Inuit Nunangat Surface Freshwater and Ice

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INUIT TAPIRIIT KANATAMI

Our Vision:
Canadian Inuit are prospering through unity and self-determination

Our Mission:
Inuit Tapiriit Kanatami is the national voice for protecting and advancing the rights and interests of Inuit in Canada

About Inuit Tapiriit Kanatami

Inuit Tapiriit Kanatami (ITK) is the national, democratic Inuit representative organization whose mandate is determined by Inuvialuit Regional Corporation, Nunavut Tunngavik Inc., Makivvik, and Nunatsiavut Government. These four Inuit Treaty Organizations have each signed one or more modern treaties with the Crown. They are the only Section 35 Inuit rights holding organizations in the country and their members include all Inuit.

Inuit are one of three Indigenous Peoples recognized by Section 35 of Canada's Constitution. Our homeland, Inuit Nunangat, makes up 40 percent of the country's land area, 72 percent of its coastline, 32 percent of Canada's surface water, and significant marine areas. Our people monitor, use and manage all of it.

Inuit Treaty Organizations form the voting members of the Board of Directors of ITK and Inuit Circumpolar Council Canada. ITK works closely with Inuit Circumpolar Council Canada, whose mandate is to strengthen unity among Inuit internationally. Pauktuutit Inuit Women of Canada and the National Inuit Youth Council are permanent participants of the ITK and Inuit Circumpolar Council Canada Boards.

Vision

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ITK Research Briefings

ITK Research Briefings provide analysis of timely policy matters that are of direct relevance to Inuit. Briefings are prepared by ITK, consistent with its mandate to produce research and analysis that can be used to support the advancement of Inuit priorities. ITK Research Briefings are a deliverable of ITK's 2024-2028 Strategy and Action Plan.

Introduction

Inuit Nunangat, the homeland of Inuit in Canada, is a region of profound natural richness, particularly in terms of its water resources. This vast area, encompassing the Inuvialuit Settlement Region, Nunavut, Nunavik, and Nunatsiavut, holds a significant portion of Canada's water.

Inuit Nunangat's water resources extend beyond its lakes, rivers, and wetlands to include vast reserves of permanent snow and ice. These frozen water sources are a vital part of the region's overall freshwater system, storing immense quantities of water and supporting the hydrological cycles that sustain ecosystems and shape the northern environment. Snow and ice play essential roles in replenishing surface waters seasonally, regulating the climate, and providing habitat for wildlife. Historically, Inuit relied on this frozen water by melting ice and snow in winter to meet drinking water needs, a practice deeply connected to seasonal patterns and local knowledge. As climate change accelerates the transformation of these frozen reserves, understanding their extent and dynamics becomes increasingly important for planning, resilience, and long-term water security in Inuit Nunangat.

Inuit Nunangat's water resources must be understood not only through a scientific and geographic lens, but also within a broader rights-based framework. The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which Canada committed to implement through the UN Declaration on the Rights of Indigenous Peoples Act (2021), affirms the right of Indigenous Peoples to own, use, develop, and control their waters (Articles 25 and 26). The human right to safe drinking water and sanitation, recognized by the United Nations in 2010 and endorsed by Canada in 2012, further establishes a moral and legal imperative to ensure Inuit Nunangat communities have equitable access to clean water. Complementing these international commitments, the modern Inuit land claims agreements — including the James Bay and Northern Quebec Agreement (1975), the Inuvialuit Final Agreement (1984), the Nunavut Agreement (1993), the Labrador Inuit Land Claims Agreement (2005) and the Nunavik Inuit Land Claims Agreement (2008) — affirm Inuit rights to manage and benefit from Inuit lands, waters, and resources. Together, these legal instruments provide essential context for this research as they showcase that policies for water management, monitoring, and governance in Inuit Nunangat must align with Inuit rights to self-determination, environmental stewardship, and well-being (United Nations, 2007; Government of Canada, 2021).

In light of these rights, and compelled by the persistent challenges facing Inuit communities in accessing clean water, Inuit Tapiriit Kanatami (ITK) and Inuit Treaty Organizations have undertaken efforts to explore and understand the region's water wealth. What began as an effort to map the coastline of Inuit Nunangat evolved into a broader initiative to estimate the full extent of its water resources. This work led to a vital partnership with the Canada Centre for Mapping and Earth Observation (CCMEO) at Natural Resources Canada (NRCan), aimed at enhancing understanding of the region's water wealth and supporting sustainable management and future planning.

This paper marks the first step in that research partnership. Its primary goal is to estimate, with precision, how much of Canada's surface water and ice lie within Inuit Nunangat. Beyond mapping the present, the comprehensive Landsat dataset also provides the ability to examine past trends in surface water dynamics across four decades. These historical insights help reveal how climate change, human activity, and natural processes have shaped water coverage in Inuit Nunangat. Just as importantly, they establish a foundation for forecasting future changes, enabling researchers to identify cycles and trajectories that will inform planning, resilience, and long-term water security. A further aim is to consider how these data can support the well-being of Inuit communities. Future work will expand the scope to examine additional dimensions of freshwater, including groundwater and total water.

Partnership with the Canada Centre for Mapping and Earth Observation

The collaboration between Inuit Tapiriit Kanatami (ITK) and the water research group led by Dr. Shusen Wang at the Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources Canada (NRCan), has significantly advanced understanding of the extent and importance of Inuit Nunangat's water wealth. This partnership provides valuable insights to inform sustainable management and future planning. The research was also supported by the National Inuit Climate Change Committee and the Inuit Qaujisarvingat National Committee, who provided review, feedback, and co-developed the research questions to ensure they align with Inuit priorities and knowledge systems.

The use of satellite imagery—facilitated by Dr. Wang and his team—has been key to acquiring and analyzing these data. Satellite observations offer an unparalleled tool for monitoring water coverage, quantity, and flow across the vast expanse of Inuit Nunangat. In this briefing, we present analyses of surface water distribution and changes across the entire region, based on observations from the Landsat satellite series. Landsat data were chosen for their relatively high spatial resolution (30 metres), complete spatial coverage, and long record of observations dating back to the 1970s.

The technology developed at CCMEO enables monthly monitoring of water parcels as small as 30 by 30 square metres over more than four decades, providing an exceptionally detailed and accurate view of water dynamics across Inuit Nunangat. This level of detail supports efforts to address water-related challenges and seize opportunities for improved management in support of Inuit communities.

Methodology: Exploratory Approach

This briefing is exploratory in nature. The primary goal is to explore the metrics of surface freshwater and permanent snow and ice in Inuit Nunangat and to examine trends over the past three decades. By leveraging advanced satellite technology and integrating diverse data sources, this preliminary analysis of data aims to provide an introductory understanding of Inuit Nunangat's water wealth.

Surface Water

Surface water refers to water that is visible on the Earth's surface, including lakes, rivers, ponds, wetlands, and other water bodies that can be directly observed from above. In this study, surface water is identified based on the presence of water covering the land, as seen in satellite imagery. The measurement focuses on the extent of water coverage — it does not provide information about water depth, volume, or underground water sources such as groundwater. It also does not account for water stored within soil, vegetation, or snow and ice. The analysis is limited to mapping where water is present on the land surface, regardless of how deep or how much water may be there.

Surface water is a critical component of Inuit Nunangat's natural wealth, encompassing lakes, rivers, and wetlands that are visible on the Earth's surface. The methodology for measuring surface water in this region leverages advanced satellite technology to provide a detailed and accurate assessment of water dynamics over time.

Satellite Imagery and Data Collection

The Landsat program is the world's longest-running satellite system for optical remote sensing of land, coasts, and inland waters. For more than 40 years, it has provided high-resolution (30-metre) imagery of Inuit Nunangat at an average revisit time of about three days. These data, openly available through the United States Geological Survey (USGS) and accessed via the Google Earth Engine (GEE) cloud platform, form the basis of this study. The analysis draws on imagery from four satellites: Landsat-5, Landsat-7, Landsat-8, and Landsat-9.

Determining Land and Water Areas

Consistent Landsat observations allow researchers to distinguish land from water with high precision. Using computer-based classification methods, monthly image composites were created to map the extent of surface water through time. Because optical sensors depend on sunlight, coverage is more limited during the dark winter months. To assess persistence, each location was evaluated for the proportion of months it was covered by water, a measure known as water frequency (WF). This approach made it possible to group areas by how consistently they hold surface water.

The determination of land and water areas includes the following major steps:

(1) Imagery Classification
Landsat Collection 2 atmospherically corrected surface reflectance imageries were used to extract water at 30-metre resolution for each image that covers any area of Inuit Nunangat. This includes processing a total of over 366,000 images (cloud cover < 20%) for the period of 1984-2023. The Dynamic Surface Water Extent (DSWE) algorithm, originally developed by United States Geological Survey (USGS) and later enhanced by CCMEO, was implemented in GEE for water extraction. Pixels were classified as water, land, and others (including pixels with cloud, terrain or cloud shadows, snow or ice covers, no observations or problematic observations due to satellite sensor malfunctions). The results also include classification uncertainties for each pixel.

(2) Monthly Water Cover Map Production
All classified imageries available in a month were composited to produce a surface water extent map for that month. The classification uncertainty results were used in the compositing process. Note that Landsat image collection relies on incoming solar radiation, so the available observations vary in different months with the daylight durations, and in high latitude areas there are no observations available for winter months. When a pixel has no data in that month, it was filled using the spatial coherence of pixels and the water frequency map produced below.

(3) Water Frequency (WF) Map Production
The monthly surface water extent maps produced for the 30 years of 1991-2020 were used to calculate the water frequency for each pixel. Water frequency is defined as the percentage for a pixel that appears as water in the total available observations during the 30 years, as shown by the scale below (Figure 1).

Based on this analysis, areas in the surface water frequency map (Figure 2) are classified into three main categories:

1. Permanent Land:
Permanent land areas are those where water is never present in any of the satellite images over the 30-year period (WF=0%). These areas are consistently dry and do not experience inundation. On the scale (Figure 1), they correspond to the colour at 0% frequency, typically grey (though just above 0% it becomes magenta).

2. Permanent Water:
Permanent water areas are those that remain consistently as water surface throughout all the months in the 30 years (WF=100%). These are identified by the presence of water in every satellite image for a given parcel of land throughout the 30-year period. Permanent water bodies include lakes and rivers that do not dry up seasonally and are reliable sources of water year-round. On the scale (Figure 1), they correspond to the colour at 100% frequency, typically deep blue.

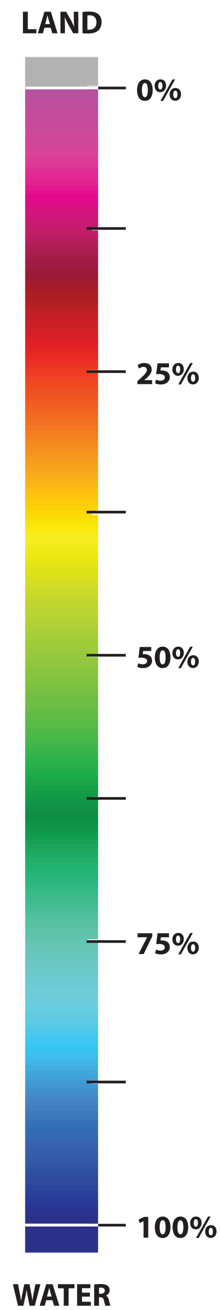
3. Seasonal Water:
Some areas in Inuit Nunangat have water only during certain times of the year or in certain years. These are called seasonal water areas. They may look like land in some satellite images and like water in others, depending on the time of year, rainfall, snowmelt, or broader climate patterns. For example, they might include meltwater ponds, the edges of lakes that expand during spring, or low-lying areas that flood only in wet years.

Each location may be covered by water as little as 1% or as much as 99% of the time. At the low end, these could be shallow depressions or melt zones that appear only occasionally. At the high end, they might be lakes or rivers that are nearly permanent but shrink slightly during dry seasons. These patterns can shift over time, especially with climate change.

From a technical standpoint, seasonal water areas are those that appear as land and water at different times during the 30-year period, likely due to the seasonal changes in precipitation and melting, or interannual changes in climate. The frequency of water presence for a pixel can range from 1% to 99%, indicating varying degrees of water occurrence through time.

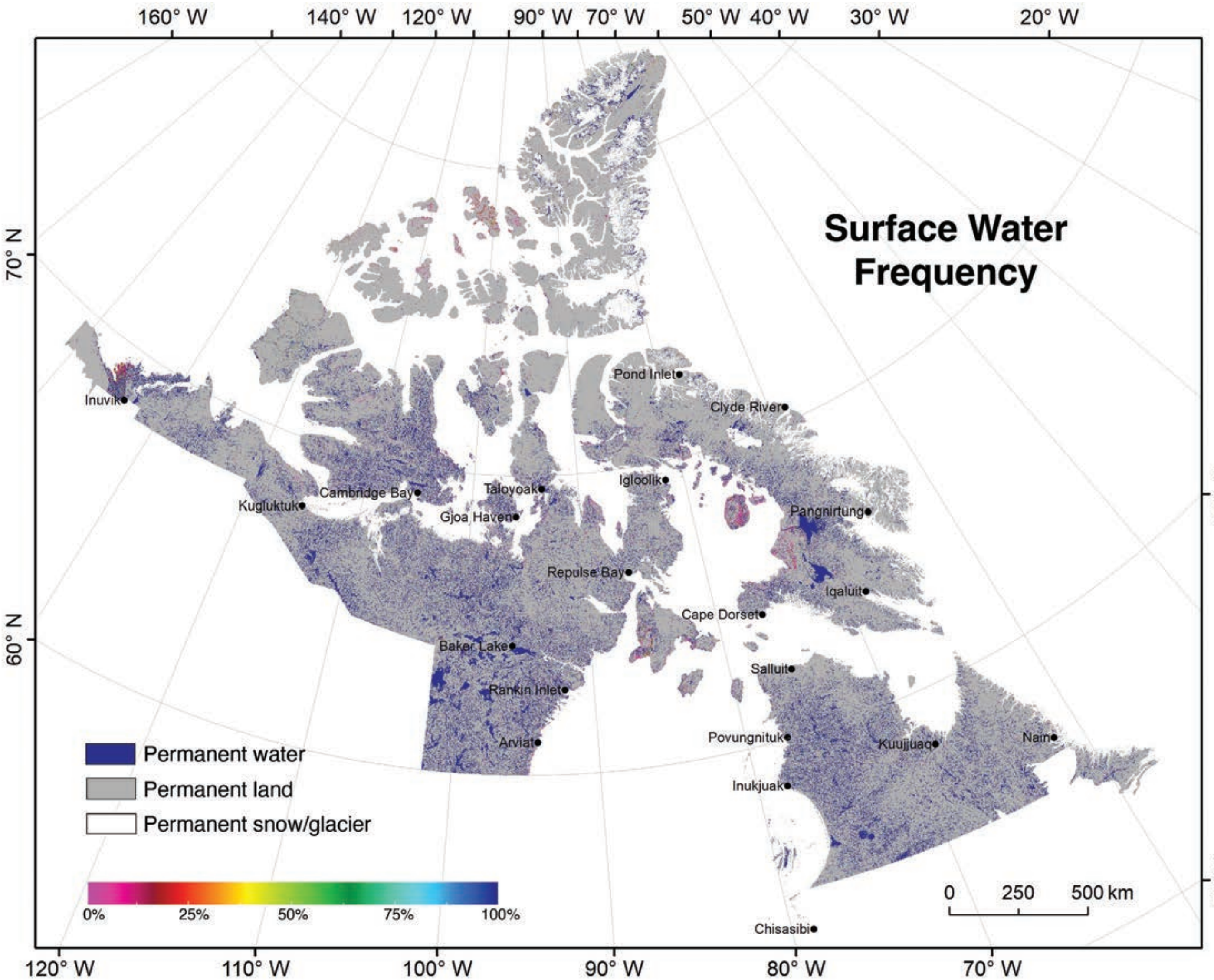
On the water frequency scale, seasonal water is represented by colours ranging from pink (very low frequency, just above 0%) through yellow and green (moderate frequency, around 25% to 50%) to cyan (higher frequency, approaching 75%). These colours indicate how often water was observed at each location over time, reflecting natural variability in water coverage.

Figure 1: Water Frequency Colour Scale (%)



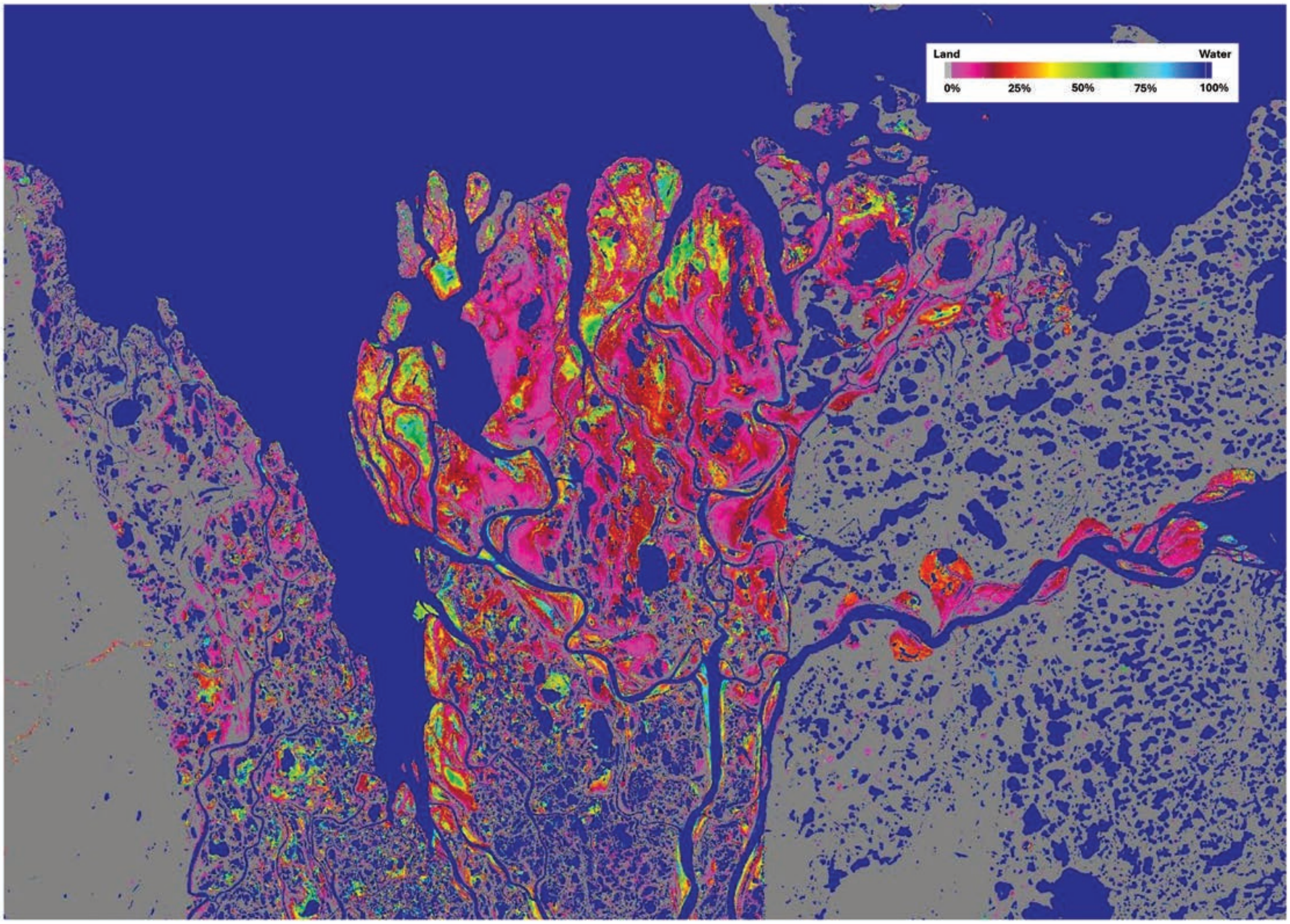
At the lower end of this range, parcels with water present in only a few images may represent areas that are periodically inundated like intermittent ponds, winter melts, shore areas of a water body, or areas flooded in wet years. At the higher end, parcels with water present more frequently may represent bodies of water that are nearly permanent but experience some occasional variation such as in dry years. Note that the identification of the above three categories can vary with the period of years, especially for regions with significant climate change impacts which may have resulted in long-term historical changes in water distributions. The above three categories can be recalculated to other time periods following users' interest.

Figure 2: Map of Surface Water Frequency in Inuit Nunangat



Source: Natural Resources Canada. 2023. *Canada's surface water frequency*. https://open.canada.ca/data/en/dataset/2b76d117-d940-4ebb-bf26-91f768081c5f

Figure 3: Map of Surface Water Frequency in the MacKenzie Valley Delta



Source: Natural Resources Canada. 2023. *Canada's surface water frequency*. https://open.canada.ca/data/en/dataset/2b76d117-d940-4ebb-bf26-91f768081c5f

The above map (Figure 3) shows a zoomed-in view of surface water frequency in the Mackenzie Valley Delta, illustrating the complex distribution of surface water in this region over the study period (1991-2020). Deep blue areas represent permanent water bodies, including the main river channels, large lakes, and marine areas, where water was present in 100% of observations. These features form the core of the delta's hydrological system.

Cyan and green zones, where water was present much of the time but not permanently, likely correspond to tidal flats, backwaters, and low-lying marshes that experience regular seasonal flooding or are influenced by tides. These areas could also include oxbow lakes or channels that are frequently filled but can dry during drier years or certain seasons.

Yellow and pink areas indicate regions where water appeared only occasionally. These colours are characteristic of ephemeral ponds, floodplains that are only inundated in exceptionally wet years, and upland edges of marshes that flood during spring melt or heavy rains. The pink zones might also mark small depressions or low-lying terrain where water pools briefly after significant precipitation events or during ice melt.

Grey areas denote permanent land — areas that remained dry throughout the 30-year period — including higher ground, levees, or other stable landforms that are not typically affected by flooding or surface water accumulation.

Together, the colour patterns reflect the delta's dynamic environment, shaped by river discharge, tidal influences, seasonal snowmelt, and long-term climate variability.

Permanent Snow and Ice

Permanent snow and ice are another important part of Inuit Nunangat's natural water wealth. These areas include glaciers, ice caps, and regions where snow and ice remain on the ground year-round. The same Landsat satellite images used to identify surface freshwater were also used to spot permanent snow and ice.

To determine where permanent snow and ice are located, we looked at all the satellite images over the study period and checked which areas were covered by snow or ice every time they were visible. If an area was classified as snow or ice in 100% of the available images over the 30 years, we marked it as permanent snow or ice. These areas represent places where frozen cover stays in place through all seasons, year after year.

Like permanent water, this method helps to map frozen water resources with confidence, showing where these important features are found and how stable they have been over time.

Understanding Past Trends and Forecasting Future Changes

The comprehensive dataset obtained from Landsat satellite imagery provides a unique opportunity to analyze past trends in surface water dynamics. By examining the historical data, researchers can identify patterns and changes in water coverage over the past four decades and their spatial and temporal variations. This retrospective analysis is crucial for understanding how climate change, human activities, and natural processes have influenced surface water in Inuit Nunangat.

Moreover, these data serve as a foundation for forecasting future changes in surface water. By identifying trends and cycles in historical data, researchers can develop models to predict how surface water may evolve in response to future environmental changes.

Results: 3 takeaways

1. The Significance of Water Wealth in Inuit Nunangat

The most recent data obtained from Landsat satellite imagery have provided new insights into Canada's surface freshwater distribution. Inuit Nunangat contains approximately 32.02% of all surface freshwater in Canada by area (based on the permanent water category). This represents an expansive 312,983 km^2 of water-covered area out of Canada's total 977,629 km^2. Furthermore, Inuit Nunangat holds about 78.41% of Canada's total permanent snow and ice cover, amounting to 112,438 km^2 out of the national total of 143,392 km^2.

Figure 4: Map of Surface Freshwater in Inuit Nunangat.

32% of Canada's surface freshwater is in Inuit Nunangat

78% of Canada's permanent snow and ice

Surface water and permanent snow and ice are two of the five key components of total water resources, alongside groundwater, soil moisture, and vegetation water content. With Inuit Nunangat holding nearly one-third of Canada's surface water and over three-quarters of its permanent snow and ice, the region represents a vital reservoir of the country's surface freshwater.

Table 1: Surface Water and permanent snow and ice in Inuit Nunangat vs. Canada

	Surface Water (km^2)	Permanent Snow/Ice (km^2)
Total Inuit Nunangat	312,982.90	112,438.32
Canada	977,629.10	143,392.40
Total %	**32.02%**	**78.41%**

Source: Natural Resources Canada. 2023. *Canada's surface water frequency.* https://open.canada.ca/data/en/dataset/2b76d117-d940-4ebb-bf26-91f768081c5f

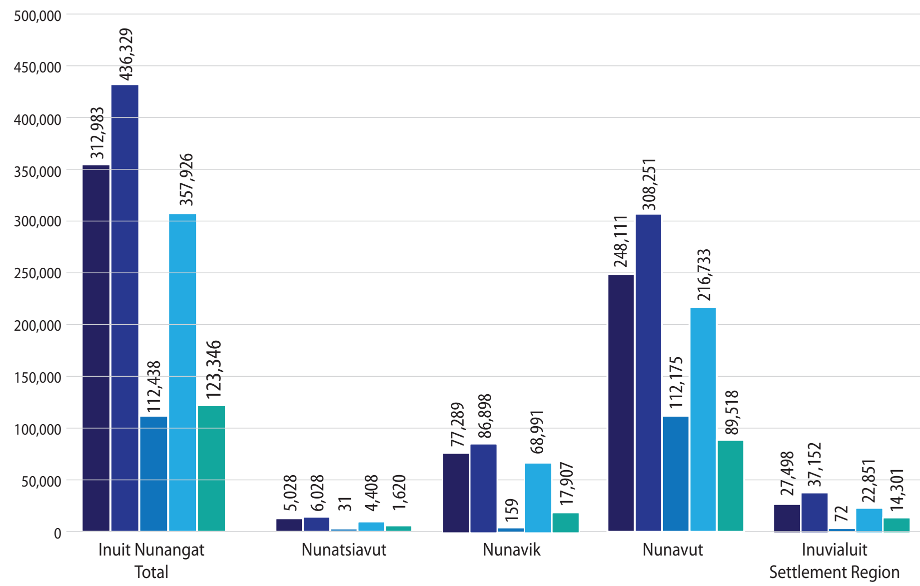
2. Variations in Water Distribution across the regions of Inuit Nunangat

The distribution of surface freshwater across Inuit Nunangat varies significantly by region, as illustrated in Figure 5. The Inuvialuit Settlement Region contains 22,850.94 km^2, representing 7% of the total surface water in Inuit Nunangat. Nunavik holds a larger share with 68,991.44 km^2, accounting for 22%. Nunatsiavut, with 4,407.91 km^2, makes up 2% of the total. The largest contribution comes from Nunavut, which encompasses 216,732.60 km^2, or 69% of the territory's surface water.

The distribution of permanent snow and ice across Inuit Nunangat also reveals significant regional variations. The Inuvialuit Settlement Region holds 72.26 km^2 (0.06% of Inuit Nunangat's total permanent snow and ice), while Nunavik has 159.42 km^2 (0.14%), and Nunatsiavut contains 31.48 km^2 (0.03%). Nunavut accounts for the overwhelming majority — 112,175.16 km^2, or approximately 99.8% of the total. Together, these regions add up to 112,438.32 km^2 of permanent snow and ice.

The following chart offers a more detailed portrait of Inuit Nunangat's water wealth in 2024, detailing the distribution of surface water across its regions:

Figure 5: Distribution of Permanent Surface Freshwater, Permanent Ice or Snow and other metrics across the regions of Inuit Nunangat (in km²)



Note 1: Metric descriptions

- **Maximum Inundation Area:** The total area that has ever been observed as inundated (temporarily covered by water, such as floods, wetlands, or seasonal lakes) during the 30-year period.
- **Permanent Water:** Areas that were classified as water in all observations across the 30-year dataset (e.g., lakes, rivers, coastal zones).
- **Permanent Snow/Ice:** Areas consistently covered by snow or ice throughout the study period (e.g., glaciers, ice caps).
- **Maximum Water Extent:** The largest combined surface area of water observed at any point in the 30-year record, including both permanent and seasonal water.
- **Median Water Area (1991–2020):** The median (typical) annual surface water extent over the 30-year period, representing the middle value of long-term variation.

Source: Natural Resources Canada. 2023. *Canada's surface water frequency*.
https://open.canada.ca/data/en/dataset/2b76d117-d940-4ebb-bf26-91f768081c5f

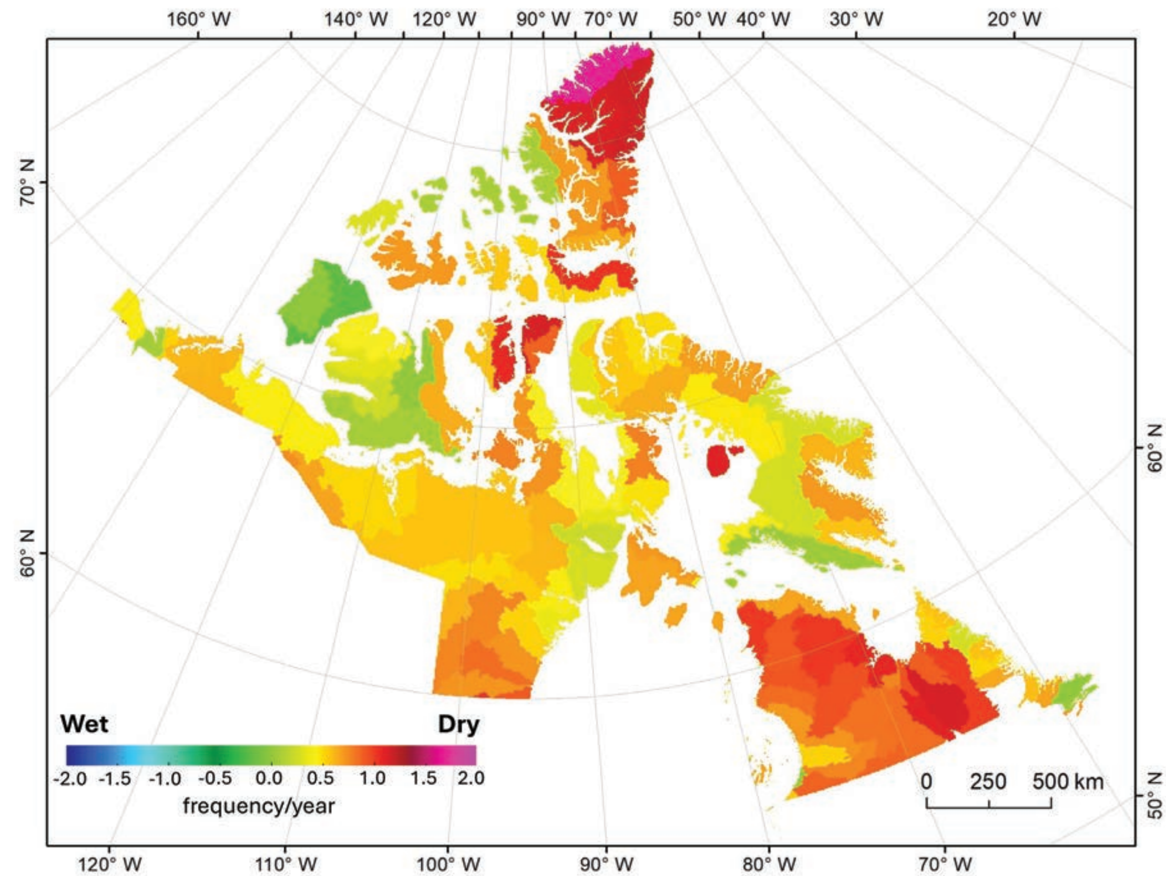
3. Trends in Surface Water Dynamics in Inuit Nunangat

Recent observations and data have revealed several significant trends that highlight the evolving nature of the region's water resources. In this study, the trends in surface water dynamics are analyzed and depicted in Figure 6. To generate these trends, time-series data from Landsat imagery over 19 years were analyzed for every 30-metre parcel of land across Inuit Nunangat. For each parcel, changes in water frequency (the proportion of months in which water was present) were calculated over time. The result is a long-term trend showing whether areas are becoming wetter or drier. These parcel-level results were then aggregated by watershed to illustrate broader regional patterns.

Across many regions in Inuit Nunangat, as shown in Figure 6, smaller bodies of water are noticeably shrinking or disappearing. The reduction in these water bodies diminishes water availability and could impact local ecosystems, posing challenges for both wildlife and communities that depend on these resources.

Figure 6 shows decreases in surface water area across the High Arctic and the permafrost transition zone over the 19-year period, which is mainly distributed in the southern part of Inuit Nunangat. Notably, Nunavik shows a significant declining trend in surface water. Growing evidence points to increased infiltration of water into porous ground, largely driven by the melting of permafrost due to climate change. As permafrost thaws, it alters the hydrological cycle, affecting groundwater recharge and surface water dynamics.

Figure 6: Map of Surface Water Dynamics (2004-2023)



Note: The values represent water frequency changes per year for each watershed. Since higher frequencies correspond to smaller water extents, and lower frequencies indicate larger extents, a negative value on the map indicates the watershed becomes wetter, and a positive value indicates the watershed becomes drier.

Source: Natural Resources Canada. 2023. *Canada's surface water frequency*. https://open.canada.ca/data/en/dataset/2b76d117-d940-4ebb-bf26-91f768081c5f

For example, Zhou et al. (2024) show that permafrost degradation improves hydraulic connections between surface water and groundwater, leading to increased infiltration of surface water into subsurface layers. Similarly, Jin et al. (2022) describe how thawing permafrost enhances groundwater storage and discharge, affecting seasonal flow regimes. This shift can lead to changes in water distribution and availability, further complicating water management efforts.

Steep declines are also observed on Ellesmere Island. While further analysis is needed, it is worth considering whether such changes could affect the watersheds that supply Grise Fiord, Canada's northernmost community.

Potential applications of Data and Future Work

Applications: Use of the data

Climate Change and Environmental Monitoring

Monitoring surface water is essential for understanding both climate change and environmental impacts. Satellite data can show how lakes, rivers, and wetlands evolve over time, making it possible to track changes caused by shifting climate patterns as well as local pressures such as mining projects. For example, water movement and surface area fluctuations around a mining site can be detected and compared across years, offering valuable insights into environmental effects that might otherwise go unrecorded.

This kind of monitoring is most effective when paired with Inuit knowledge, which provides context about seasonal changes, animal behaviour, and land use patterns that satellites alone cannot capture. Together, these approaches create a powerful system for tracking environmental change, supporting Inuit decision-making, and strengthening resilience to both climate pressures and industrial development.

Global dynamics

Inuit Nunangat's vast water resources are significant in a world where freshwater scarcity is becoming a growing source of tension. Population growth and climate change are driving shortages, and many regions already face high water stress. Canada's neighbours reflect this reality, with the United States categorized as "medium-high risk" and Mexico as "high risk" for water scarcity (Kuzma, Saccoccia, and Chertock 2023). In this context, the concentration of freshwater in Inuit Nunangat makes it an important part of both Canada's and the world's water security. It also points to the need for careful management of these resources in the years to come.

Economic Development

Freshwater resources in Inuit Nunangat hold potential economic value in a world where demand for water is steadily increasing. However, any discussion of commercial use must begin with the recognition that Inuit communities continue to face challenges in securing safe, reliable, and affordable access to drinking water. Meeting Inuit demand is the first and most important priority. This requires sustained investment in infrastructure, training, and long-term, community-led monitoring programs that establish a solid understanding of water quality and availability.

Only once these fundamental needs are met, and with the full and informed consent of Inuit rights-holders, could broader economic opportunities be considered. Even then, such discussions must be guided by Inuit self-determination and careful assessment of ecological carrying capacity to ensure that ecosystems remain healthy and resilient. In this way, freshwater in Inuit Nunangat can be seen as a resource with potential economic dimensions, but one whose use must always be rooted in Inuit values and the principle that water is first and foremost a human right, not just a commodity.

Drinking Water

Monitoring water sources is essential for ensuring the availability of clean drinking water for Inuit communities. While data on water dynamics alone cannot prevent the frequent boil water advisories — which are often linked to infrastructure limitations, maintenance issues, or operator training — it provides a crucial evidence base for solutions. In particular, this surface water and permanent snow data can help identify seasonal and long-term changes in the quantity and reliability of source waters that many communities draw upon. These insights can guide decisions about where to locate water intakes, how to design infrastructure, and when to schedule maintenance, ensuring that facilities are better matched to the realities of changing water systems. Looking ahead, complementary studies on groundwater and total water availability will be equally important, as many communities rely on multiple sources. Together, these strands of data can provide the knowledge base needed to support resilient infrastructure, reduce reliance on boil water advisories, and strengthen long-term water security across Inuit Nunangat.

Limitations

This study reports on surface water area only. It does not capture water volume or other important components of the hydrological system such as groundwater, soil moisture, or water stored in vegetation. These elements require separate investigation and should be addressed in future work.

Satellite observations also have seasonal constraints. Because optical sensors rely on sunlight, coverage is reduced during the dark winter months, leading to gaps in temporal continuity.

In addition, the analysis presented here has not yet been paired with Inuit knowledge and community priorities. Without this integration, the findings cannot fully reflect local realities or be applied in ways that best serve Inuit communities.

Indeed, while satellite imagery offers a powerful tool for mapping and analyzing surface water, models derived from these data are not sufficient on their own. Long-term monitoring programs that combine remote sensing with Inuit and local knowledge will be essential to validate or refine modelled trends. Together, these perspectives can build a more robust and accurate understanding of water dynamics over time, and support monitoring and forecasting that are both technically rigorous and locally meaningful.

Future Work:
Pairing Community Knowledge with Satellite Data

To build a more complete picture of water in Inuit Nunangat, future work could expand beyond Landsat surface water maps to include other satellite-based tools. For example, data from the GRACE (Gravity Recovery and Climate Experiment) mission can show changes in total water storage (TWS), helping to track underground water and snowpack. Other products, such as land surface evapotranspiration, lake evaporation, and water yield, can give insight into how water moves through the environment. Together, these tools can provide a more detailed understanding of water resources across Inuit Nunangat. Pairing satellite-based data with community knowledge will ensure that multiple ways of knowing guide research and decision-making, leading to better planning and stronger communities in the face of climate change. Future work should focus on strengthening this integration by incorporating Inuit and local observations directly into monitoring and analysis. This approach grounds interpretation in lived experience while expanding the relevance and accuracy of the data. By combining knowledge systems in freshwater research, Inuit can plan more effectively and strengthen resilience to face climate change and other challenges.

Conclusion

Inuit Nunangat's vast freshwater resources are both an extraordinary opportunity and a profound responsibility. As climate change, population pressures, and global water scarcity intensify, safeguarding this abundance for future generations is essential. Doing so requires governance that reflects Inuit rights, values, and priorities — ensuring that water is first and foremost a human right and cultural foundation, not merely a resource.

The mapping presented here marks an important step toward understanding the full scope of Inuit Nunangat's freshwater. Yet maps and models alone cannot ensure water security. Long-term protection depends on bringing together multiple forms of knowledge — from satellite monitoring that reveals broad trends to Inuit observations that provide fine-scale, place-based insights. When connected, these perspectives create a richer and more accurate understanding of water systems and the changes they are undergoing.

By committing to this shared approach, we can move toward a future where Inuit Nunangat's freshwater is understood, protected, and managed in ways that uphold Inuit self-determination and sustain Inuit communities for generations to come.

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INUIT TAPIRIIT KANATAMI

75 Albert St., Suite 1101
Ottawa, ON Canada K1P 5E7

613-238-8181

/InuitTapiriitKanatami

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