fixed questions were posed to knowledge holders with the support of local translators. Follow-up questions were posed during the interviews if responses hinted at descriptors of physicochemical water quality properties or were too broad, and required prompting by a "curious scientist" to gain further information. This water-quality-focused departure from the standard semidirected interview garnered additional detail from interviewees to establish more tangible linkages between reported observations and measurable western science variables. Iterative interviews were conducted with progressively focused objectives (Table 1). Parallel programs were conducted for the fish health and water quantity VECs, but insufficient data (scientific and IQ) was generated through the current study for inclusion in this discussion. Future investigations have been proposed to collect the requisite data.

Initial exploratory individual interviews in Year 1 (November 2015) were held with ten male knowledge holders and included general discussions on water quality, quantity, and flow (as per the Inuit rights to an unaltered aquatic environment under the 1993 NLCA) and the use of fish, waterfowl, and insects as aquatic indicators. Interviews in Year 2 (January 2017) included eight men from Year 1 and four women to better capture possible gendered differences. Questions were intended to confirm conclusions from Year 1; explore traditional land uses linked to the aquatic environment, with a focus on water quality, fish, and transportation; and refine the hypothesized IQ thresholds. Maps at a 1:85,000 scale depicting the terrain within a 50 km radius and a 100 km radius around the hamlet of Baker Lake were provided to participants to geographically focus discussions on the most frequented locations. Locations that interviewees indicated as having consistently high or low water quality were recorded in preparation for field investigations in Year 3. Interviews in Year 3 (August 2017) were held on the land with individual or pairs of knowledge holders; all were participants in the previous years of the program. Nine locations with high-quality water previously indicated and four locations with low-quality water indicated were visited. At each location, interviewees were asked to identify the site as having high or low water quality and describe the taste, look, smell, mouth feel, and overall impression of the water. Water samples were collected concurrently

Table 2: Inuit traditional water uses and IQ-based thresholds of environmental change.

Valued Ecosystem Component	Inuit Use	IQ Thresholds of Environmental Change
Water Quality	Hot beverages (tea, coffee)	Water is no longer acceptable for consumption or washing. This threshold may be based on taste, sight, smell or perceived impairment. Thresholds may also differ with season and differ with uses*.
	Drinking water	
	Cooking water	
	Washing	
Water Quantity	Transportation by boat	Changing methods of transportation and altered route access, or reduced safety.
	Access to traditional routes	
Fish and Fisheries	Harvesting fish	Significant decline in catch per unit effort.
	Consuming fish	Undesirable size, condition, fat content or appearance.

*e.g., Saline water is seen as undesirable for drinking water, but is desirable for boiling fish or caribou as it helps season the meat.

for laboratory analysis. Analytes were chosen to assess the organoleptic[2] microconstituents highlighted by interviewees. These analytes were assessed in the field (dissolved oxygen, electrical conductivity, pH, and water temperature) and laboratory (alkalinity, total suspended and dissolved solids, turbidity, major ions, nutrients, total and dissolved organic carbon, and total metals).

Results and discussion

Interviewees consistently identified three characteristics associated with the freshwater aquatic environment: water quality, water quantity, and fish/fisheries (Table 2). Interviewees were consistent in reporting key uses for each, the normal and usable environmental conditions required for those uses, and the conditions signalling environmental concerns. This finding is consistent with the findings of McDonald et at. (1997), that Inuit had a clear image of what were normal environmental conditions and what revealed abnormalities. The point at which a land user consciously acknowledges that environmental conditions have deviated from normal conditions is considered the IQ threshold of change (Table 2).

Interviewees used organoleptic and physicochemical characteristics to evaluate whether water was acceptable for consumption or other uses. Follow-up questions delved into the responses of knowledge holders, eliciting detailed descriptors of the water quality that could potentially be linked to scientific indicators. These "common indicators" are outlined in Table 3. Although similar terminology has been recorded in other studies conducted in Canada's North (Goldhar et al. 2013), they were not linked to organoleptic microconstituents measurable through western science.

The most desirable waters were those flowing over rocky substrates (Fig. 1c), and were described as being deeper (i.e., greater than 3 m), clear, cool, and "refreshing," and having "no taste, no smell" (Thomas Iksariq: personal communication). Interviewees in other studies specified a preference for water from familiar sources (Goldhar et al. 2013). Spence and Walters (2012) suggested this was due to a history of demonstrated safety at a given location from ongoing community usage and habituation to a given organoleptic profile. This was confirmed in the present study through evidence of frequent use at sites with high-quality drinking water; interviewees pointed out kakivaks (spears with three prongs for catching fish) and kettles left nearby for future use, as well as cabins of Baker Lake residents (Fig. 1a, 1b). We note that this observation is not generalizable to other communities; water quality in proximity to small human developments may be seen as less desirable in other contexts. This highlights the importance of collecting community-specific information when evaluating the perceived

2 *Organoleptic microconstituents act on or involve the interviewees' sense organs. Specific to this study, organoleptic microconstituents acted on interviewees' senses of taste, sight, smell, and touch (mouth feel).*

Table 3: Common indicators between IQ and western science to evaluate freshwater quality.

Taste and smell	Taste of "land"	Organic carbon	pH
		Conductivity	Nutrients
		Chlorophyll a	
	Saltiness	Salinity	Chloride
		Sodium	Hardness
		Alkalinity	Conductivity
	Fishy smell	Specific algal community	Chlorophyll α
		Nutrients	
	Water is "refreshing"	Total suspended solids	Total dissolved solids
		Salinity	Conductivity
		Chloride	pH
		Turbidity	Hardness
		Copper	Iron
		Manganese	Sodium
		Flow	Oil and grease
Water temperature	Assessment of water temperature by touch or taste	Water temperature	

safety and risks of a water source.

Sites with high-quality water were grouped into two categories based on taste profiles. The water at some sites had no taste while others had water with some taste, though their descriptions ranged broadly between interviewees and sites. For example, some water tasted like "there's more rocks around the area" (James Kalluk: personal communication) while water at other sites had a "strong taste of vegetation" (Jamie Seeteenak: personal communication). Interviewees had difficulty describing the specific profile at several sites where taste was noted. Similar observations appear in the literature, whereby even trained tasters consistently report a perceptual characteristic from the combined effect of the microconstituents, but have difficulty articulating the taste profiles (Burlingame et al. 2017). Specific reported tastes are further complicated by individual sensitivities as well as the sex, age, health, and smoking history of an individual (Burlingame et al. 2017). Sites with a reported taste had a greater concentration of total dissolved solids and a higher proportion of parameters (particularly organoleptic parameters such as calcium and sulphur) at detectable concentrations than those without taste (Fig. 2a, 2b). Of the other analyzed microconstituents, no specific parameter was consistently higher across those sites; the data has not been summarized here.

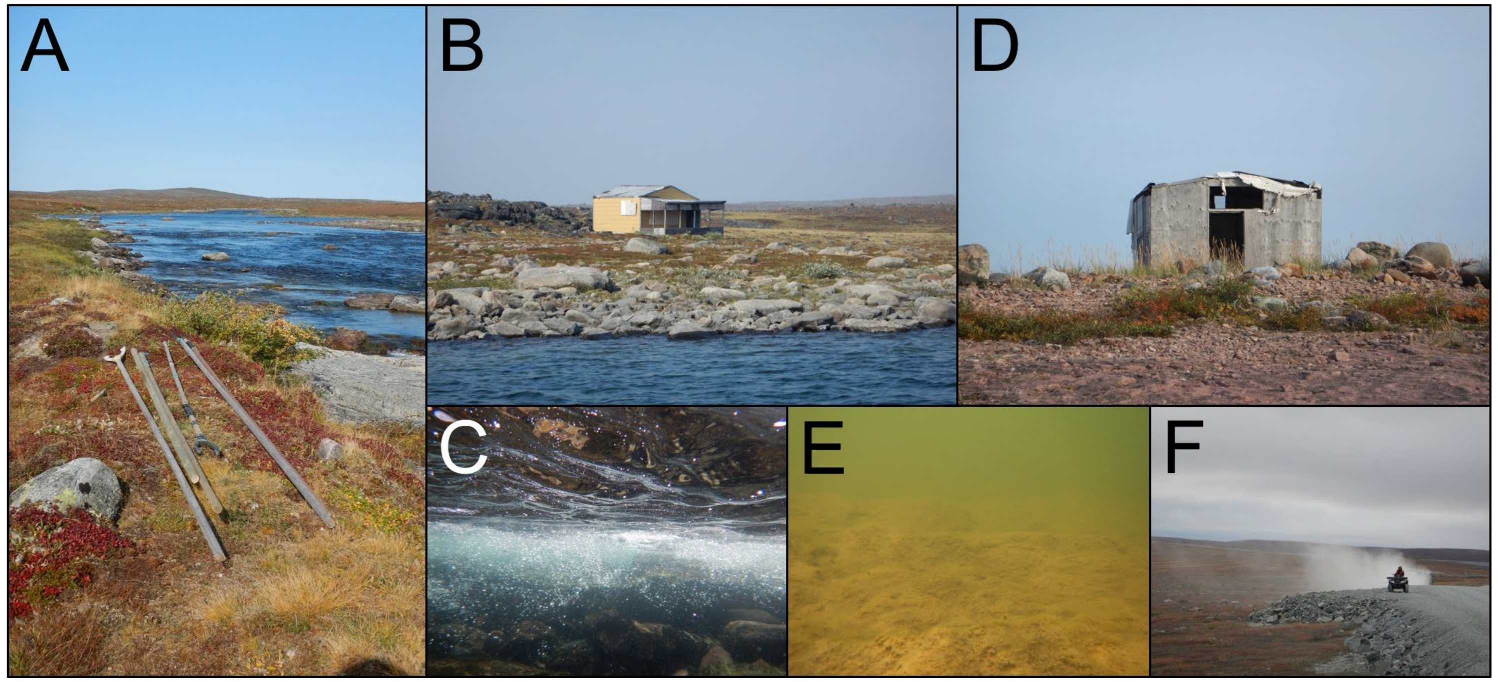

Figure 1: Photographs of sites with high-quality water (a, b, c) and low-quality water (d, e, f).

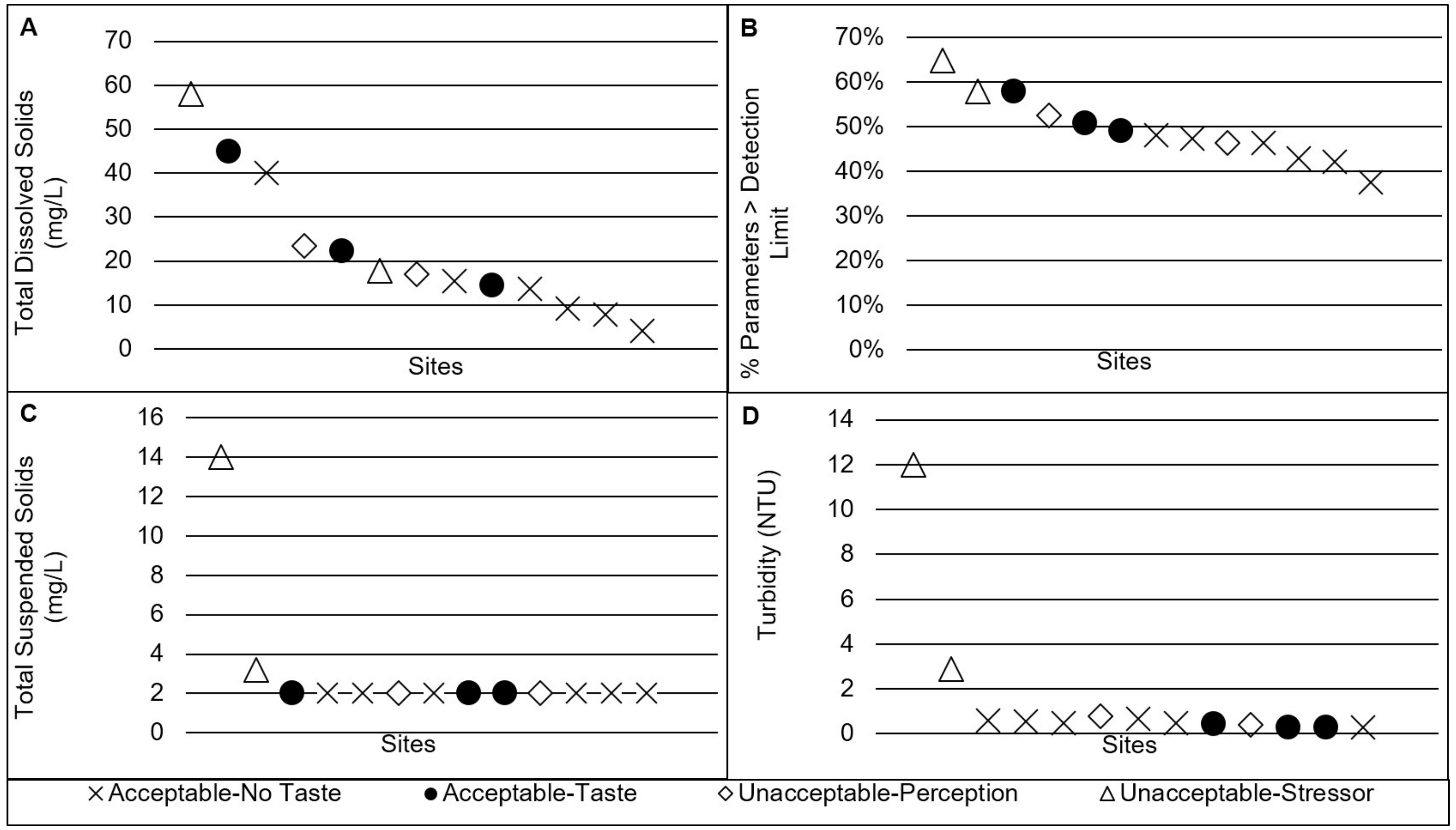

Figure 2: Water chemistry results from samples collected, concurrent to IQ interviews: (a) total dissolved solids, (b) percent of parameters above the detection limit, (c) total suspended solids, and (d) turbidity. Site categorizations are consistent across the figure.

Of the sites interviewees preferred not to drink from, two were turbid: "the murkier, the less you want to drink it" (Thomas Iksariq: personal communication; Fig. 1e). These two sites had the highest turbidity and total suspended solids, indicating participants were able to discern concentrations as low as 2.89 mg/L (Fig. 2c, 2d). These sites also had the greatest percent of parameters above the detection limit (Fig. 2b). Two other sites were identified as undesirable because of proximity to human activities; one site was in proximity to a disused cabin (Fig. 1d) while the other had inflows from a headwater area in which domestic sewage and garbage were dumped. These sites had visually pristine water (clarity did not differ from the acceptable sites), but interviewees had pre-existing knowledge indicating the water might be contaminated upstream. This is consistent with other studies where the knowledge of land uses near a water source influenced the perception of current safety (de França Doria 2010). In the latter example a dusty mine road (Fig. 1f) could be seen from the site close to the disused cabin, but the site was beyond the range of the dust fall (AEM 2017), while a sewage lagoon was associated with the other site, even though water was not flowing at that time (Fig. 1c, 1d).

Conclusions

Historical qualitative observations on the land can serve as a sentinel for change and impacts on the aquatic environment. Interviewees were sensitive to changes in taste, smell, mouth feel, turbidity, and temperature. While reports of such change . cannot be used to determine the magnitude of a change or the microconstituents involved, these reports can signal a shift in water chemistry and flag locations for future detailed analysis. Changes in proximity to land use can meaningfully impact people's use of the aquatic environment, regardless of whether that change is intermittent or having a measurable impact. Perceived changes in the environment as well as measurable changes in water quality may alter Inuit behaviour on the land, and should be considered as a real impact of development when conducting an environmental assessment and making land use decisions.

While the results are preliminary, Inuit knowledge of their water sources and their ability to describe the relevant characteristics in terms of preferred taste, smell, mouth feel, temperature, and appearance set a foundation for improved quantification using IQ and western science together in One Voice. If future work can identify an IQ-based threshold of change in the measurable perceptual characteristics of water, then such changes could be considered as quantifiable inputs to the environmental assessment process, with direct relevance to Inuit land use.

Community considerations

Community assessment of the common indicators is intended to empower Nunavummiut to evaluate the impact of stressors on their local aquatic environment, provide meaningful input to aquatic monitoring and contribute to a more holistic characterization of the valued ecosystem components.

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