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# Permafrost Thaw: An Overlooked Climate-Health Crisis

Prepared by Aruni Ranaweera and Tessa Varvares for Permafrost Pathways\*

\*Woodwell Climate Research Center launched the Permafrost Pathways project in 2022 with funding through the TED Audacious Project—a collaborative funding initiative catalyzing big, bold solutions to the world’s most urgent challenges. Through partnerships with the Arctic Initiative at Harvard Kennedy School, the Alaska Institute for Justice, and the Alaska Native Science Commission, and in collaboration with Alaska Native Tribes, Permafrost Pathways seeks to harness the combined expertise of leading research institutions and on-the-ground organizations specializing in climate science, policy, and environmental justice to inform and develop adaptation and mitigation strategies to address permafrost thaw.

## Executive Summary

Rapid thawing of permafrost has accelerated a public health crisis in Alaska by disrupting access to clean water, sanitation resources, and basic health infrastructure. For example:

- Permafrost thaw-induced damage to hospitals, roads, and runways has disrupted the delivery of critical medical services and supplies.
- Destabilization of housing and water infrastructure has created hazardous living conditions for children and families.
- Thaw-induced disruptions to fishing, hunting, and subsistence practices have threatened food security and imposed barriers to practicing traditional cultures.

As this concept note explains, these outcomes are not inevitable or irreversible. Rather, strategic investments by the U.S. federal government, Alaska state agencies, Tribal government, and other community-based entities can help to bolster financial and technical assistance programs and infrastructure that will better enable those affected by permafrost thaw to adapt and build resilience to public health disruptions.

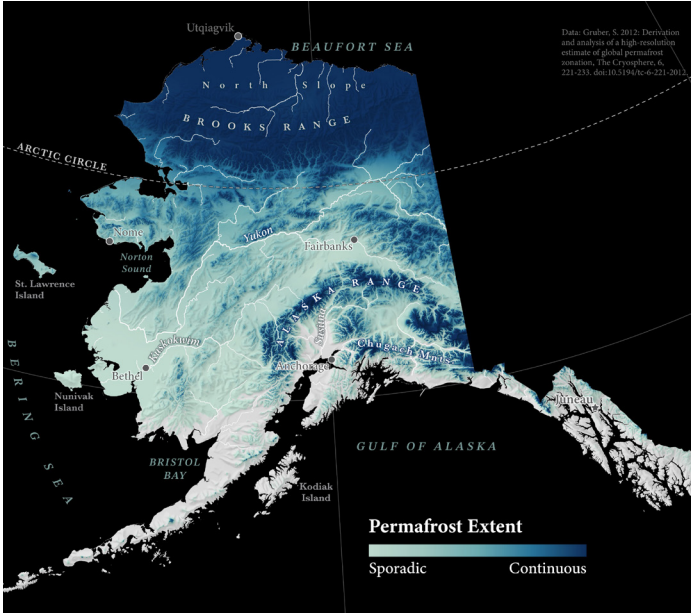
## Background

### What is permafrost and permafrost thaw?

Permafrost, rich in stored carbon,<sup>1</sup> is continuously frozen ground that underlies ~85% of Alaska’s land area.<sup>2</sup> As permafrost thaws, the softening ground can destabilize local ecosystems and cause disruptions to surface and subsurface infrastructure, including homes, buildings, roads, and public utilities. In worst-case scenarios, permafrost

Public Health Infrastructure Governance in Alaska	
Scales of Management	Key Institutions
<b>Government</b>	
Federal	Denali Commission, U.S. Environmental Protection Agency, U.S. Department of Agriculture, Indian Health Service, U.S. Department of Interior, U.S. Economic Development Administration, U.S. Department of Homeland Security, Center for Disease Control
State	Alaska Department of Environmental Conservation, Alaska Department of Commerce, Community, and Economic Development, Rural Utility Business Advisory Program (RUBA), Division of Public Health
Borough / Municipal	Local government agencies (manage roads, landfills, water and sewer)
Tribal	Tribal councils
<b>Nongovernmental</b>	
Alaska Native Tribal Health Consortium, Alaska Municipal League, Rural Community Assistance Corporation, Alaska Rural Water Association, Youth Alliance for a Healthier Alaska, Alaska Native Health Board	

thaw and compounding erosion and flooding can result in permanent land collapse, or ‘*usteq*’ in Yup’ik. Nearly 170,000 people, representing 192 communities in Alaska, live in permafrost zones,<sup>3,4</sup> and are consequently affected by the direct impacts of permafrost thaw. There are 229 federally recognized Tribes in Alaska,<sup>5</sup> each with distinct cultural practices and ways of life that are particularly impacted by these changes.<sup>6</sup>



Permafrost extent in Alaska (2024). Map: Christina Shintani/Woodwell Climate Research Center.

### How does permafrost thaw compromise human health outcomes?

Permafrost thaw puts thousands of Alaskans at serious risk of water contamination, subsistence food shortages, hospital closures, severe mold exposure, and other physical and mental health challenges. Permafrost thaw also threatens Native Alaskans’ access to natural resources and traditional practices, including firewood gathering, hunting, fishing, and trapping.

These consequences are not only of immediate concern to affected populations but signify a violation of fundamental health freedoms to which the global population is entitled. Successful safeguards of such health freedoms are those that meet four essential criteria: availability, accessibility, acceptability, and quality.<sup>7</sup> Health services must be **available** in sufficient quantities with functioning facilities, **accessible** without financial or physical barriers, **acceptable** to cultural practices, and meeting standards of **quality** for safety and effectiveness. Despite efforts by the U.S. federal government, Alaska state government, and Tribal governments and entities to implement such safeguards via institutional and policy frameworks, permafrost thaw threatens all four pillars of this right to health.

As this concept note explains, the effects of permafrost thaw contribute to discrete and measurable disruptions to the physical infrastructure and natural ecosystems that uphold environmental health in Alaska.

### Health Impact Areas & Policy Considerations

While the health impacts of permafrost thaw are extensive, this report focuses on some of the most acute health hazards, including contamination of safe drinking water, disruption of access to hospitals and healthcare, and contribution to food and housing insecurity. The included considerations for policymakers highlight opportunities to combat these challenges using government and community resources.

#### Unsafe Water and Sanitation

Permafrost thaw can **pollute drinking water sources** and **damage sewage and sanitation infrastructure**, exposing rural Alaskans to waterborne and water-washed diseases, and reducing the availability, accessibility, and quality of health services.

- Drinking Water Contamination:** In Alaska’s Brooks Range, thawing permafrost leached **toxic metals and sediments** from the soil into the watershed, exposing the community’s water supply to iron and toxic metals.<sup>8</sup> Severe erosion from permafrost thaw also **damaged the water treatment plant** in Noatak, endangering the community’s drinking water supply.<sup>9</sup> In Quinhagak, permafrost thaw has destabilized the local sewage lagoon, which is a landfill used to dispose of human waste in communities without piped water, and repairs to the lagoon may cost \$6m.<sup>10</sup> The breach of the lagoon threatens **human waste contamination** of Kuskokwim Bay and Arolik and Kanektok Rivers, a vital subsistence fishing ground for the community.



Foundation failure caused Nunapicuaq’s washeteria to temporarily close in 2022, leaving the village without running water for cleaning dishes, flushing toilets, and laundry. Photo: Susan Natali/Woodwell Climate Research Center.



- **Waterborne Disease:** Ground destabilization from permafrost thaw has **collapsed above-ground water distribution systems**, reducing access to in-home piped water and leaving rural Alaskan families to **self-haul water and human waste**. In Nunapicuaq (Nunapitchuk), the village's only water treatment facility is leaning at 20 degrees, threatening to collapse and leave the village with no treated water for dishes, laundry, and flushing toilets.<sup>11</sup> Alaskan families exposed to self-hauling practices have **more hospital visits for respiratory and skin infections**,<sup>12</sup> and reduced water supply drives one of the highest global rates of **invasive pneumococcal disease**<sup>13</sup> among Alaskan Native children.

#### Considerations for Policymakers:

- Financial and technical assistance programs can help water and utility providers maintain and upgrade treatment facilities, conduct quality assessments, and publish inspection reports.
- Public workshops and multi-generational classroom trainings can build community awareness of best practices in safe water treatment, testing, and usage.

#### Reduced Access to Healthcare

Ground destabilization from permafrost thaw has nearly **collapsed hospitals and health clinics** across Alaska, reducing access to and availability of already **limited health services and supplies**.

- **Hospital Repairs:** In Nome, permafrost thaw carved a “cave” beneath Norton Sound Regional Hospital, requiring **specialized emergency repairs** to prevent the building from collapsing.<sup>14</sup> Permafrost thaw in Quinhagak is also causing the **community's only health clinic to sink** into the ground, requiring an estimated -\$2.5m for relocation efforts.<sup>15</sup>
- **Medical Supplies:** Hospitals in rural Alaska depend on air delivery of **critical medical supplies** and equipment. Permafrost destabilization of local airport runways and roadways has temporarily severed hospitals in Nome from vital supplies.<sup>16</sup>

#### Considerations for Policymakers:

- The Indian Health Service's Maintenance and Improvement funds can be used to repair existing health facilities that have been damaged.
- Contractors familiar with constructing in permafrost regions can assist in the planning, design, and construction of resilient medical facilities.
- Logistical and administrative hurdles to procure specialized materials to construct in permafrost zones can delay project completion timelines.

#### Food Insecurity

In both Native and non-Native communities, the high costs of imported food make local foods a significant source of nutrients and energy, contributing up to 50% of energy intake in some regions.<sup>17</sup> In Alaska Native cultures, subsistence foods are also central to culture, identity, and well-being. Salmon, in particular, carry a distinct spiritual significance in Native practices.<sup>18,19</sup> “Wild foods” that are hunted, fished, or gathered are the primary local food source in Alaska. Permafrost thaw **disrupts migration patterns of food species, coastal access, and food storage capacity**, threatening the availability and accessibility of natural food sources and impeding cultural subsistence practices.

- **Hunting:** Land mammals, which account for over one-fifth of wild foods consumed by rural Alaskans,<sup>20</sup> have **adjusted their migration patterns** around landscape distortions and lake drainage from permafrost thaw.<sup>21</sup> These migration changes jeopardize food security for subsistence hunters by adding **uncertainty to locating and hunting animals**.<sup>22</sup>
- **Fishing & Marine Hunting:** Approximately 70% of wild foods consumed by rural Alaskans are salmon, other fish, and marine mammals,<sup>23</sup> but coastal permafrost thaw has destabilized coastlines, making traditional **fishing and marine hunting areas inaccessible**. As a result, coastal subsistence has become an increasingly **dangerous and limited activity** for Alaskans.<sup>24</sup>
- **Food Storage:** Permafrost has traditionally served as a natural food storage cellar with sufficient capacity for large community hunts.<sup>25</sup> Permafrost thaw can reduce cellars' cooling capacity and cause **fish and meat to spoil**, exposing communities to **food-borne illness**.<sup>26</sup>

#### Considerations for Policymakers:

- Trainings on ethical harvesting of traditional and medicinal plants, with consent of communities, can raise awareness of the cultural and practical significance of wild foods.
- Food assistance programs are a critical source of free or low-cost groceries and produce for families experiencing disruptions in the availability of subsistence foods.
- Storytelling of traditional subsistence practices, including outdoor food storage, can help document the impacts of ongoing environmental changes.

## Unsafe Housing Conditions

Permafrost thaw has caused catastrophic damage to homes by collapsing or sinking foundations, exposing families to **mold and physical safety hazards**. As homes become more costly to safely build on permafrost,<sup>27</sup> families are **overcrowding** into multigenerational homes or living in **existing unsafe homes**.<sup>28</sup>

- **Mold & Cold Exposure:** Permafrost thaw in Nunapicuaq has destabilized home foundations to the point that **walls and floorboards are cracking and gapping**. These openings allow rain, snow, and wind to leak in, **exposing residents to freezing cold** and creating **damp conditions for severe mold to flourish**. Residents have **developed chronic respiratory illness** from mold exposure.<sup>29</sup>
- **Overcrowding:** The **shortage of stable** land to build homes combined with the high **costs of building permafrost-resilient foundations** has contributed to housing shortages and severe home overcrowding.<sup>30</sup> In Northwest Alaska, 39% of homes are overcrowded by Housing and Urban Development standards.<sup>31</sup> Overcrowding can **increase stress, strain relationships, and deteriorate sleep quality and mental health**.<sup>32</sup>

### Considerations for Policymakers:

- Indoor air quality monitoring projects organized by community-based health organizations can bring greater public awareness to household hazards such as mold.
- Regular monitoring and evaluation of in-home environmental threats can help reduce risk and exposure to health hazards.
- Energy efficiency evaluations, infrastructure upgrades, and regular maintenance can help ensure homes are sufficiently insulated from the cold.

## Compounding Health Effects

The thawing of permafrost in Alaska poses multiple threats to public health, and policymakers must support programs, policies, and initiatives that safeguard the fundamental human right to health. However, permafrost thaw is only one of many public health challenges facing Alaskans. An increasing health risk to Alaskans comes from wildfire smoke exposure. Alaskans exposed to wildfire smoke had **higher cardiorespiratory visits to the emergency room** both during and several days after exposure.<sup>33</sup> Alaskans living in permafrost zones also experience mental health challenges from existential anxiety about the current and future state of environmental conditions in Alaska<sup>34</sup> as well as the mental health strains of housing overcrowding. These health risks are compounding stressors for public health. Finally, while some permafrost in Siberia was discovered

to have ancient frozen pathogens, harmful pathogens have not yet been discovered in Alaska, and scientists have determined these risks to human health to be low.<sup>35</sup>

## Conclusion

The public health hazards of permafrost thaw are mediated by damage to both the natural environment and critical water, sanitation, housing, and healthcare infrastructure. Programs and advocacy to build infrastructure resilience and protect natural resources can help guarantee Alaskans' rights to health. Community-based organizations like the Alaskan Native Tribal Health Consortium are leading these efforts, but additional federal and state resources should help accelerate adaptation and resilience to permafrost thaw and stop the permafrost public health crisis in Alaska.

## References

1. "Global policy positions on permafrost and wildfire mitigation and adaptation," Woodwell Climate Research Center, June 2024.
2. "Permafrost," AK Department of Fish and Game.
3. "Alaska Population Overview: 2017 Estimates," AK Dept of Labor & Workforce Development, Nov. 2018.
4. Ramage, J., et al., "Population living on permafrost in the Arctic," *Pop & Environ*, 43, 2021.
5. "Alaska Region," Bureau of Indian Affairs.
6. "The Unmet Needs of Environmentally Threatened Alaska Native Villages: Assessment and Recommendations," Alaska Native Tribal Health Consortium, Jan. 2024.
7. "Human Rights," World Health Organization, Dec. 2023.
8. O'Donnell, J.A., et al., "Metal mobilization from thawing permafrost to aquatic ecosystems is driving rusting of Arctic streams," *Comms Earth & Environ*, 5, 268, 2024.
9. Naiden, A., "Escalating erosion prompts move to repair Notak's water system, secure fuel tanks and protect airport," *Arctic Sounder*, Oct. 3, 2024.
10. Shallenberger, K., "For Quinhagak, climate change means they may have to move," Alaska Public Media, June 17, 2019.
11. McCarthy, W., "Nunapitchuk's laundromat and water treatment building is tilting precariously," KYUK, Aug. 25, 2022.
12. Hennessy, T. W., & Bressler, J. M., "Improving health in the Arctic region through safe and affordable access to household running water and sewer services: an Arctic Council initiative," *Int Journ Circumpolar Health*, 75(1), 2016.
13. Wenger, J., et al., "Invasive Pneumococcal Disease in Alaskan Children," *Pediatric Infectious Disease Journ*, 29(3), Mar. 2010.
14. McDonald, D., "Emergency Beneath the Hospital," *Spray Foam*, Nov. 28, 2018.
15. Shallenberger, "For Quinhagak."
16. Berton, H., and Ringman, S., "As climate change melts Alaska's permafrost, roads sink, bridges tilt and greenhouse gases release," *Seattle Times*, Dec. 16, 2019.
17. Walch, A., et al., "A scoping review of traditional food security in Alaska," *Int Journ Circumpolar Health*, 77(1), 2018.
18. "Social and Cultural Dimensions of Salmon Systems Working Group," State of Alaska's Salmon and People.
19. Carothers, C., et al., "Indigenous peoples and salmon stewardship: a critical relationship," *Eco & Soc*, 26(1), 2021.
20. University of Alaska Fairbanks and Alaska Food Policy Council, "Alaska Food Security and Independence Task Force 2022 Report," Mar. 2023.
21. Joly, K., et al., "Caribou and reindeer migrations in the changing Arctic," *Animal Migration*, 8(1), 2021.
22. "Climate change and wild foods in Alaska," U.S. Dept. of Agriculture.
23. "Alaska Food Security and Independence Task Force 2022 Report."
24. "Permafrost Thaw Emerges as Key Driver of Arctic Erosion," *Technology Networks*, Dec. 4, 2024.
25. Schwing, E., "Alaska whaling communities pilot a project to keep traditional ice cellars frozen," *High Country News*, Jan. 30, 2023.
26. Brubaker, M., et al. "Climate change effects on traditional Inupiat food cellars," Alaska Native Tribal Health Consortium, Oct. 19, 2009.
27. George, K., "New study hints at huge price tag from permafrost thaw in Alaska," Alaska Public Media, Oct. 17, 2023.
28. AK Housing Finance Corporation, "2018 Alaska Housing Assessment," Jan. 2018.
29. Bean, S., "As the permafrost melts, the houses in Nunapitchuk are breaking down," Alaska Public Media, Jan. 12, 2024.
30. Bean, "As the permafrost melts."
31. Lindsey, K., "Overcrowded homes remain a health crisis in North America's Arctic," *ArcticToday*, Feb. 20, 2018.
32. "Housing Instability," U.S. Dept. of Health & Human Services.
33. Hahn, M.B., et al., "Wildfire smoke is associated with an increased risk of cardiorespiratory emergency department visits in Alaska," *GeoHealth*, 5(5), 2021.
34. Brubaker, M., et al., "Climate change and health effects in Northwest Alaska," *Global Health Action*, 2011(4), 2011.
35. Wu, R., et al., "Permafrost as a potential pathogen reservoir," *One Earth*, 5(4), 2022.