

Survey on Water and Sanitation in the Arctic:

Access, Disease Surveillance, and Threats from Climate Change

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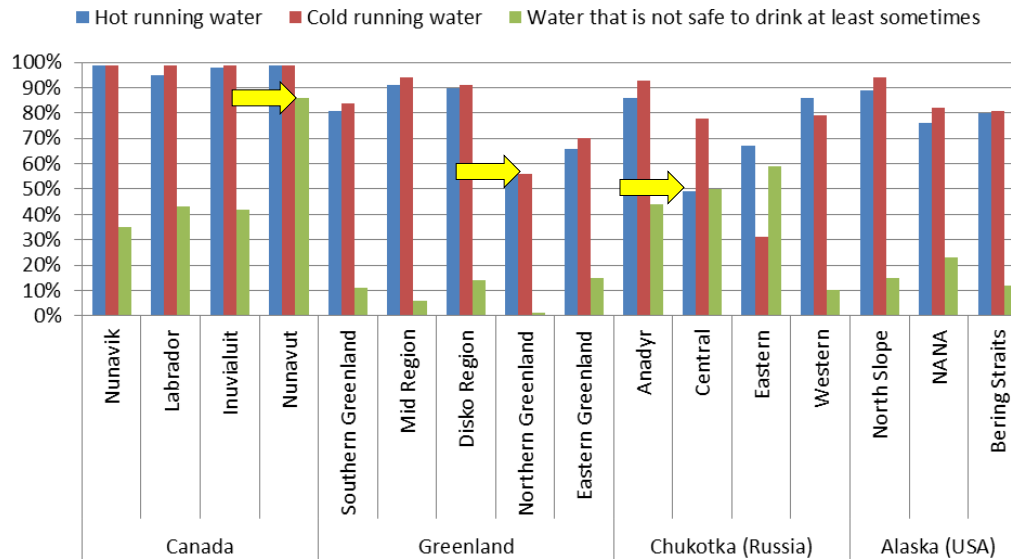
Sustainable Development Goal 6:

Ensure access to water and sanitation for all

- **Millennium Development Goal #7: Ensure environmental sustainability**
 - Target 7.C: Halve proportion of world population without improved drinking water and basic sanitation by 2015.
 - Accomplished goal in 2010.
- **2010 UN General Assembly Resolution 64/292:**
 1. Recognized access to safe and clean drinking water as a human right.
 2. Called upon States and international organizations to provide resources and cooperate to achieve safe drinking water and sanitation for all.
- **Sustainable Development Goal #6: Ensure access to water and sanitation for all**
 - By 2030...
 - achieve universal access to safe and affordable drinking water for all.
 - achieve access to adequate sanitation and hygiene for all.
 - implement water resource management at all levels, and through trans-boundary cooperation.
 - Support and strengthen the participation of local communities in improving water and sanitation management.

Water and Sanitation in the Arctic

- *Survey of Living Conditions in the Arctic (SLiCA), 2001–2006**



In-home water service in the Arctic by sample community

- Hot running water as low as 49% (Central Chukotka)
- Cold running water as low as 56% (Northern Greenland)
- Water that is sometimes unsafe to drink as high as 86% (Nunavut)

Water and Sanitation in the Arctic

- *UN National Human Development Reports 2006/2007**



Proportion of homes in Arctic Russian regions with sewerage installation

- Some areas of Russia estimated to have under 25% of homes with household sewerage. (Evenkia)

Water and Sanitation in the Arctic

- *Healthy Alaskans 2020* estimates that in 2010, **78% of rural Alaskan homes had water and sewer service.**¹
 - Among all Alaskan homes, 95.6% have complete plumbing.²
 - Among all U.S. homes, 99.6% have complete plumbing.²
- Access to water and sewer is still inadequate, and SDG #6 for access to water and sewer service for all has not been achieved in the Arctic region.
- Higher water service has been associated with lower rates of water-washed disease in the Arctic, such as skin and respiratory tract infections.^{3,4}

1. State of Alaska. Healthy Alaskans 2020. Leading Health Indicator #19.

2. US Census, American Community Survey.

3. Hennessy T, et al. The relationship between In-home water service and the risk of respiratory tract, skin, and gastrointestinal tract infections among rural Alaska natives. *Am J Public Health*. 2008;98:2072–8.

4. Gessner BD. Lack of piped water and sewage services is associated with pediatric lower respiratory tract infection in Alaska. *J Pediatr*. 2008;152:666–70.

Climate Change Threats to Water and Sanitation

- Climate change poses threats to water and sanitation.
 - Accelerated erosion and increased storm intensity damages infrastructure.¹
 - Permafrost melting and drainage of tundra ponds have caused loss of source water.²
 - Saltwater intrusion into wells have resulted from rising sea levels.²
 - Similar events have likely gone undocumented.
- Resources must be secured to maintain and improve water and sanitation services for the health of Arctic residents.

1. Warren JA, Berner JE, Curtis T. Climate change and human health: infrastructure impacts to small remote communities in the North. *Int J Circumpolar Health*. 2005;64:487–97.

2. Arctic Climate Impact Assessment (2005). Cambridge University Press.

Assessing the Current Status of Water and Sanitation in the Arctic

- Arctic Council project:
 - “Improving Health through Safe and Affordable Access to Household Running Water and Sewer in Arctic and Sub-Arctic communities.”
 - Objectives:
 - a) Promote innovations in water and sewer technologies and services provision.
 - b) Document the status of water and sewer service and associated health outcomes.
 - c) Describe climate-related vulnerabilities and adaptation strategies for community water and sewer systems and source water protection.
- Last two objectives addressed in **Survey on Water and Sanitation in the Arctic**: https://www.surveymonkey.com/r/arctic_council_water_sanitation



Methods



Survey on Water and Sanitation in the Arctic

- Three-part survey:
 - Access to water and sanitation services
 - Water- and sanitation-related disease surveillance
 - Climate or environmental changes affecting water and sanitation
- Distributed survey to professionals in health, water and sanitation; government authorities; and interested residents in the Arctic nations.
- Survey is open through September 2016.

Preliminary Results: Respondent Profile

Number of complete responses, by country and survey section

	Canada	Finland	Greenland	Iceland	Norway	Sweden	Russia	US (Alaska)
Total	5	3	3	1	1	3	0	32
Water & Sanitation	5	3	1	1	1	3	0	30
Disease Surveillance	1	0	1	1	1	1	0	7
Climate	3	0	1	1	1	1	0	12

Number of complete responses, by country and professional affiliation

	Canada	Finland	Greenland	Iceland	Norway	Sweden	US (Alaska)
National government authority			1	1	1		1
Local government authority	3	3	1			3	6
Tribal or indigenous organization							11
Community member							8
Other expert or interested party	2		1				6

Preliminary Results: Water & Sanitation

- Most respondents reported >90% access to improved water and sanitation in homes, schools, and health centers in their area.
 - However, responses describe mainly large national or provincial populations, while some small towns and villages have no services.
 - Responses are unreliable due to approximation, likely misunderstanding of definitions, and lack of empirical evidence provided for data.

Preliminary Results: Water & Sanitation

Water service used by most of population, according to respondents

	Canada	Finland	Greenland	Iceland	Norway	Sweden	US (Alaska)
Total respondents	5	3	1	1	1	3	30
Centralized piped distribution	4	3	1	1	1	3	13
Vehicle or self-haul with plumbing							2
Self-haul without plumbing							5
Private well							3
Other	1						

Sanitation service used by most of population according to respondents

	Canada	Finland	Greenland	Iceland	Norway	Sweden	US (Alaska)
Total	5	3	1	1	1	3	30
Centralized piped distribution			2		1	1	3
Vehicle or self-haul with plumbing	4						1
Private septic							2
Pit latrine							2
Composting, electric, or chemical toilet							
Honey bucket							4
Other							

Preliminary Results: Water & Sanitation

Water quantity and wastewater treatment standards according to respondents

	Water quantity standard	Is quantity standard met?	Are there a wastewater treatment standards?	Are treatment standards met?
Canada	90 L/p trucked 225-250 L/p piped	Yes (2) No (2)	Yes (3) No (1)	-- No (4)
Finland	120 L/p	Yes (2) --	Yes (2) --	Yes (2) --
Greenland	No standard	N/A	No response	N/A
Iceland	No standard	N/A	Yes (1) --	Yes (1) --
Norway	200 L/p	Yes (1) --	Yes (1) --	Yes (1) --
Sweden	No standard	N/A	Yes (2) --	Yes (2) --
US (Alaska)	Responses varied	Yes (43) No (6)	Yes (20) No (3)	Yes (12) No (7)

L/p = liters per person per day

Notable Water & Sanitation Information

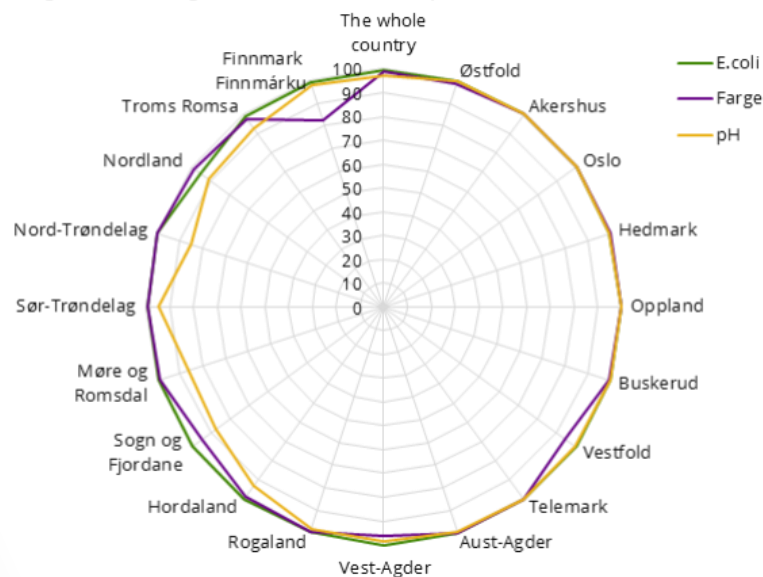
- Canada-Nunavut Agreement on the Transfer of Federal Gas Tax Revenues under the New Deal for Cities and Communities 2005 – 2015
 - “The infrastructure found in the majority of communities in Nunavut are beyond their useful lifecycle and many are inefficient, expensive to operate, and potentially hazardous to the community and the environment. These deficiencies are particularly evident in critical components such as water, wastewater, and solid waste infrastructure, where renovations/repairs are desperately needed to keep pace with expanding communities.”
- Northwest Territories 2013 Water Quality Summary
 - Annual summary of water quality in public systems throughout province

COMMUNITY	WATER SOURCE	CERTIFIED OPERATOR	TREATED WATER BACTERIA TESTS (% of compliance, 48 required, 216 for Yellowknife)			TREATED WATER CHEMICAL TESTS (1 required)			COMMUNITY	PLANT CLASSIFICATION	WATER TREATMENT PROCESS
			2013	2012	2011	2013	2012	2011			
Aklavik	Mackenzie River (Peel Channel)	✓	100%	100%	88%	✓	✓	✓	Aklavik	Class II	Conventional (Coagulation, Flocculation, Storage)
Colville Lake	Colville Lake	x	*63%	*35%	*7%	✓	✓	✓	Colville Lake	Small System	Cartridge Filtration, Chlorination, Storage
Déljné	Great Bear Lake	✓	100%	100%	100%	✓	✓	✓	Déljné	Small System	Cartridge Filtration, UV, Chlorination, Storage
Dettah	Yellowknife River		59%	27%	27%	N/A			Dettah	N/A	Chlorination
Behchokō (Edzo)	West Channel	✓	77%	100%	100%	✓	✓	✓	Behchokō (Edzo)	Class II	Conventional (Coagulation, Flocculation, Storage)
Behchokō (Rae)	Marian Lake	✓	77%	100%	100%	✓	✓	✓	Behchokō (Rae)	Class II	Conventional (Coagulation, Flocculation, Storage)
Enterprise	Town of Hay River		N/A						Enterprise	N/A	see Town of Hay River
Fort Good Hope	Mackenzie River	✓	100%	100%	95%	✓	✓	✓	Fort Good Hope	Class I	Membrane filtration, Chlorination and Storage
Fort Liard	Groundwater Well	✓	100%	100%	100%	✓	✓	✓	Fort Liard	Class I	Potassium Permanganate Assisted Green
Fort McPherson	Deep Water Lake	✓	100%	100%	100%	✓	✓	✓	Fort McPherson	Class II	Conventional (Coagulation, Flocculation, Storage)

Notable Water & Sanitation Information

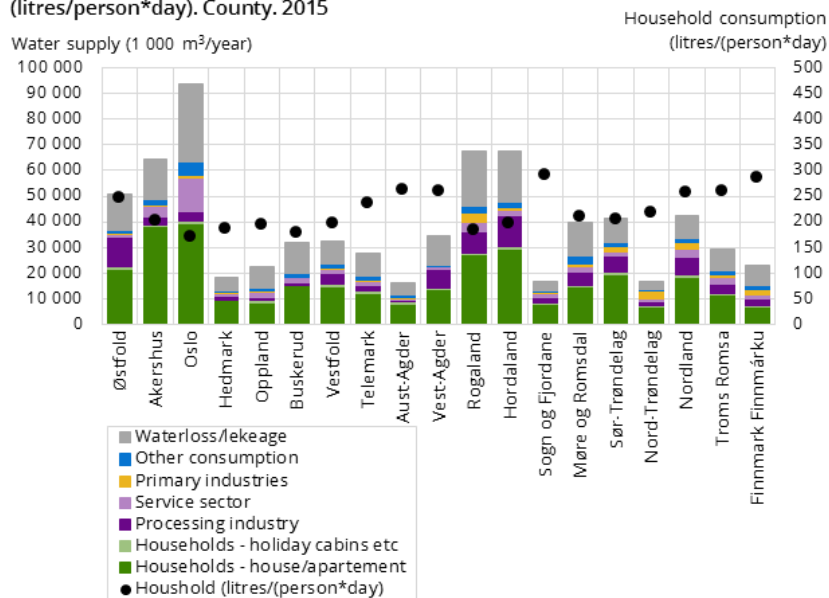
- Report on Municipal water supply in Norway, 2015
 - Only in municipalities, not rural areas

Figure 1. Per cent inhabitants connected to public waterworks supplied with safe drinking water with regard to E.coli, colour and pH. 2015



Source: Statistics Norway.

Figure 2. Water supply by sector (1 000 m³/year) and spesific household consumption (litres/person*day). County. 2015



Source: Statistics Norway.

Preliminary Results: Disease Surveillance

- Most *water-borne* infections are reported to public health authorities, but few *water-washed* infections are reported.
 - Skin and lower respiratory tract infections rarely reportable.
- Responses vary on which specific infections are reported.
 - *Influenza* and *pneumoniae* infections reportable in Alaska and Canada.
 - *Influenza* not reported in Sweden unless H1N1.
 - *Hep A*, *Typhoid*, *Cholera*, *Shigellosis*, *Campylobacter*, *Salmonella*, *Giardia*, *Legionella*, *Cryptosporidia*, and *Vibrio* reportable in Canada, Iceland, Norway, Sweden, and US (Alaska)
- Other existing data systems according to respondents
 - **Population registries** in Greenland, Iceland, Sweden and United States
 - **National patient registries** in Greenland and Sweden
 - **Electronic health records** in Canada, Greenland, Iceland, Sweden and United States
 - **Other data systems** in Norway (MSIS; outbreak alert) and Sweden (emergency calls; syndromic surveillance)

Preliminary Results: Climate Change

- **Decreases in source water quantity** were reported in Alaska, Canada, Greenland and Sweden.

Respondents reporting water <u>quantity</u> decrease	
Total respondents	20
Decrease in groundwater supply	4
Loss or decrease of tundra pond water or other surface water	8
Change in the course of a river that reduced access to water	6
Other decrease in quantity or volume not described here	4
<i>No decrease in water quantity has been observed</i>	1
<i>Respondent was unaware of any decreases in water quantity</i>	6



Preliminary Results: Climate Change

- **Decreases in source water quality** were reported in Alaska, Canada, Greenland, Norway and Sweden.

	Respondents reporting water <u>quality</u> decrease
Total respondents	20
Increased salt content, dissolved solids, or other contaminants in groundwater	3
Flooding of coastal areas by storms, causing contamination of surface water with seawater	3
Increased salt and bromide content in river intakes due to sea-level rise	0
Excessive algal, bacterial, fungal, insect, or other biological growth in source water	2
Other decrease in quality not described here	5
<i>No decrease in water quality has been observed</i>	3
<i>Respondent was unaware of any decreases in water quality</i>	6

- Other decreases in water quality described:
 - Change in water color



Preliminary Results: Climate Change

- **Damage to water or sanitation infrastructure** was reported in Alaska, Canada, Greenland, Norway and Sweden.

	Respondents reporting infrastructure damage
Total respondents	20
Damage to infrastructure due to high overland water flow (runoff) after intense storms.	5
Damage to infrastructure from riverbank erosion after intense rainstorms.	6
Damage to structure founded on frozen soil due to thawing permafrost	8
Damage to other water infrastructure due to event(s) not described here.	3
<i>No damage to water infrastructure has occurred.</i>	0
<i>Responded was unaware of any damage to water infrastructure.</i>	8



Preliminary Results: Climate Change

- Other infrastructure damage described:
 - Leaking water reservoir due to berm instability (thawing). (Nunavut)
 - ANTHC Climate Change Assessment Reports (Alaska):
<http://anthc.org/what-we-do/community-environment-and-health/center-for-climate-and-health/climate-health-3/>
 - Describe flooding, erosion, water quality and quantity decreases, infrastructure damage, health effects, etc.
 - Failure of buried water distribution and collection systems, requiring temporary installation of tanks until an above-ground system can be built. (Alaska)
 - Dam safety incidents due to power cuts during intense storms, land collapse, rising water level. (Finland)

Preliminary Results: Climate Change

- **Climate-related maintenance issues** were reported in Alaska, Canada, Greenland, Norway and Sweden.

	Respondents reporting maintenance issues
Total respondents	20
Use of dirty, contaminated, or unsafe water due to high cost of repairing or replacing damaged structures or contaminated water sources.	4
Increase in cost of operations and maintenance.	9
Other operations or maintenance issue(s) caused by climate change not described here.	5
<i>No climate- or environment-related maintenance issues have occurred.</i>	0
<i>Respondent was unaware of any climate- or environment-related maintenance issues.</i>	7



Preliminary Results: Climate Change

- Other maintenance issues described:
 - Need for installation of flexible service lines to minimize damage following buildings shifting due to freeze/thaw cycles and melting permafrost. (Alaska)
 - Stalling or incompleteness of infrastructure projects due to lack of funding. (Alaska)

Preliminary Results: Climate Change

- **Climate change has affected planning** of infrastructure in Alaska, Canada, Greenland, Norway and Sweden.
- Examples of planning changes due to climate change threats:
 - Lining reservoirs since relying on permafrost is no longer realistic. (Nunavut)
 - Chemical and UV treatment upgrades. (Sweden)
 - Protective walls in treatment plant to prevent contamination from floods. (Sweden)
 - Some communities to receive funding for decentralized in-home water and sanitation systems to ease relocation following erosion, etc. (Alaska)
 - Planned research to address climate change-caused infrastructure problems. (Greenland)
 - Climate change adaptation plans for some countries.



Preliminary Results: Climate Change

- **Water treatment has been affected** in Alaska, Canada, Greenland, Norway and Sweden.

	Respondents reporting effects on water treatment
Total respondents	20
Rise in bromide concentration requiring treatment of water source.	1
More difficult to appropriately treat water after increase in turbidity, pathogens, or natural contaminants in the water.	6
More frequent or severe algal blooms affecting water treatment.	0
Other treatment issue(s) not described here.	5
<i>Water treatment has not been affected by climate change.</i>	2
<i>Respondent was unaware if water treatment had been affected by climate change.</i>	8



Preliminary Results: Climate Change

- Other treatment issues described:
 - Storm water entry into sewage plants reduces the effectiveness of water treatment. (Norway)
 - More rapid clogging of filters. (Alaska)
 - Greater organic loads in source water requires stronger chemical treatment, resulting in more disinfection byproducts. (Alaska)

Preliminary Results: Climate Change

- Respondent from Iceland reported only being **unaware of climate-related changes** to water and sanitation infrastructure.
 - Quantity or quality decreases and damage might have occurred without respondent's knowledge.
 - Other climate-related incidents have likely occurred in all Arctic nations that have not been noted.
- No responses on climate change were received from Russia or Finland.

Preliminary Conclusions

- The picture of water and sanitation access in the Arctic is incomplete, but clearly Sustainable Development Goal #6 has not yet been achieved in many areas of the circumpolar north.
- Reportable water- and sanitation-related diseases are not consistent across the region.
 - **Water-borne** infections are usually reportable to public health officials, while few **water-washed** infections are.
- Climate change has caused decreases in water quality and quantity, infrastructure damage, maintenance and treatment issues, and has affected planning in almost all Arctic countries.
- As remote communities build infrastructure to increase access to water and sanitation, they must also address how climate change may damage or burden that infrastructure.

Limitations

- Survey not comprehensive.
- Reported numbers in the survey are unconfirmed, and some responses and data for the same areas are discordant.
- Unclear definitions may affect responses.
- However...
 - Survey results clearly show that areas of very low water and sanitation service exist in the Arctic.
 - Responses indicate previously unrecognized climate-related issues that will affect water and sanitation access in the future.
 - A comprehensive picture of water and sanitation issues in the Arctic is needed.

Lessons Learned

- The amount of numerical water and sanitation data requested was excessive and mostly uninformative.
 - Few respondents had access to empirical data on number served with water/sewer services.
 - Length of section likely detracted from survey completion.
- Translation into other languages in the Arctic region may improve survey completion and response.
 - Russian language version may have attracted greater response from Russia.

The survey is still open!

- Experts and officials representing Arctic and Sub-Arctic areas are encouraged to complete the survey.
- Survey results will be published and reported to the Arctic Council, and included in summary proceedings of the WIHAH conference.
- Responses will be collected through the end of September 2016.
- Survey URL:
 - https://www.surveymonkey.com/r/arctic_council_water_sanitation

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