



Climate Change Effects on Traditional Food Cellars in Barrow, Alaska

Center for Climate and Health

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This paper reports on a special health concern identified during surveys performed in November of 2009 and January 2010: the thawing of traditional, underground food storage cellars. Thawing permafrost is reducing the quality and quantity of food resources for some families, and resulting in cellars that have the potential to collapse and cause injury. In this Bulletin, the problem is described and recommendations are presented for performing comprehensive assessments of traditional ice cellars in Barrow and other Arctic communities.

Introduction – George Adams is Inupiaq Eskimo, a Whaling Captain. In the spring and the fall of each year, his six man crew hunts bowhead and beluga whale in the coastal waters of the Beaufort Sea. Harvested whale meat and blubber is divided between the crew, and then stored in traditional ice cellars (sigl-uaqs). His family has relied upon their cellar for generations; even in summer they could descend into the icy, earthen room and retrieve frozen food for their dinner. But in January George Adams opened the cellar door, and found water on the floor of his cellar. Despite outside temperatures that were below zero degrees Fahrenheit, the interior of the cellar was well above the freezing point. The food was not frozen, but wet and beginning to mold. For the first time in over 100 years, the cellar had failed.



Price Leavitt and George Adams inspect the Adam's ice cellar. (M. Brubaker, 2010)

In Barrow, the northern most community in Alaska, some traditional ice cellars are no longer providing a safe or effective method of food storage. The reason is climate change related warming, and resulting thaw of permafrost. There are many cellars in Barrow used by whaling crews and their families to store meat and blubber from the spring or fall hunt. The failure of these ice cellars is a crisis for the Inupiat. The cellars are a critical component of the northern marine subsistence culture, providing an inexpensive and effective method for storing large quantities of harvested food. But now, some cellars, even in winter, are too warm for food storage. As they thaw, the Inupiat are increasingly at risk for foodborne illness, food spoilage, and even injury from structural failure. Climate change is disrupting the traditional food system and creating a new safety risk.



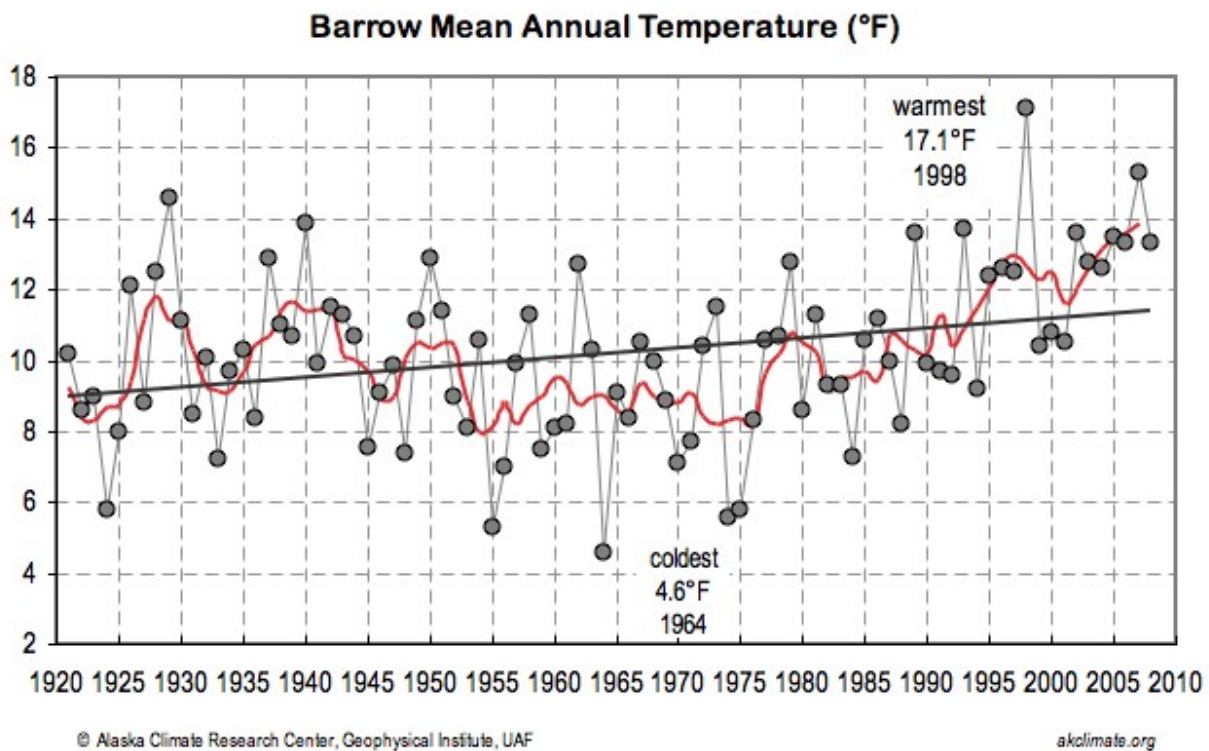
Price Leavitt examines standing water on the floor of the Adam's ice cellar. (M. Brubaker, 2010)

But some cellars continue to perform adequately. This raises questions about the kinds of factors that influence cellar temperatures. Will Barrow someday be like Point Hope, where the summer use of cellars has mostly failed? What makes a cellar vulnerable to thawing and what options are available for improving food storage? A comprehensive survey to understand these factors (location, surface conditions, design, type of construction, depth, soil type, use, maintenance, etc.) is the first step in addressing the problem.

Background

Evidence of Warming - The Barrow weather station is located at the Wiley Post / Will Rodgers Memorial Airport and is operated by the National Weather Service. Mean temperatures at the station remain below the freezing point most of the year and below zero degree temperatures have been observed in every month. February is typically the coldest, with a mean of -15.9 degrees Fahrenheit (1971-2000). July is the warmest month with mean temperature of 40.4 degrees Fahrenheit (Alaska Climate Research Center).

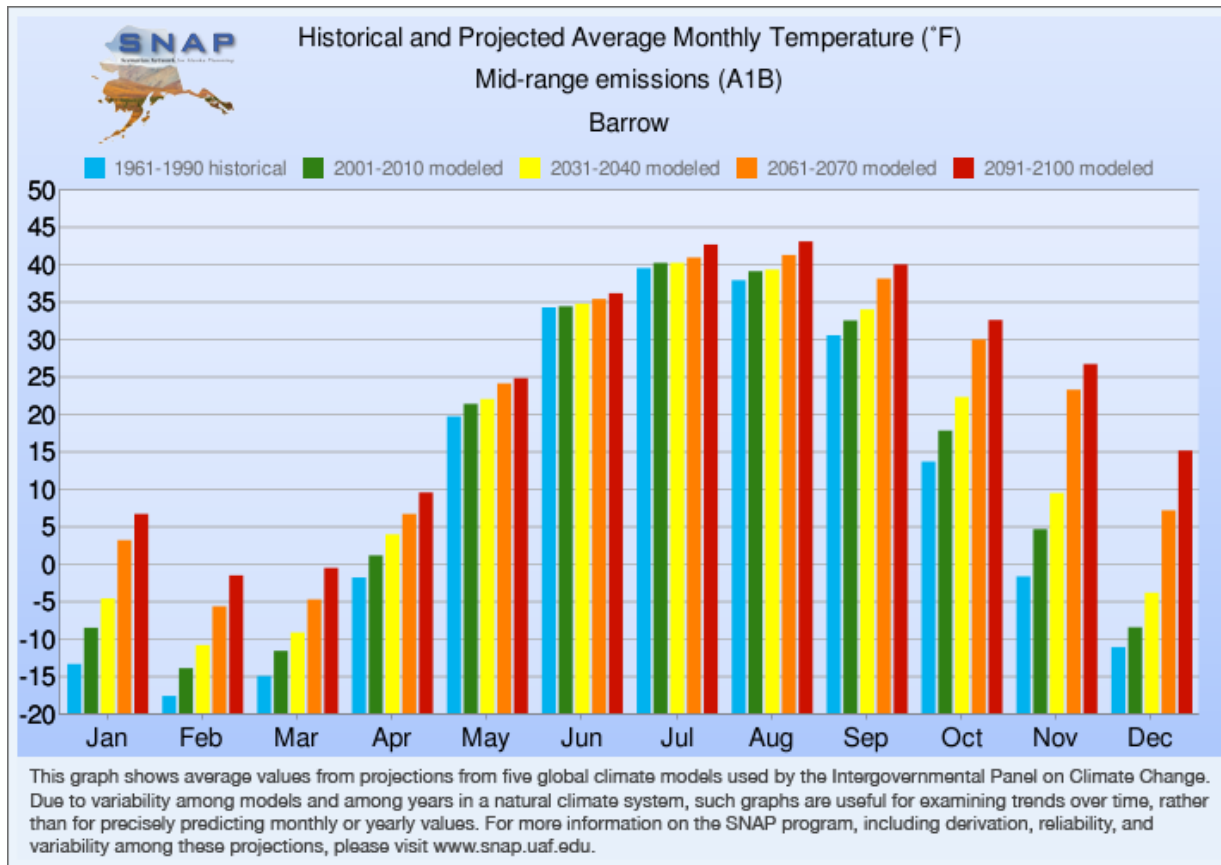
The temperature archives from the National Weather Service station in Barrow provide one of the longest temperature records available in Alaska, dating from the early 1920s. The following graph shows temperature trend data for much of the past century. Though there has been considerable variation and periods of warming and cooling, the mean average annual temperature has been gradually increasing. Over the past 50 years, the mean annual temperature in Barrow has increased by 4.5°F, higher than the statewide average. The amount of change varies with the season, but all seasons have increased: average winter temperatures by +6.7°F, spring by +4.5°F, summer by +3.0°F, and fall by +3.7°F (Alaska Climate Research Center).



Thawing Permafrost - Soil temperatures have also increased throughout Alaska (Romanovsky et al., 2007). As much as the top 30 ft of discontinuous permafrost is projected to thaw in Alaska over this century (Parson, 2001). The largest increases in soil temperature have been measured in the northern part of the state (Osterkamp, T., 2007). Researchers from the University of Alaska Fairbanks, Permafrost Laboratory have been monitoring changes in soil temperatures in Barrow since 2003, at depths of up to 50 meters below surface grade. The soil temperature have gradually increased in the top ten meters (Romanovsky et al, 2010).

The climate history over the past 100 years clearly demonstrates a warming trend in Barrow. Climate models project that warming will continue into the future. The Scenario Network for Alaska Planning (SNAP) at UAF, projects increases in Barrow’s annual temperature for every month of the year through 2100 (SNAP, 2010). The “A1B Mid Range Emission Model” based on mid range projections for current and future global CO₂ emissions is provided in the following

graph. The SNAP Projections are based on five global climate models used by the United Nations, Intergovernmental Panel on Climate Change (IPCC).



Ice Cellars - Arctic indigenous peoples are known to be particularly vulnerable to health impacts of climate change, in part because of the threat to traditional food safety and food security (Confalonieri et al., 2007). The traditional subsistence diet of Alaska Natives is nutritious and protective against the development of cancer, heart disease, diabetes and other metabolic disorders (Boyer et al., 2007). Ice cellars, a traditional method of storing whale meat and blubber are still in use in many northern coastal communities, including Kivalina, Point Hope, Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik. The traditional cellars offer convenience, ample space, and an economical method for refrigeration.

ANTHC has documented ice cellar thawing in Kivalina and in Point Hope (Brubaker et al., 2009). In November of 2009 and in January of 2010 representatives of the North Slope Borough, Department of Health and Social Services (NSB), the Inupiat Community of Arctic Slope (ICAS), and the Alaska Native Tribal Health Consortium's Center for Climate and Health (ANTHC) performed surveys of ice cellars in Barrow. The ice cellars are the property of three whaling captains: George Adams, Harry Brower (2 cellars), and Qulliuq Pebley. The Pebley cellar was surveyed on November 6, 2009 on a day when the outside temperature was 3°F. Heather Dingman from the North Slope Borough, Captain Pebley, and Mike Brubaker from ANTHC

participated. There was no evidence of thawing observed in the Pebley cellar, and Mr. Pebley stated that he had not experienced any problems.



Qulliuq Pebley opens the door to his ice cellar. (M. Brubaker 2009)

The other three cellars were surveyed on January 5, 2010, when the outside temperature was -7°F . Whaling Captain George Adams, Price Leavitt, and Jim Martin from the Inupiat Community of the Arctic Slope and Mike Brubaker from ANTHC participated. All three of these cellars showed evidence of thawing and temperatures that were near or above freezing. Despite warmer than average conditions during the winter, mean monthly temperatures were still well below freezing: 0°F in November, -3° in December and -16°F in January 2010.

In each of the three cellars, the temperature and degree of thaw varied, but temperatures in the cellars were considerably warmer than the outside air. Measurements taken on the same day from the Barrow Arctic Research Consortium (BASC) Permafrost Research Tunnel, recorded a difference of 33 degrees between the outside air temperature (-13°F), and the temperature at a depth of 18' in the tunnel (20°F). The construction design of each of the cellars also varied. Two of the cellars were enclosed in sheds that provided some insulation and allowed for opening the cellar door without concern for blowing snow or intrusion. The other two cellars were open to the environment and accessed through a door that was flush and slightly raised above the ground surface. Two of the cellars had standing water, despite opening of the cellar during periods of sub zero temperatures (G. Adams, personal communication).



Price Leavitt and Jim Martin inspect one of Harry Brower's ice cellars. (M. Brubaker, 2010)



Price Leavitt inspects the condition of a cellar shaft and walls. (M. Brubaker, 2010)

The composition of this water is unknown, and may have been brackish, affecting the freeze temperature. Brackish water has been described as a problem in some cellars (K. Yoshikawa personal communication), although not observed in the past in the Adam's cellar. Thawing is not only resulting in unsafe food storage conditions but is also undermining the structural integrity of some cellars. Instead of being hard, the walls in thawing cellars are friable,

beginning to crumble and collapse. In one deep cellar (~40 feet) the piling foundation of the shaft had begun to sink into the ground, slumping was occurring and collapse of the shaft appeared imminent.

Food Safety - Warming soil conditions also facilitate spoilage of food. The temperature and humidity inside the cellar is critical for food safety. Higher temperatures can increase *salmonella*, a bacteria that causes fever, diarrhea and abdominal cramps (Kovats et al., 2004). Bacteria must multiply before enough are present in food to cause illness. Given warm, moist conditions and an ample supply of nutrients, one bacterium can produce millions of progeny in a single day. Below freezing temperatures impede most bacteria growth but allow some to survive. The optimal storage temperature for most frozen foods is from 0°F to -10°F (USDA, 1994). Whale meat and whale blubber preserve differently, temperatures below -10°F are ideal, allowing for preservation of up to one year (D. Drum, Personal Communication). The temperature profiles for traditional cellars in Barrow and other locations are largely unknown.

Discussion

Underground cellars have provided food storage for thousands of years, but today they are increasingly vulnerable to warming. In Kivalina and Point Hope, the cellars thaw and flood during the summer. Now in Barrow, the northernmost community in Alaska, the cellars are also beginning to fail. The traditional diet and overall food security relies upon having adequate storage for large quantities of harvested whale meat and blubber. Loss of adequate storage affects food security and raises concerns about foodborne illnesses.

To address the food security and safety problems in Barrow and other Arctic communities, alternative methods for food storage must be developed. There are several possible adaptive approaches: 1) improve the storage environment in existing cellars, 2) establish new cellars at a location with a better environment and more stable permafrost, and 3) develop an alternative method for food storage. Since many cellars are still in use, the priority is on finding ways to prevent them from thawing. Understanding the conditions inside the cellars, and the factors that affect them is critical for determining the best food storage adaptation options.

Recommendation – A study of food cellars in Barrow is recommended, to be performed in collaboration with the Barrow Whaling Association. The purpose of the study would be to characterize the cellars and environmental changes affecting the cellars and the food quality. The study would include surveys of cellars, mapping of locations and conditions of cellars and surrounding environmental conditions (outside air temperature, snow accumulation, soil moisture etc.), and monitoring of the cellar and surrounding outside environments, with the objective of describing cellar conditions and vulnerability to the effects of warming. The need is urgent, but the study could proceed in phases if necessary, based on availability of funding and other resources, and schedules of use.

The methodology would include interviews of cellar owners and inspections of cellars. Locations of existing temperature monitoring probes would be recorded, and where possible, probes would be installed in active cellars; data from the probes would be downloaded on a semi annual basis. Air temperature and snow conditions outside of cellars also will be recorded. A preliminary report with findings would be developed with mapping, interview and survey results. Analysis would be performed at the end of the first year, and soil temperature data would be added annually. Data collection components of the study would include:

- Interviews – of whalers to ascertain cellar history, construction, use, and condition;
- Surveying – to determine cellar depth, size, condition, structural integrity;
- Mapping – location of cellars in Barrow, and local soil temperature conditions;
- Monitoring – to record soil temperature, air temperature and humidity, inside air temperature and snow accumulation outside of cellars;
- Analysis of raw food samples collected from cellars.

Conclusion - Loss of traditional cellars is occurring in Barrow and in other Arctic communities, due to warming soil temperatures and permafrost thaw. This is reducing the quality and quantity of food available to residents. The degree of vulnerability and the factors that influence ice cellar success and failure are not well understood, but adaptive measures are necessary in some locations. Any adaptation response should be locally driven, culturally appropriate, economical, sustainable, and should meet public health guidelines. Adoption of adaptive measures for food management can help to reduce the negative effects of climate on health (Lake et al. 2009). Without adaptive measures, the current climate conditions will continue to destabilize food security and increase the risk of foodborne illnesses.

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