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# Climate change, water, and human health research in the Arctic

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ABSTRACT

We reviewed the nature, range, and extent of literature on drinking water and human health outcomes in the context of climate change in the Circumpolar North. We used a systematic process to identify and synthesize articles. While the number of climate-water-health articles increased recently, this topic remains under-studied despite the transformational changes that the Circumpolar North has already experienced due to climate change. Of the climate-focused articles, most considered climate change to a major extent and discussed waterborne infections. Research examining and evaluating adaptation options and future impacts at the climate-water-health nexus is absent in the Circumpolar North. Responding to this research gap should become a top priority for research, given the urgent need for this evidence to inform climate change policies, actions, and interventions.

## 1. Introduction

The Arctic is experiencing the fastest warming on the planet [1–2], resulting in transformational changes to water systems with important implications for human health [1]. The Circumpolar North landscape is characterized by vast low-lying permafrost areas which limit surface water drainage, creating shallow lakes, ponds, streams, and wetlands [1,3]. Climate change continues to impact these water systems, including water quantity and quality impacts. Examples of climate change impacts on water quantity include changes due to melting glaciers, changing seasonal precipitation, increasing river flows and increasing groundwater contributions to these flows, thawing permafrost that impacts groundwater flow into streams and rivers, and increasing evapotranspiration [1,4–6]. Changes in surface water quantity varies regionally across the Circumpolar North; for instance, lakes in continuous permafrost zones have increased in size and number, and are projected to continue to increase in area by over 50% by 2100 under RCP8.5; however, lakes in some discontinuous permafrost zones have decreased or disappeared [1,4]. In terms of climate change impacts on water quality, lowland areas have been flooded with salty ocean water during storms, chemical contaminants that were stored in the environment are being released into water sources, permafrost thaw and erosion have increased water turbidity, runoff has decreased in non-glacial watersheds and winter river discharge has increased in other regions, water temperatures have increased, and the occurrence and/or emergence of microbial contaminants has increased [1,4,6–8]. These climate change impacts on Circumpolar water systems have important impacts on drinking water availability and safety for northern residents [1,9–11], especially since most Circumpolar communities rely on surface water for drinking water [12].

These climate change risks to drinking water are compounded by existing water treatment infrastructure challenges related to extremely cold climates, rural and remote locations of many communities, often relatively smaller population sizes than southern locales, and often limited resources [6,10,13–14]. As such, in many communities in the Circumpolar North, surface water often undergoes basic primary treatment (e.g. chlorination) and is either piped under- or above-ground to houses or is trucked to houses. As such, heavy rainfall, rapid snowmelt, and high impact weather events, as well as climate-related events that increase water turbidity, can overwhelm water treatment infrastructure that is intended to protect public health [4,14–15]. Furthermore, while most northern residents have access to treated tap water, the practice of drinking untreated water (e.g. from lakes, ponds, rivers, melted snow or ice) in the Circumpolar North is not uncommon [10,13,16–17]. This practice is particularly prevalent when northern residents are on the land visiting cabins, hunting, fishing, trapping, and gathering [10,16–18]. In addition, many northern Indigenous peoples prefer untreated water over treated drinking water, which often stems from personal and cultural preferences and norms [17,19–20]. As such, some households collect untreated water in containers and bring it back to the community for later consumption [10,16–17,21–22]. The safety of this practice is increasingly challenged by intensified environmental change in hydrological systems, increased turbidity, and increased and/or emergence of microbial and chemical contaminants [10–11,14].

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These direct and indirect climate change impacts on drinking water quantity and safety have important implications for waterborne diseases. Drinking, bathing, washing, or eating food exposed to contaminated water can result in waterborne diseases and outbreaks that range from mild and self-limiting to life threatening illnesses. Climate change is anticipated to exacerbate an already high burden of waterborne disease in the Circumpolar North [4,14,23–24]. Indeed, some of the highest rates of self-reported acute gastrointestinal illness in the global literature occur in the Circumpolar North, with drinking water identified as a risk factor [14,25–27].

While narrative reviews have synthesized information about climate change and northern water systems [3], northern water systems and waterborne disease [28], or global water systems and health [29], fewer reviews have examined where these topics intersect. Therefore, considering the often transformational climate change impacts on water systems, the vulnerability of drinking water to climate change, and the existing high burden of waterborne disease in the Circumpolar North, this literature review examined trends in the nature, range, and extent of published literature on drinking water and human health outcomes in the context of climate change in the Circumpolar North.

## 2. Methods

A scoping review approach was used to systematically and transparently identify, select, and synthesize articles using replicable methods [30–31]. Scoping review methods are used to examine trends in the extent, range, and nature of published literature, particularly when the evidence base is emerging, large, complex, and/or heterogeneous in nature. Scoping review methods are particularly useful in quantitatively mapping broad topic areas to identify gaps in research, clarify concepts, and report on the types of evidence available to inform practice [31]. The scoping review approach included four steps: (i) identifying the research question; (ii) systematically identifying and selecting relevant articles; (iii) extracting and charting information from each article; and (iv) summarizing, analysing, and reporting results [32–33].

### 2.1. Search strategy

A search string was developed in consultation with a research librarian at the University of Guelph. The search string included terms for drinking water, human health, and the Circumpolar North (Table 1). The search string was used to search PubMed® and Web of Science™ aggregator databases. The initial search was conducted on January 9, 2017 and updated on January 14, 2019. To confirm the sensitivity of our search strategy, two journals (*Journal of Water and Health* and *International Journal of Circumpolar Health*) were hand-searched for relevant articles. The searches were restricted to articles published this century (January 1, 2000 to December 31, 2018), but were not restricted by language. Citations were downloaded to Mendeley® (Elsevier, Amsterdam, Netherlands) reference manager, where duplicate citations were removed. Then, citations were exported to DistillerSR© (Evidence Partners, Ottawa, Canada) to facilitate article screening and data extraction.

### 2.2. Inclusion criteria

Inclusion criteria were developed *a priori*. Articles were eligible for inclusion if they described primary/secondary research that examined drinking water and human health in the Circumpolar North and were published this century (2000–2018) (Fig. 1). For the purposes of this review, drinking water included reference to any source of fresh water used for drinking. Human health outcomes included relevance to physical, mental, and/or social health. The Circumpolar North included countries identified by the University of the Arctic [34]. Within these countries, specific cities, regions, and communities were chosen according to the Arctic or Subarctic Köppen-Geiger climate classification system [35].

### 2.3. Article selection process

A two-stage process was used to select relevant articles (Appendix A). In the first stage, the title and abstract of each article was reviewed for relevance based on inclusion criteria using a stacked screening form. Titles and abstracts were screened by one reviewer, and a second independent reviewer confirmed the exclusion of the article. Then, potentially relevant articles proceeded to the second stage of review, where the full text of the article was reviewed for relevance by two independent reviewers. Disagreements between reviewers were resolved via consensus. The level of agreement between reviewers was evaluated using Cohen's Kappa value [36].

### 2.4. Analysis

Our analysis focused on charting and mapping overarching trends in the climate, water, and health literature in the Circumpolar North. Specifically, our analysis was comprised of two steps. First, we examined the extent to which climate change is considered in the broader water and health literature in the Circumpolar North (results presented in Section 3.1). As such, articles did not have to include climate change content to be included in this review. This enabled us to calculate the proportion of water and health-related articles that included climate change considerations in the literature base (i.e. number of articles with climate change considerations divided by the number of all water and health-related articles in the Circumpolar North), and how these proportions changed over time, by region, and other attributes.

Second, the articles that included climate change considerations were examined in-depth (results presented in Section 3.2). Articles were categorized as explicitly considering climate change to a major extent if "climate change" or "global warming" was included in the title, objectives, methods, and/or results of the paper. Articles were categorized as explicitly considering climate change to a minor extent if "climate change" or "global warming" were included in the introduction and/or discussion, but not incorporated into the objectives or methodology of the study. Finally, articles were categorized as implicitly considering climate change if climate-related or sensitive factors (e.g. shifts in seasonal patterns and temperature) were discussed without explicit use of the terms "climate change" or "global warming."

To facilitate this analysis, a data extraction form (Appendix B) was

**Table 1**
Search string used to search PubMed® and Web of Science™ databases for published articles about drinking water quality and human health outcomes in the Circumpolar North.

| Category | Terms |
|---|---|
| Water | (water OR waters OR freshwater OR waterborne) |
| | AND |
| Human Health | (health OR healthy OR disease OR disorder OR illness OR wellness OR "well being" OR wellbeing OR mental OR social OR morbidity OR mortality) |
| | AND |
| Circumpolar North | (Circumpolar OR Alaska OR Denmark OR Greenland OR Iceland OR Norway OR Sweden OR Finland OR Scandinavia OR Russia OR Inuvialuit OR Yukon OR "Northwest Territories" OR NWT OR Nunavut OR Nunavik OR Quebec OR Nunatsiavut OR Labrador OR Arctic OR Subarctic) |

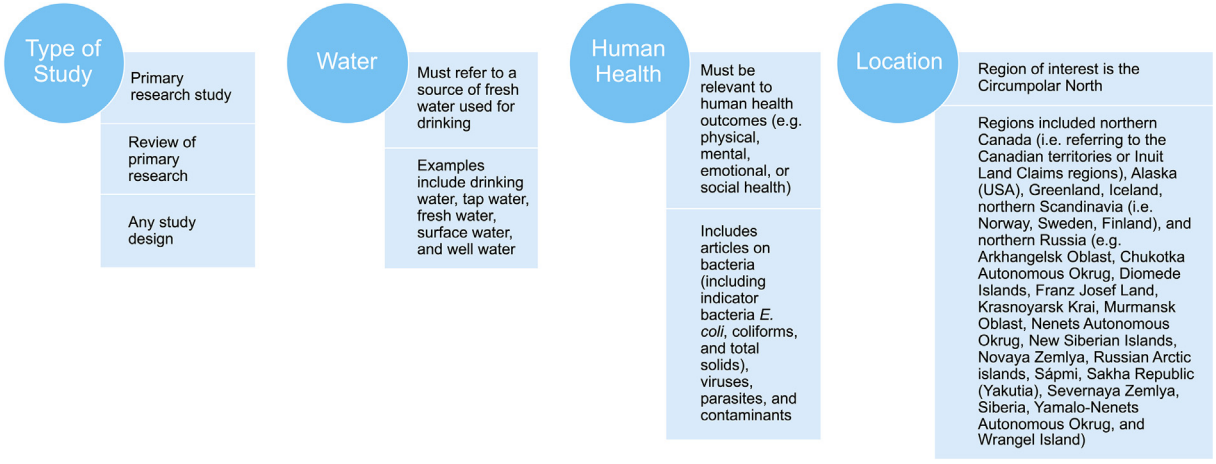


**Fig. 1.** Inclusion criteria used to select articles on drinking water quality and human health outcomes in the Circumpolar North.

created and used to obtain information from each article using DistillerSR©. For literature reviews, only the research topics were recorded. For primary research articles, extracted data were analysed using descriptive statistics, including chi-square tests and logistic regressions. Analyses were conducted using Stata® 13.1 (StataCorp, College Station, TX, USA) and graphs were generated using Microsoft® Excel 2016 (Microsoft Corporation, Redmond, WA, USA).

## 3. Results

The initial search identified 6,826 articles. After screening, 74 articles met the inclusion criteria and were analysed (Fig. 2). The level of agreement between reviewers was "good" [36], with a Cohen's kappa statistic of $\kappa = 0.83$ for first-level screening, and $\kappa = 0.75$ for second-level screening.

### *3.1. To what extent is climate change covered in the water and health literature?*

#### *3.1.1. One third of water and health articles considered climate change*

Of the 74 articles on water and health in the Circumpolar North, approximately one third (n = 25 articles; 33.8%) of the articles assessed or made reference to climate change (Table 2), with a higher number of climate-focused articles published in more recent years (Fig. 3). There was no clear trend in the proportion of water and health articles that considered climate change over time; however, the proportions were highest from 2015 to 2018. There were seven literature reviews and 67 primary research articles. Of the literature reviews about water and health in the Circumpolar North, all but one article considered climate change (n = 6/7 articles).

Of the 67 primary research articles that examined water and health, 19 considered climate change (28.4%). While the water and health literature was dominated by quantitative research methods (n = 51 articles; 76.1%), the articles relating to climate change were more evenly distributed among study designs (Fig. 3). In primary research articles, methodological approach was associated with whether the article examined climate change: qualitative studies had 10.98 times greater odds of considering climate change compared to quantitative studies (p = 0.01). Of the articles that considered climate change, 31.6% used participatory methods (n = 6 articles); however, participatory methods were not used in any of the articles that did not consider climate change (Fig. 4).

#### *3.1.2. The main foci of articles varied by country and locale*

While most of the water and health research was conducted in Finland (n = 20/74 articles; 27.0%), only one of these articles considered climate change (n = 1/20 articles; 5.0%). Canada had the second highest number of water and health articles (n = 18/74 articles; 24.3%); however, in contrast to Finland, most of the articles describing

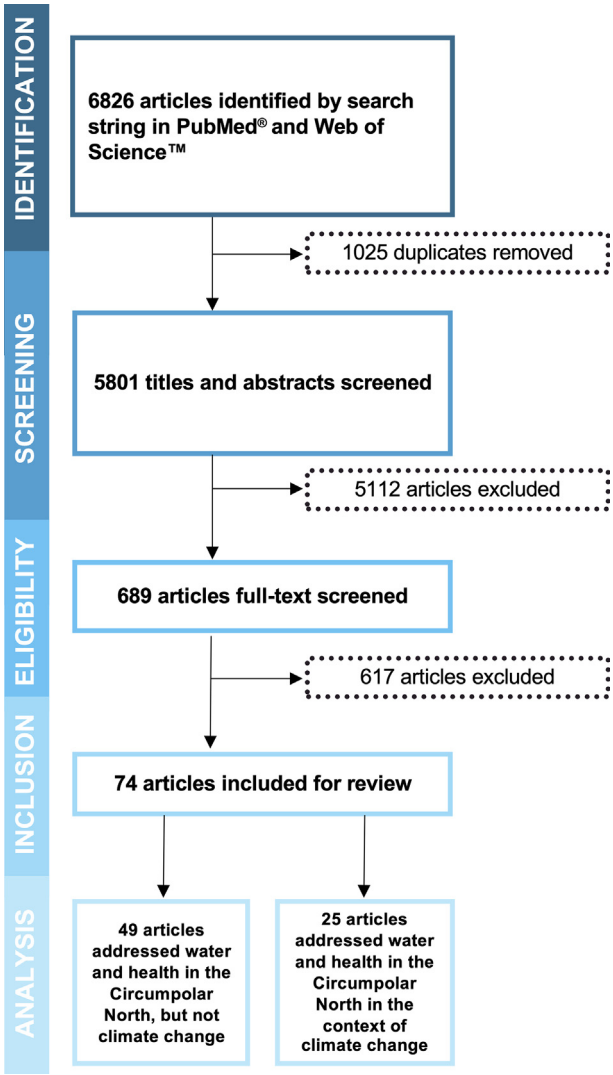


**Fig. 2.** Overview of the identification, screening, eligibility, inclusion, and analysis phases of the literature review on climate change, drinking water, and health in the Circumpolar North.

**Table 2**
A summary of articles about climate change, water, and health in the Circumpolar North by depth of climate change consideration, extent of climate-health association, and consideration of future climate change impacts [39,44,45].

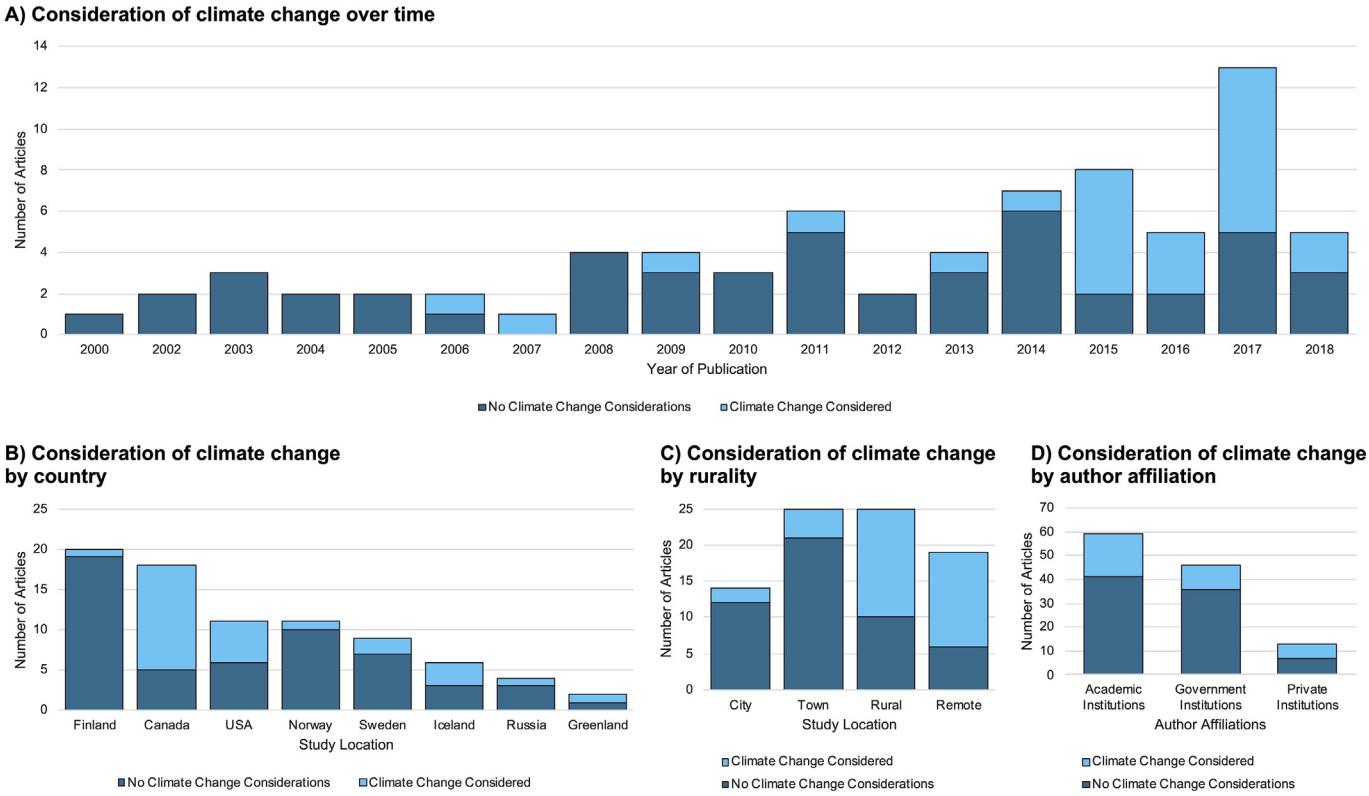


**Fig. 3.** Consideration of climate change in articles by (A) time; (B) country; (C) rurality; and (D) author affiliation for water and health articles in the Circumpolar North.

research in Canada considered climate change (n = 13/18 articles; 72.2%) (Fig. 3). The proportions of water and health research that examined climate change was similar in the USA (n = 5/11; 45.5% of articles investigated climate change) and Iceland (n = 3/6; 50.0% of articles investigated climate change).

The location of water and health primary research were somewhat evenly distributed among cities (n = 14 articles; 20.9%), large towns (25 articles; 37.3%), rural locations (n = 25 articles; 37.3%), and/or remote locations (n = 19 articles; 28.4%). Of these articles, however, most climate change research took place in rural (n = 15/25 articles; 60%) and remote (n = 13 articles; 68.4%) communities, and very little climate change research took place in cities (n = 2 articles; 14.3%) and/or large towns (n = 4 articles; 16.0%) (Fig. 3).

#### *3.1.3. Water source, contaminants, and health outcomes varied by articles that did and did not consider climate change*

Water and health articles most commonly examined tap water (n = 23 articles) and surface water (n = 11 articles); similarly, articles that considered climate change also most commonly examined tap water (n = 11 articles) and surface water (n = 11 articles) (Appendix C). Few articles examined trucked water, meltwater, and water in storage tanks; however, the proportion of these articles that considered climate change was high: of the five articles that examined trucked water, four considered climate change (80.0%); of the seven articles that examined meltwater, five considered climate change (71.4%); and of the 11 articles that examined water in storage tanks in homes, seven considered climate change (63.6%).

Metals, metalloids, and other elements were most commonly examined in water and health articles (n = 25 articles); however, few of these articles considered climate change (n = 3/25 articles; 12%). Bacteria (n = 17 articles) and parasites (n = 10 articles) were often the focus of water and health articles, and climate change was considered in some of these articles (n = 5/17 articles examined bacteria and considered climate change; 4/10 articles examined parasites and considered climate change). While 12 water and health articles examined viruses in water, only one of these articles considered climate change.

Most water and health articles collected data on human health (n = 48 articles), of which only 12 considered climate change (n = 12/48 articles; 25%). Many water and health articles examined waterborne disease outbreaks (n = 16 articles); however, very few of these considered climate change (n = 3/16 articles; 18.8%).

### *3.2. What is the nature of climate change considerations in water and health literature?*

#### *3.2.1. Many articles considered climate change to a major extent*

While 25 articles considered climate change in some capacity, the degree to which it was considered and/or evaluated varied greatly within the literature (Table 2). Approximately half of the articles (n = 12 articles; 48.0%) considered climate change to a major extent, while ten articles (40.0%) considered climate change explicitly to a minor extent, and three articles (12.0%) made implicit references to climate change. For instance, some articles included climate change in the study goals, data collection, and analysis (explicitly considered to a major extent) [11,13–14,19,37,41], while others discussed their results in the context of climate change (explicitly considered to a minor extent) [21–22,25–26,38,40,43,46,48–49]. Other articles considered climate change implicitly. For instance, articles examined associations between waterborne outbreaks and precipitation [42]; mentioned "the links between medical, ecological, socioeconomic, and climatic factors" [47]; and referenced a "rapidly changing Arctic environment" [20].

#### *3.2.2. Few articles empirically associated water/health with climate change*

Few articles (n = 6; 24.0%) empirically evaluated associations of water and/or health with climate change. Of the studies that did evaluate an association, three articles did so via qualitative

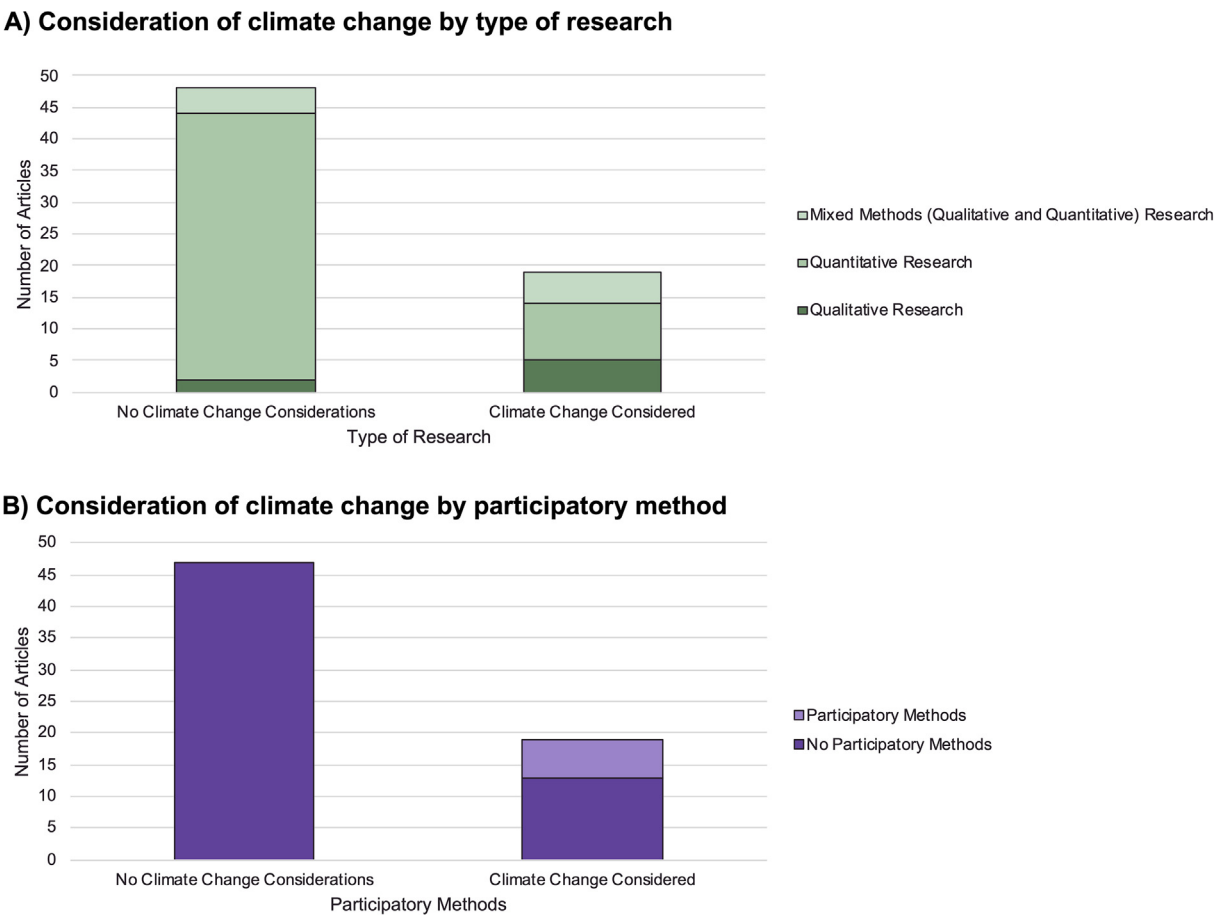


**Fig. 4.** Consideration of climate change in articles by (A) type of research; and (B) participatory method in water and health articles in the Circumpolar North.

methodologies, one article used quantitative methodologies, and two articles utilized a mixed-methods (qualitative and quantitative) approach. For example, studies used interviews [11,13,19,41] and participatory methods [11,13] to record Indigenous knowledge and other observations related to climate change impacts on drinking water and health. Other studies used surveys [11,37], hospital records [14], and water sampling [13–14] to understand the climate-water-health nexus.

*3.2.3. Health implications of both water quality and quantity was assessed in the context of climate change*

Of the articles that considered climate change, most addressed relationships between water quality and health (n = 17/25 articles; 70.8%). Of these articles, the most commonly described issues included infectious waterborne illnesses (n = 13/17 articles; 76.5%). Some of these articles collected health data on illnesses, including cryptosporidiosis (n = 3) [13,20,40], giardiasis (n = 1) [20], norovirus (n = 1) [42], and all-cause acute gastrointestinal illness (n = 7) [13–14,21,26–27]. Few articles that considered climate change described chemical contaminants (n = 4/17 articles; 23.5%). These chemicals included non-microbiological contaminants, such as metals, metalloids, and other elements (n = 3) [40,43,46] and pesticides (n = 1) [43].

Water quantity impacts on health were considered in six climate change articles (n = 6; 24.0%) [11,13,19,37,40–41]. For instance, some articles documented Indigenous knowledge related to observed declines in drinking water quantity related to reduced snow, warmer temperatures, and loss of groundwater aquifers [11,13,37]. Indigenous knowledge related to observations of decreased water quantity linked to health impacts were also documented in some studies [11,13,41].

*3.2.4. Remote populations, Indigenous peoples, and age were most commonly described as factors influencing vulnerability to climate change*

Many articles identified remote populations (n = 14 articles; 56%), Indigenous peoples (n = 13 articles; 52%), and age (n = 5 articles; 20%) as factors that contribute to climate change vulnerability. For example, articles described increased vulnerability to climate change due to the close relationships that many Indigenous peoples have with the environment [11,13]; water treatment infrastructure challenges in remote locations [38,40]; high gastrointestinal illness rates among infants, children and the elderly [19]; and concerns about water access and health impacts on children and Elders [41]. Fewer articles, however, identified public health service access (n = 3 articles; 12%), gender (n = 2 articles; 8%), and the economy (n = 2 articles; 8%) as factors that influence climate change vulnerability.

*3.2.5. Examining climate change adaptation was rare*

Of articles that considered climate change, only seven explicitly mentioned climate change adaptation (n = 7/25; 28.0%). Only two primary research articles collected data on climate change adaptations (n = 2/19; 10.5%) [13,37], which included forums for sharing strategies and innovations for climate change adaptation [37], as well as environmental monitoring [13].

*3.2.6. No articles quantitatively projected future climate change impacts on water*

No articles quantitatively projected future climate change impacts on water. Two articles, however, did capture qualitative data on concern for future impacts on climate change based on Indigenous knowledge [11,41]. For instance, one article documented "concern over how observed climate-related environmental changes could

compromise the safety of drinking water in the future" based on Inuit knowledge [11].

While few articles projected future climate change impacts, the majority of primary research articles did mention future implications of climate change in the introduction and/or discussion sections of the paper (n = 11/19; 57.9%). For example, articles called for further research on future climate change impacts [25]; discussed results in the context of future climate change [14,22]; and mentioned future climate change projections in the introduction and/or discussion sections of the article [19,49].

## 4. Discussion

While the number of climate change, water, and health articles has increased relatively recently, research on this topic remains nascent despite the risks posed by climate change. Indeed, only 25 of the 74 included articles implicitly or explicitly mentioned climate change, of which only 12 articles considered climate change in-depth and explicitly, and only 6 articles collected data on climate variables (e.g. temperature over time). A variety of different water sources were examined in articles, capturing the range and variety of drinking water sources that northern residents utilize, including surface and ground water; treated and untreated tap water; and meltwater from snow, ice, and icebergs. While the consideration of populations vulnerable to climate change impacts on drinking water was not in-depth, Indigenous peoples, rural populations, and children and elderly were most commonly mentioned as potentially vulnerable.

While most water and health research was conducted in Finland and Canada, articles focusing on climate change were rare in Finland but more frequent in Canada. This finding highlights an opportunity for increased climate-water-health research in Finland and elsewhere in the Arctic. Indeed, given the demonstrated high level of water and health research capacity in Finland, there are clear opportunities to develop a stream of water and health research that encompasses, addresses, and responds to climate change threats in this country. Water and health research in Norway, Sweden, Iceland, Russia, and Greenland infrequently considered climate change, creating a large gap in understanding in a region experiencing the fastest warming on the planet with vulnerable drinking water sources [1,50–52]. Northern Canada and Alaska, USA had the most water and health articles that considered climate change; however, most of this research only mentioned climate change, with very few articles empirically examining climate change impacts or risks.

Water and health research spanned urban, rural, and remote settings; however, water and health research that considered climate change was concentrated in rural and remote settings. This finding could reflect the heightened vulnerability of rural and remote systems to climate change impacts on drinking water [1,4,12]. For instance, many rural and remote communities rely on surface water for drinking, but the water treatment systems often provide only basic water treatment (e.g. chlorination) [12]. Without more advanced treatment options (e.g. filtration, UV treatment, coagulation, flocculation and sedimentation, etc.) surface water can be vulnerable to heavy rainfall and rapid snowmelt that can increase runoff and turbidity, as well as by seasonal and long term changes in water quality, all of which can potentially overwhelm water treatment facilities [53–54]. Furthermore, climate change impacts on water distribution systems in rural and remote areas can interrupt water provision for community members [12]. For instance, permafrost thaw can damage water distribution infrastructure, high impact weather events can interrupt trucked water service to homes, and water storage tanks in homes can be insufficiently designed and maintained for climate-related changes in water quality, among other impacts [12–13]. Urban centres are also vulnerable to climate change impacts on drinking water. Globally, it is clear that even major metropolitan cities in high income countries have water treatment and distribution infrastructure that is vulnerable to climate change [53–58]. Urban centres in the Circumpolar North are, indeed, also vulnerable to climate change impacts on drinking water [12,52,59]. Given most people in the Circumpolar North reside in urban centres, this presents an important and under-studied climate change risk.

Water and health research that considered climate change included articles focused on microbial contamination of drinking water and consequent health impacts. This topic of research is particularly important given the high baseline level of acute gastrointestinal illness in the Circumpolar North [14,25–27], which is anticipated to be exacerbated by climate change [1]. Indeed, Finland and Sweden have already reported increased waterborne disease in the past decade, and waterborne illness has been reported as an important climate change concern in Norway and Sweden [52]. The breadth of infectious waterborne pathogens, however, has not been investigated sufficiently in cold climates in general, and even less so in the context of climate change. Studies focusing on specific species of parasites, bacteria, and viruses in the context of climate change remains erratic, sporadic, and patchy.

Water and health research was dominated by articles about chemical contaminants; however, this focus was rare in articles that considered climate change. This research gap is detrimental given the uncertainty, risk, and adverse consequences of chemical contaminants contaminating drinking water sources due to climate change. Persistent contaminants are already found throughout northern ecosystems as a result of local sources (e.g. mining, pesticide use) as well as transport from lower latitudes through air, water, and terrestrial routes [60]. Climate change is expected to exacerbate these existing chemical contaminant risks in the Circumpolar North [61–64]. Accelerated temperature rise and the subsequent melting of glaciers, snow, and ice can enhance transport of chemical contaminants, and airborne chemical contaminants that have been deposited onto glaciers and trapped in the ice may be deposited into glacier fed lakes and waterbodies, increasing exposure to humans and wildlife [65]. Given this climate change risk, further research is warranted.

While adaptation was frequently mentioned in the introduction and discussion sections of papers, articles examining climate change adaptation options were rare. This research gap has critical implications for planning, policy, and programming related to water, health, and/or climate change in the Circumpolar North. Examining the range, nature, efficacy, efficiency, and relevance of adaptation options are important in any region [66], but is particularly critical for the Circumpolar North [67] given the important differences in cold climate, culture, livelihoods, and resources available compared to other more southern locales [10,12–13,16–17]. While adaptation options have not been evaluated, more generally the health and climate change literature emphasizes the need for community-based monitoring of water systems, the integration of water and health monitoring, the development of climate, water, and health metrics that matter locally and culturally, and the inclusion and/or prioritization of Indigenous knowledge in monitoring and decision making in the Circumpolar North [5,13,24,37,67–72].

Both water quality and quantity were investigated in the context of health outcomes, and current and historic impacts of climate change on water and health were considered. Understanding how future climate change will impact human society has become a critical area of research [73–74], including in climate-water-health research e.g. [75–77]; however, no articles quantitatively projected future climate change impacts on drinking water in the Circumpolar North. This research deficit limits the ability of the Circumpolar North to look forward, understand future risks, plan and prioritize adaptations, and respond to climate change.

## 5. Conclusion

While the number of articles has increased recently, this area of

research remains under-studied despite the transformational changes that the Circumpolar North has already experienced – and will continue to experience – due to climate change. More research investigating the climate-water-health nexus is needed in order to understand current and future risks and to adapt, particularly given the unique features of drinking water quality, access, provision, and safety in the Circumpolar North. Research examining and evaluating adaptation options, as well as research projecting future climate change impacts at the climate-water-health nexus is absent in the Circumpolar North. Responding to this research gap should become a top priority for research, given the urgent need for this evidence to inform climate change policies, actions, and interventions.

## CRediT authorship contribution statement

**Sherilee L. Harper:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing - original draft, Writing - review & editing. **Carlee Wright:** Data curation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **Stephanie Masina:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing - review & editing. **Shaugn Coggins:** Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing.

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## Declaration of interest

The authors declare no conflict of interest.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wasec.2020.100062.

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