Climate Change in **Point Hope**, Alaska

Strategies for Community Health

ANTHC Center for Climate and Health

Funded by

Report prepared by:

Michael Brubaker, MS (Lead Author)
James Berner, MD
Jacob Bell, MS
John Warren, PE
Alicia Rolin

ANTHC Advisors:

Tim Gilbert MPH
Jeff Smith MS
Mike Bradley DVM MPH
Kathy Graves PhD
Steve Weaver PE
Gary Ferguson ND
Jennifer Johnson MPH
Desirae Roehl
Troy Ritter MPH
Aaron Wernham MD MPH

Funded by United States
Indian Health Service Cooperative
Agreement No. AN 08-X59

Special thanks to the many people who assisted this project:

Annabelle Alvite
David Atkinson
Lillian Alyssa
Lee Anne Ayers
Susan Beck
Matthew Bergen
Melissa Boney
Carl Borash
Gordon Brower
Jill Brubaker
Caroline Cannon
John Chase
David Christie
Louie Commack
Sally Cox
Ben Crosby
Amy Davenport
Michelle Davis
Jeffrey Demain
Heather Dingman
Michael Dirks
Liz Dowd
David Driscoll
Doug Drum
Darcy Dugan
Laura Eichelberger
Hajo Eicken
Ian Ehrlich
Jim Evak
Courtney Flint
Berit Arnestad Foote
Andrew Frankson
Teddy Frankson
Connie Fredenberg
Charlie Gregg
Yuri Gorokhovich
Kyla Hagen
Clark Hanfield
Millie Hawley
Stan Hawley
Jack H'ebert
Tom Hennessey
Grant Hildreth
Helena Hildreth
Jackie Hill
Larry Hinzman
Amy Holman
Eldon Hunnicutt
Willard Hunnicutt
Irving Igtanloc
Troy Izatt
Anore Jones
David Kang
Andy Kliskey
Angie Koonook
Ray Koonuk Sr.
Mida Koenig
Danny Lane
Rachael Lee
Anthony Leiserowitz
Cindy Lincoln
John Lingaas
Harry Lind
Eva Long
James Magdanz
Ingemar Mathiasson
Molly McCammon
Jim Magdanz
Tina Moran
Steve Oomittuk
Tom Okleasik
Iris Oktolik
Bessie O'Rourke
Reggie Ovick
Toren MaCarthy
Florence Mitchell
Alan Parkinson
Sverre Pedersen
Jackie Poston
Dan Rinella
Stephanie Rolin
Bruce Richmond
Barrett Ristroph
Vladamir Romanovski
Scott Rupp
Cheryl Rosa
Daisy Sage
Bob Schaffer
Bruce Sexauer
Mark Shasby
Martha Shulski
Robbin Garber-Slaght
Hazel Smith
Fred Sorensen
Ellen Sovalik
Kimberly Stone
Scott Sharp
Kurt Schmidt
Stanley Tomaszewski
Joe Towksjhea
Sarah Trainer
Lily Tuzroyluke
Cathy Villa
Hiram Walker
John Walsh
Jeff Welker
Dan White
Siikauraq "Martha" Whiting
Charles Wohlforth
Lloyd Vincent
Kenji Yoshikawa

Alaska Native Tribal Health Consortium (ANTHC), August 2010

TABLE OF CONTENTS

Through adaptation, negative health effects can be prevented.

Cover Art:
Whale Bone Mask by Larry Adams

SUMMARY

On a narrow promontory extending far out into the Chukchi Sea, the village of Point Hope enjoys one of the finest locations in Alaska for the harvest of subsistence resources, including fish, marine mammals, birds and caribou. This amazing place has allowed the Inupiat of Point Hope to flourish for centuries, and it is one of the oldest continuously occupied communities in Alaska. But it is also one of the most exposed, vulnerable to the full force of coastal storms and the constant shaping of the land by the wind and the sea. Shore erosion and the risk of flooding has forced relocation in the past. Today with the added pressure of climate change, Point Hope continues its struggle with increased urgency; against erosion and against other new emerging challenges to the community, the culture, and to public health.

Weather archive data from the 1930s show a gradual increase in temperature and precipitation in Point Hope. By 2061 to 2070, climate models suggest that average July temperatures will have increased by approximately 2°F and December temperatures by 22°F. Increases in precipitation are projected for every month except June, as is a drier summer with broad impacts to wildlife, vegetation.

The rate of shoreline erosion is increasing due to changes in timing of ocean freezing and thawing, delays in the development of shore-fast ice, and increases in the intensity of storms. Flooding has been prevented through village relocation and beach berm construction. Despite these efforts, Point Hope continues to be vulnerable to storm surges and ice jams, with both the air strip and overland evacuation route at risk. It is projected that the mean sea level could cover much of the Point Hope Peninsula within 50 to 100 years. Changes in weather and ice conditions are causing delays to subsistence activities, including the timing of spring whale and walrus hunts. Ice conditions have been inadequate in recent years to provide haul-out platforms for walrus, or for hunters to clean bowhead whales. Shore ice has become unstable, putting hunters at greater risk for injury. In the spring of 2008, shore-fast ice broke free, casting Point Hope whaling crews and camps adrift, and requiring a helicopter rescue from Barrow.

Hunters are also observing changes in wildlife. Hungry polar bears have begun to frequent Point Hope, becoming a nuisance and a public safety concern. Warm summer temperatures are providing opportunities for invasive species to become established and in some instances to interfere with subsistence activities. Ravens and gull populations are increasing and interfering with summer fish camp activities. Beaver are changing the river system and increasing the

Protection of human life and health is the top priority.

risk of waterborne disease. New salmon species are being harvested, presenting a positive new subsistence opportunity.

Three issues were identified that are of special public health concern: first, the permafrost that cools traditional underground food storage cellars is thawing, and there are currently no community alternatives for storage of whale meat and blubber. Secondly, warming is contributing to changes in 7 Mile Lake, the community drinking water source. Temperature influenced blooms of organic material have clogged water filters, adversely affecting water treatment. Thirdly, the community is increasingly vulnerable to flooding, due to storm intensity, erosion and late freeze up. The airstrip and 7 Mile road are also vulnerable. Emergency planning should continue to address these vulnerabilities, encourage early warning systems for storm events and ensure that evacuation routes and adequate shelter is available in a safe location.

Point Hope would benefit from increased participation in weather, coastal zone and wildlife observation and monitoring programs, expanded collaborations with researchers, and increased local capacity for climate change coordination and management. Through such efforts, informed decision-making can occur within local government to address vulnerabilities, and to adapt to climate change impacts.

Point Hope Alaska
Mike Brubaker, 2009

Traditional values should guide local and regional decision making.

INTRODUCTION

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2008). Climate is changing rapidly in the Northwest Arctic and leadership organizations seek better information about impacts and vulnerabilities, so that adaptive measures can be developed. This includes new approaches for developing health infrastructure and providing health services and health care. The twelve Northwest Arctic communities receive health services from Maniilaq Association, the regional tribal health consortium for the Northwest Arctic (Figure 1).

The community of Point Hope is located at the western most point on the northwest Alaska coast (Figure 2). Life in Point Hope revolves around the harvest of sea mammals: walrus, seal, and, most importantly, whale. In 2009, many things are the same as they have been for thousands of years; whaling crews and their families spend months preparing for the spring hunt, repairing skin boats and wooden sleds, mending clothing and tents, sharpening harpoons, and preparing underground food cellars for storage of meat and blubber. But whaling, like other aspects of life in Point Hope, is changing.

In almost every month the air temperature is warmer. Sea ice is diminishing, making travel and hunting more difficult and dangerous. New species of plants, fish, birds, and other wildlife are becoming increasingly common, while endemic species such as walrus are becoming increasingly rare. Land is thawing, washing away into the rivers or disappearing in great chunks into the Chukchi Sea. Warming water is causing blooms of algae in tundra ponds, changing the ecology and diminishing drinking water quality.

These changes are influencing food and water security and the potential for disease and injury. They are also raising new concerns about the effects of life-altering change on the mental health of Arctic people. Many effects are negative, but some can be positive: new food resources, a shorter flu season, economic opportunity, and a lengthened season for making potable water. This project has recorded local observations, described climate relationships (where possible), and explored potential community health implications. It is hoped that this work will help facilitate informed decision-making, and the development of adaptive measures that will encourage a safe, healthy, and sustainable future for the people of Point Hope.

This report documents observed climate-related change in one community and evaluates potential effects on health. What occurred in the past is reported based on the record, and the recollection of Point Hope residents. What will happen in the future is unknown, and the reader is reminded that all predictions included in this report are subject to inherent uncertainty, and limited by the quality of data and the state of the science in this developing field of health impact assessment.

Although there is good regional climate and general health data for the Maniilaq Area, local data is limited. Weather archives are incomplete, coastal erosion rates are outdated, permafrost measures are unavailable, and estimates of sea level change have not been performed.

Local data was used when available, but the assessment was limited both by the data gaps and by the limitations of down scaling

COMMUNITY PROFILE

Point Hope is located

330 miles southwest of Barrow and 180 miles north of Kotzebue. It is near the tip of Tigara Peninsula, a gravel spit that is the western most point on the Northwest Alaska coast (Figure 3). It is also within the boundaries of the North Slope Borough and receives health services from the Maniilaq Association. All other communities served by Maniilaq are located in the Northwest Arctic Borough.

The Chukchi Sea surrounds the Point Hope promontory on three sides but the near shore waters are very shallow; up to five miles from the shore, the water reaches depths of only 60 feet. Tides do not have a direct impact on Point Hope, but strong ocean currents bring waters north through the Bering Strait. Sea ice can be present from October to early July. Sediments deposited by the Ipewik and Kukpuk branches of the Kuukpak River form beach ridges that extend into the sea in a triangular shape. The mountainous areas reach elevations of 1,000 to 2,000 feet in the Lisburne Hills to the north and the Kemegrak Hills to the south.

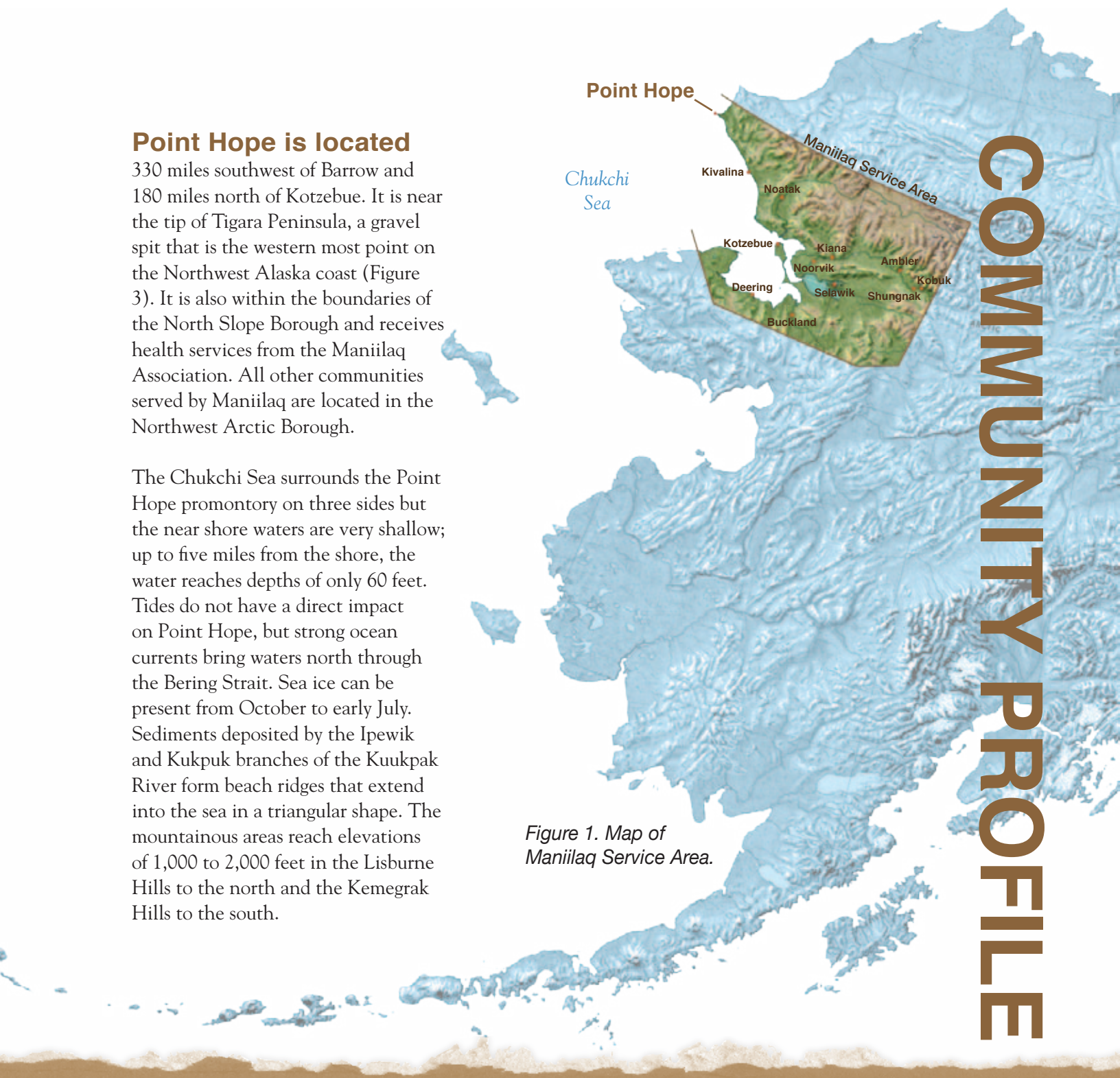


Figure 1. Map of Maniilaq Service Area.

from regional sources. The value of health indicators, such as incidence of heart disease or pneumonia, is difficult to gauge at the community level because small populations limit the statistical reliability.

Anecdotal data was collected on the observations and experience from local experts in health, wildlife, whaling, Inupiat culture, weather, subsistence, education, sanitation, local governance, law enforcement, and emergency services (Appendix A). Predictions and projections on future conditions such as warming, flooding, and erosion are based on available information, and limited by the quality of current scientific data and the uncertainties inherent in climate models.

The Tigara (Tikeraq) Peninsula, named for the Inupiaq word for index finger, dates back to 600 B.C as one of the oldest continuously occupied Iñupiat marine mammal hunting communities in the Arctic. Commercial whaling came to Point Hope in the 1800s, including shore-based stations. For the next 100 years commercial whaling exerted a powerful influence on Point Hope, providing jobs, but also increasing exposure to western goods, technology, culture, and disease. The City of Point Hope was incorporated in 1966. The Native Village of Point Hope is the federally recognized tribal government.

In 1990, Point Hope had a total population of 639. In 2000, the population was 757, with 91% Alaska Native. In 2000, 25.71% of the population was employed and 51.32% of adults were not in the workforce. The median household income was $63,125, per capita income was $16,641, and 14.83% of residents were living below the poverty level (DCCED, 2009). Most full-time employment is with the city, tribal and borough governments, or with Tikigaq, the local Alaska Native for-profit corporation formed under the Alaska Native Claims Settlement Act.

Figure 2. Map of Point Hope Area

"The storms are very scary. It is the lagoon side of town where the flooding can start, the sea washing into the lagoon."

Lily Tuzroyluke

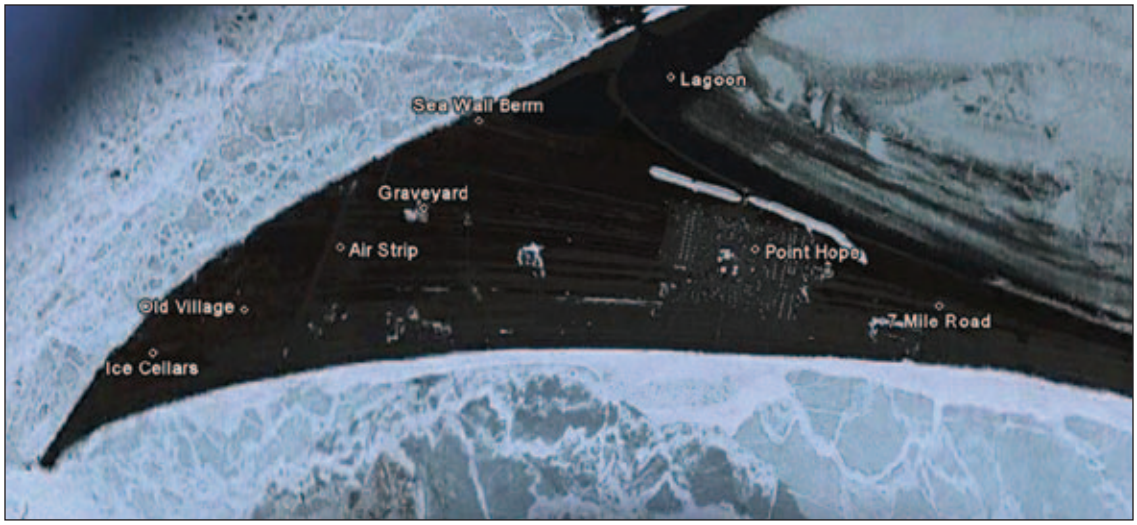


Figure 3. Map of Point Hope Area (Google Earth)

Residents are active year-round with subsistence activities for seals, walrus, bowhead whales, beluga whales, caribou, polar bears, birds, fish and berries, greens, and other edible plants. Commercial fishing is limited; in 2000, only two residents held a commercial fishing permit. Whalebone masks, baleen baskets, ivory carvings, and Inupiat clothing are manufactured locally. Point Hope is a dry community, where the sale, importation or possession of alcohol is banned.

A paved airstrip provides Point Hope's only year-round access. An overland evacuation route via the 7 Mile Road leads inland. Skiffs, skin boats, and snowmachines are used for local transportation and barges deliver goods during summer months.

The North Slope Borough provides all utilities, and piped water and sewer is available for most residents. The water source is a tundra lake located seven miles from the town. The Tikigaq School provides K-12 education for approximately 223 students.

The Point Hope Clinic is staffed by two community health aides and residents must travel about 150 miles by air to Kotzebue for the next level of primary care and some specialty care at the Kotzebue Hospital. Most specialty health care is provided at the Alaska Native Medical Center, located 540 air miles away in Anchorage.

"Last two years the polar bears started coming to town, hungry. It is really dangerous to walk out."

Joe Towksjhea

TEMPERATURE

Observed change: *increasing variability and extremes; delayed freeze-up and early thaw.*
Health concerns: *injury from extreme weather, increased cost for basic services.*
Projected change: *warmer and more precipitation, winter temperatures above 0°F.*
Potential adaptation: *improve local weather observations, injury prevention.*

In Point Hope, significant changes in temperature, precipitation, wind, and other indicators of climate change have been observed by local residents. This includes an increase in frequency of extreme weather and changes in seasonality, with spring thaw occurring earlier and the fall freeze-up occurring later. Residents report summers that are very hot and dry, and winters that are more variable, with sudden and dramatic temperature swings between very cold and very warm. The exception was the winter of 2008/2009 which brought extreme high temperatures, then low temperatures, and then record snow fall and snow accumulation.

Over the past 50 years, Alaska has warmed at more than twice the rate of the rest of the country. The annual average temperature in Alaska has increased 3.4°F, with winters warming by 6.3°F (Fitzpatrick et al., 2008). Average annual temperatures are projected to rise another 3.5°F to 7°F by the middle of this century (U.S. Global Change Research Program, 2009). The Point Hope climate is arctic. Historically, summers have been short and cool, with temperatures ranging from 30°F to 50°F. During the winter, temperatures averaged below zero, sometimes as cold as -50°F, but generally between 0 and -10°F. Precipitation is light, 10 to 12 inches annually, with about 36 inches of snowfall that becomes hard-packed by November. Strong northern surface winds bring storms of blowing snow. The Chukchi Sea has typically been ice-free from late June until mid-September, when the slush ice would form along the shoreline.

Weather data is collected from the FAA Station at the Point Hope airstrip and includes: wind speed, wind direction, dew point, precipitation, snow fall, snow on the ground, peak winds, extreme snow loads, and temperature (Figures 4,5). Archive data is available from 1924 to 1954, but is incomplete with no data during the 1960s, 70s, or 80s. Weather data for Point Hope from 1991 until 2008 is available from the Kotzebue Field Office of the National Weather Service (NWS). A comparison of mean monthly temperature for this period shows that Point Hope is an average of five to ten degrees colder then Kotzebue during summer months, but has

"The summers have been very hot and no rain. The winters have been very windy and bad storms."

Andrew Frankson

approximately the same average winter temperatures. Additionally, Kotzebue and Point Hope have increased temperature at roughly the same rate since 1944.

Archive weather data (temperature and precipitation) for Kotzebue spans from the 1930s until the present. The Kotzebue temperature data shows a gradual increase in average annual temperature and total annual precipitation between the 1940s and the present. Between 1949 and 2006 the Northwest Arctic had an increase in average annual temperature of 3.2°F (Shulski, 2007). During this period, winter temperatures changed most dramatically and fall temperatures the least. For December through January, temperatures increased by 6.8°F, spring (March to May) increased by 2.1°F, summer (June to August) by 2.4°F, and fall (Sept. to Nov.) by 1.4°F.

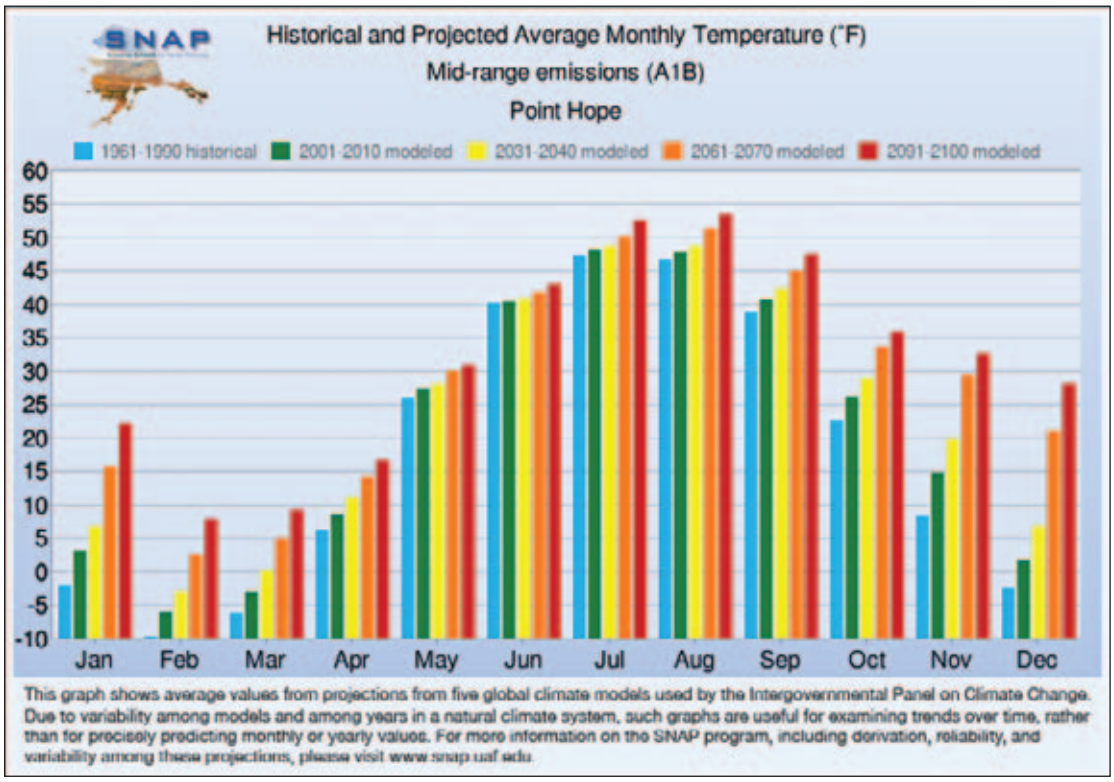


Figure 4. Historic & Projected Temperature, Point Hope, Alaska
UAF, Scenario Network for Alaska Planning 2010

"We used to have frozen whale meat and maktuk all winter and summertime, too. It is not frozen anymore."

Joe Towksjhea

Observations from Point Hope residents reflect local concerns over the relationship between weather and health. One elder stated that weather variability was increasing frequency of infectious diseases like colds and influenza, and severity of chronic conditions such as arthritis (Towksjhea, J. 2009). School officials noted that the wind and extreme cold during the winter was unsafe for young children traveling to and from school (McCarthy, T. 2009).

There was no data of a change in rates of weather-related health issues, such as vehicle accidents, hypothermia or frostbite (Davenport, A. 2009; Sharp, S. 2009). However, as reported by the Fire Chief, there were frequent travel alerts via VHF radio, 20 search and rescues were performed this year, and winter travelers exercised caution and used borough supplied personal locator beacons (Hunnicutt, W. 2009). When activated, the beacons send out a signal that is picked up by search and rescue services in Barrow.

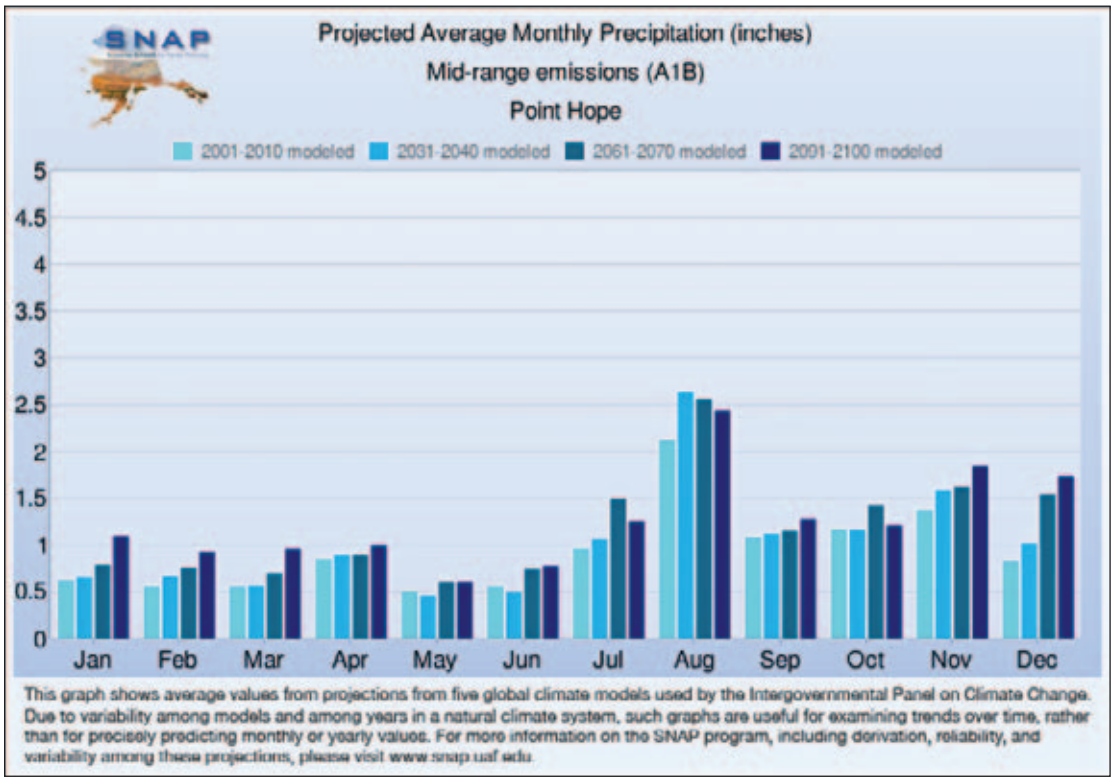


Figure 5. Projected Average Monthly Precipitation, Point Hope, Alaska
UAF, Scenario Network for Alaska Planning 2010

"New warmer water salmon species are arriving, they may become a new food resource."

Sverre Pedersen

Drying Salmon
Mike Brubaker, 2008

According to the Village Services Supervisor, extreme snowfall resulted in increased costs for labor, fuel, maintenance, and repairs on heavy equipment. This created an added and unexpected burden on the city's general fund (Stone, K. 2009). Local governments typically do not have the financial resources to provide expanded levels of service. If extreme weather results in funding shortfalls, it can affect health by undermining other services, such as operation and maintenance of water and sewer infrastructure.

Climate projections provided by the Scenario Network for Alaska Planning (SNAP) at UAF indicate that trends of increasing precipitation and temperature will continue in Point Hope. Figures 4 and 5 provide projections based on the SNAP models. Current (1990-2009) average temperatures in Point Hope are below zero from January through March. In 50 years, it is projected that no month will have an average temperature below 0°F; rather average monthly temperature will range between roughly 5°F to 30°F. Current summer average temperatures (1990-2009) range from 35°F to 45°F. In 50 years, summer temperatures are projected to range from roughly 43°F to 54°F. Despite higher annual precipitation, a generally drier summer environment is expected with dramatic effects on hydrology, wildlife and Arctic communities.

Recommendation: Point Hope residents rely upon traditional knowledge to make decisions about where and when to harvest traditional foods. They also rely upon the weather data generated from the automated Federal Aviation Administration Station at the Point Hope airstrip, and observations from Kotzebue, Barrow, Fairbanks, and other locations. Weather changes will continue to present challenges to transportation, including subsistence activities, and air service to and from the community. The capacity to measure, interpret, and forecast weather conditions is critical for individual safety and for community health, but local automated data is limited, as is the archived weather data needed for substantiating local climate change.

The National Weather Service is currently establishing regional Climate Reference Network (CRN) Stations across Alaska that will greatly expand regional climate data. Point Hope is listed as one of the possible site locations. Hosting such a site would improve access to local weather and climate data. Additionally, the National Weather Service has local observer programs that can help to improve forecasting. Collaboration on a local observer program could provide a method of combining scientific measurements and traditional knowledge for improved forecasting and climate change measures.

"Nowadays its warm and cold, warm and cold weather. It affects the people, they get sick real easy. Bad colds."

Joe Towksjhea

SEA LEVEL

Observed change: *rise in sea level is resulting in increased erosion & increased risk of flooding.*
Health concerns: *injury from extreme weather, anxiety over flood risk, damage to infrastructure.*
Projected change: *within 80-90 years, a minimum sea level rise of .6 feet to 1.9 feet.*
Potential adaptation: *flood study with climate predictions, flood protection to infrastructure.*

Point Hope is at risk for flooding from storm surge (a coastal flood that occurs when the sea is driven inland) and from ice and gravel jams. Sea level rise will increase both the risk and the level of investment needed to protect the community. The elevation of Point Hope is only about ten feet above mean high water. The highest point in town is the school, which serves as the emergency shelter. The airport located near Old Town is especially susceptible to flooding, and the primary evacuation site is Beacon Hill (elevation 46 feet), located at the end of 7 Mile Road. In 2005, 2006 and 2008, strong winds created ice and gravel dams in the drainage of the Kukpuk River. In 2006, trapped water from Marryat Inlet flooded a section of 7 Mile Road and a channel was constructed to prevent flooding of the town. Subsequent erosion required a $433,000.00 restoration project to rebuild the road (USACE, 2009).

When considering flood adaption, at-risk communities have three options: 1) create protective barriers, 2) evacuate and rebuild, or 3) relocate. The City of Point Hope and the North Slope Borough have been actively addressing flood risk for decades, and have employed all three of

Sea berm at Point Hope
Mike Brubaker, 2009

"The city has built a 10 foot (sea) berm for eight to ten miles along Nuvugalak Point."

Willard Hunnicutt

these options. For protective barriers, a 10-foot gravel berm was constructed extending 8 to 10 miles along Nubugalak Point; the berm is repaired using heavy equipment each summer. Rebuilding due to flood damage is ongoing, there is currently a $2 million dollar improvement project underway on 7 Mile Road to raise the elevation, improve drainage, and reduce flood risk. The town was relocated two miles to the east in the early 1970s.

The United Nations estimates that the minimum global sea level rise will be between .6 to 1.9 feet within 80 to 90 years (IPCC, 2007). The USGS Climate Change Science Program (Clark, P. et. al, 2008) found that the UN predictions were overly conservative. Globally, the greatest amount of sea level rise is projected to occur in the Arctic (Walsh, J, 2005a). The State of Alaska does not have an established sea level prediction. California is using a 4.6-foot prediction for 100-year planning purposes (Heberger et al., 2009). No published sea level change estimates were found for Point Hope. Yale University is developing 100-year sea level maps to predict impacts for some coastal Northwest Arctic communities (Leiserowitz, T., 2009).

A sea level rise projection map (one to three feet) was developed using Arc Map 9.3 GIS (Figure 6). A land satellite image was overlaid with USGS Digital Elevation Models (60 meter resolution); highlighting various

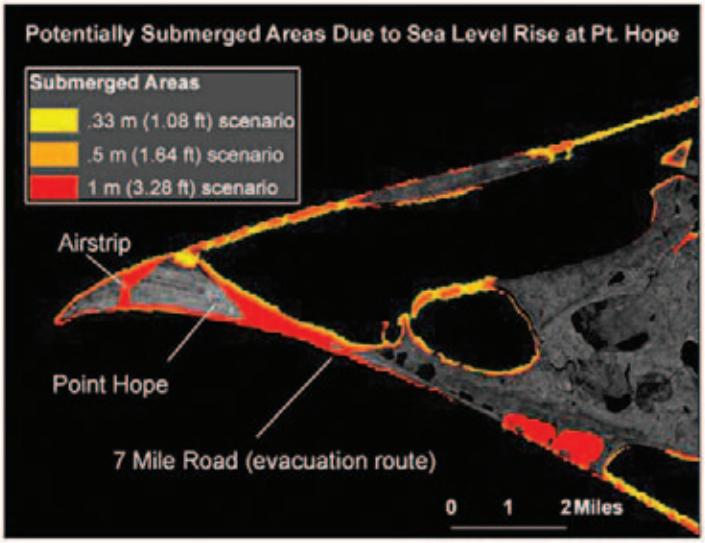


Figure 6. Potentially Submerged Areas Due to Sea Level Rise at Pt. Hope
Darcy Dugan, AOOS, 2009

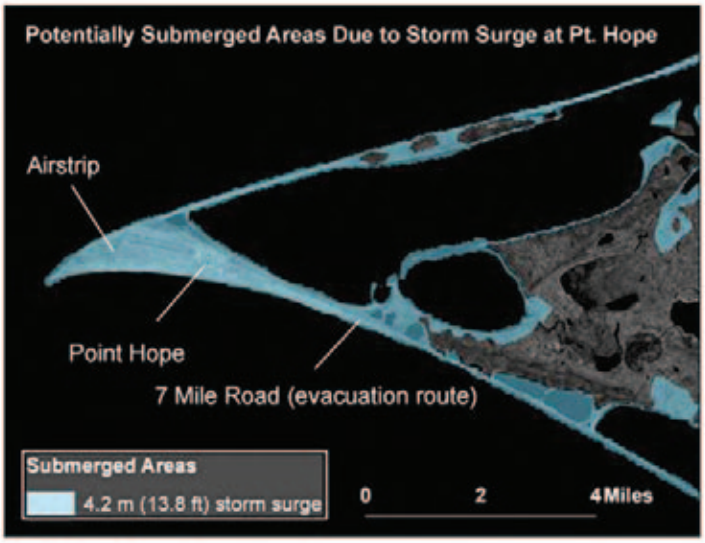
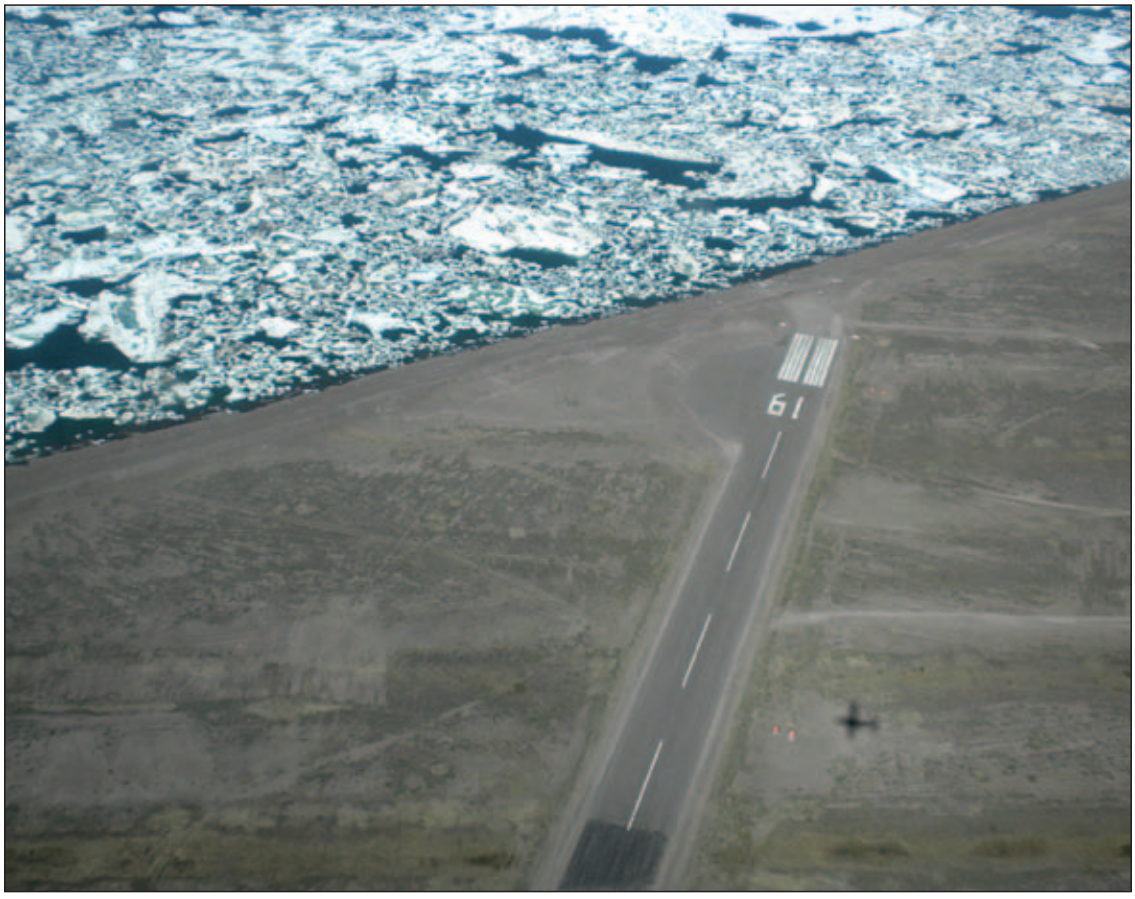


Figure 7. Potentially Submerged Areas Due to Storm Surge at Pt. Hope
Darcy Dugan, AOOS, 2009

"The ocean is coming and eroding the beach, real fast. Some of the cellars are all gone—maybe a mile out, just eroded."

Joe Towksjhea

potential ranges above mean sea level. At the 3.28-foot level (1 meter) Point Hope is cut off from the mainland; the airport, town site, egress road, and drinking water supply are all prone to damage from flooding. A storm surge map was also prepared for Point Hope. Point Hope is at "moderate" storm surge risk, meaning that flooding, six feet above the normal high tide surf level, is expected every three to five years (AK Emergency Management, 2007). The map (Figure 7), is based on a 4.2 meter surge, the 50-year estimate developed for Kivalina, (USACE, 2006).



Airstrip vulnerable to erosion and flooding.
Mike Brubaker 2010

"The northwest wind causes the waves to come over the land and the runway."

Steve Oomittuk

Recommendation: Flood and storm surge projections should be developed for Point Hope using actual erosion rates and employing finer resolution sea level and elevation data. Prevention of injury and damage to infrastructure from storm surge depends upon forecasting and adequate time for preparation and evacuation. Improved meteorological measurements may improve forecasting. Continued erosion and flood prevention, and improved evacuation routes are important to help prevent injury and damage to infrastructure. An evacuation shelter is need at a safe location outside of the flood zone.

Evacuation road protection against erosion.
Mike Brubaker 2009

"The last two miles of the evacuation road can be flooded."

Lily Tuzroyluke

EROSION

Observed change: *delayed shore ice, thawing permafrost, & storm activity resulting in rapid erosion.*
Health concerns: *damage to critical infrastructure including airport, roads, and cold cellars; injury.*
Projected change: *increased rate of shore & river bank erosion, growing river navigation hazards.*
Potential adaptation: *shore and river monitoring, erosion mitigation measures, injury prevention.*

Point Hope has, for some 2,500 years, provided a prime location for harvesting sea mammals and other subsistence resources. However, it is also an area that is extremely exposed to the coastal elements including ocean waves, coastal currents, and strong winds that sweep the Point Hope peninsula. The spit is continuously changing; building in some areas, eroding in others. Thawing permafrost and storm activity during ice-free seasons is causing increased rates of erosion along the banks of the Kukpuk and other rivers and to beaches and beach ridges.

There is limited information on the rate of erosion and no riverine erosion surveys have yet been performed. In 1972, the erosion rate on the north side of the spit was estimated at eight feet per year (USACE, 1972). It is likely that this rate has increased, and certain that episodic events, such as fall storms, can cause significantly greater rates of erosion. Storm-related events have eroded up to 50 feet of shoreline in Kivalina, 71 miles to the south. Point Hope has been classified as a "monitor conditions community", meaning that significant erosion impacts are occurring, but are not likely to affect the viability of the community (USACE, 2009). Although no structures or facilities at the new town site are considered to be at-risk, other sites including the airstrip, Old Town, grave sites, and community food storage cellars are threatened by erosion. Additionally, navigability of Marryat Inlet, the Kukpuk River, and other important waterways are changing due to a

Rapid bank erosion occurring along the Kukpuk River.
Mike Brubaker 2010

"There is a lot of erosion along the river. It is wider and more shallow than it use to be. Upriver it is muddy."

Sayers Tuzroyluke

combination of erosion, sedimentation, and reduced water levels. This diminishes access to subsistence areas, increases the risk of damage to equipment such as boats and outboard motors, and may increase the risk of accidental injury.

In 1997, the North Slope Borough spent about two million dollars constructing a 275-foot rock revetment east of the runway. This is helping to slow erosion in the coastal area. On the north beach, 10% of the old town site has been lost to erosion and only 50 to 60 traditional sod homes remain.

Also at risk from flooding is a mass grave at the old town site from the early 1900s. The reason for the burial is uncertain, but there were several devastating epidemics in Point Hope between the 1860s and through the early 1900s. These include outbreaks of tuberculosis, small pox, measles and influenza. Point Hope residents were particularly vulnerable because of the transient population of European whalers that worked from shore stations in the community. The mass grave may date back to the Spanish flu epidemic of 1918–1919. Influenza virus and other infectious agents have potential to be viable even after being frozen for many years. Whether any of the human remains in Point Hope could still be infectious is unknown.

Cultural sites vulnerable to erosion and flooding.
Mike Brubaker, 2010

Recommendation: A comprehensive erosion assessment that identifies vulnerable infrastructure and habitat is recommended. Although coastal erosion mechanisms are well documented, new erosion problems, like those along area rivers, are emerging and threatening water quality, river navigation, and critical habitat. Erosion prevention measures can help protect coastal and river areas as well as critical infrastructure. Point Hope may wish to explore opportunities with the National Weather Service to expand coastal monitoring. In the event that burial sites are exposed from erosion, infection prevention measures should be considered prior to handling any human remains. Additionally, erosion is causing the loss of coastal cold storage cellars, as they are being gradually washed into the sea; of the 50 previously used, only about 20 still remain (USACE, 2009). The loss of these cellars raises concerns about storage of whale meat and overall community food security.

"There is a lot of erosion along the river and the coast. We worry about river depth."

Ray Kookuk, Sr.

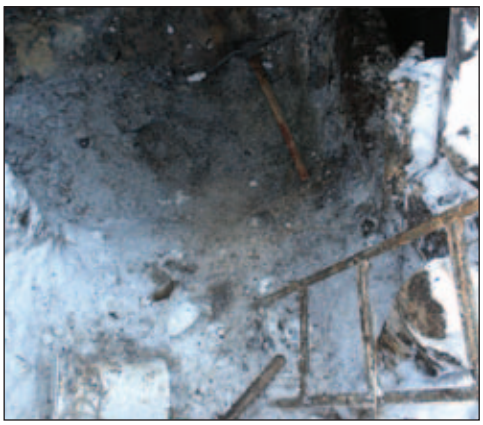
PERMAFROST

Observed change: *warming soil temperature is thawing traditional food cellars.*
Health concern: *reduced subsistence food supply and increased food borne illness.*
Projected change: *20-50+% increase in active (seasonal) thaw layer.*
Potential adaptation: *baseline permafrost mapping, monitoring, & alternative cold storage methods.*

Permafrost temperatures have been rising throughout Alaska since the late 1970s (Lettenmaier et al. 2008). The largest increases have occurred in the north, and it is projected that the top 30 feet of discontinuous permafrost will thaw in Alaska during this century (Parson, 2001). The Northwest Arctic is located in a transition zone between continuous and discontinuous permafrost that spans east-west across this region roughly in line with the Kobuk River.

Thawing of ice-rich permafrost results in land settlement (subsidence) with significant effects on ecosystems and infrastructure (USARC, 2003). Hundreds of sink holes (thermokarsts) have been observed in the Maniilaq Area and extensive erosion has been observed in coastal and river systems. Within 50 years, decreases of between 20% to 50% or more are expected in the active (seasonally freezing) permafrost layer. In the near term, thermokarsts conditions, including the rapid thaw of ice wedges along river banks and coastal areas, are expected to continue, resulting in erosion and changes to hydrology, vegetation, and wildlife (Martin et al., 2008).

The city of Point Hope is located on a gravel spit, and a gravel pad foundation for the town site provides insulation to help preserve the



Interior of Ice Cellar. *Mike Brubaker, 2009*

Flooded ice cellar. *Mike Brubaker, 2010*

"The ice cellars are thawing. We have to use buckets to get the water out."

Joe Towksjhea

underlying permafrost. There were no observed signs of permafrost thawing in the new town site: utility poles and fences are straight, and buildings appeared level. Point Hope airstrip is permafrost vulnerable as are the roads (USARC, 2003). Residents are reporting impacts at subsistence camps where foundations are settling (Towksjhea, J., 2009). Soil temperatures are determined using sensors inserted into the ground with battery-powered data loggers. Sensors are located in Point Hope and are being monitored by local students in collaboration with the Geophysical Institute at UAF (Yoshikawa, K., 2009).

Permafrost thawing is undermining food safety and security in Point Hope. Harvested whale is taken to underground ice cellars *siġl·uaqs* that have been passed down in whaling families for generations. Not only are *siġl·uaqs* being lost to coastal erosion, but they are also being compromised due to permafrost thaw. The cellars, made of whalebone and covered with tundra sod, have remained frozen year-round until the last few years. The cellars are now typically thawed in the summer, sometimes filling with water, and resulting in meat and blubber that is unsafe. Thawing meat also attracts scavengers such as hungry polar bears, presenting new safety hazards. As a result, residents may be at-risk for an increase in foodborne illness, as well as potential risk of injury or death. There is additionally an economic and nutritional loss as meat that would otherwise be consumed is discarded.

Recommendation: There are several possible approaches for improving food storage in Point Hope: 1) improve the environment (ventilation, drainage, temperature) at the current location, 2) establish new *siġl·uaqs* at a location with a better subsurface environment, and 3) develop an alternative method for food storage, such as community cold storage facilities. The status of these food storage cellars is described in greater detail in the ANTHC Climate and Health Bulletin, Climate Change and Effects on Traditional Inupiaq Food Cellars (Brubaker et al., 2009a). Improved data on soil temperature and permafrost conditions could help identify better locations for installation of new food storage cellars and identify other vulnerable infrastructure.

Fermented bowhead whale. Joe Towksjhea, 2009

"If the cold storage is bad, the meat and muktuk will taste funny. Some people will not eat it."

Joe Towksjhea

SNOW & ICE

Observed change: *delayed ice development & early thaw; thin ice, increased snow accumulation.*
Health concerns: *injury, drowning, diminished diet, and mental health.*
Projected change: *open sea routes, decline in ice-dependent subsistence species.*
Potential adaptation: *monitor ice (satellite sensing), develop ice appropriate technology.*

Changing snow and ice conditions are affecting transportation and subsistence activities, accelerating erosion, and threatening infrastructure in Point Hope. Potential health effects include injury or death from trauma, exposure, or drowning (e.g. falls through ice); damage to health infrastructure (e.g. increased snow loads and erosion damage to source water line); and mental and physical health problems related to disruption of subsistence lifestyles. Positive effects may include a longer season for open water subsistence harvesting and for drinking water collection and treatment.

In Point Hope, ice has been forming later in the fall and breaking up earlier in the spring. From the 1970s until 2006, the number of ice-free days along the Chukchi Coast has increased by an average of 50 to 95 days (Rodrigues, 2008 unpublished). This results in a shorter season for over-ice transportation and ice-based hunting and increased vulnerability to coastal erosion. Shore ice works as a coastal buffer, dissipating storm energy and protecting the shoreline from the force of wind and waves. If shore ice formation is delayed or diminished, storm-related erosion can be expected to increase (Jones et al., 2009). Sea ice extent is

Photo courtesy of Wanda Sue Page

"The ice is no good for haul out and butchering of bowhead. Too thin."

Ray Koonuk Sr.

monitored throughout the Arctic using satellite imagery. The decrease in summer sea ice has become more pronounced, especially in the Chukchi and Beaufort seas (Comiso, 2002; Shimada et al. 2006). Continued sea ice retreat is projected, and in 50 years the Northwest Passage and Northern Sea Route may be ice-free in summer (Walsh, J, 2005b).

Receding and thinning sea ice is one of the most important indicators of change for the lives of Arctic indigenous people. During the past two decades, thick multi-year ice has been replaced by thinner first-year ice over large areas of the Western Arctic; Ice depth has decreased between 0.5 to 1 meter (Shirasawai et al., 2009). Snow cover influences the amount of ice that can be grown within a season, with more snow cover resulting in less ice. Future increases in precipitation and higher temperatures will therefore likely have additional influence on future sea ice conditions. Sea ice also influences plankton blooms, and is expected to facilitate major shifts of marine species.

Unusual snow event.
Mike Brubaker, 2009

Whaling captains are concerned about ice changes and safety when working on the ice, as well as the implications for hunting success. Sea ice is used as a platform for hunting whale, seal, and walrus. Hunters recall typical ice thickness of 12 feet, as opposed to the approximate four feet typical today. On May 8, 2008, three Point Hope whaling crews were cast adrift when a huge slab of shore-fast ice broke free (Arctic Sounder, 2008). The hunters were able to return to land by boat, but their equipment had to be recovered by a rescue helicopter from Barrow. In addition to the safety concerns, ice depth has been related to decreased availability of walrus and delays in whale harvest. Point Hope hunters reported difficulty in finding ice thick enough for hauling-out a whale. The single bowhead harvested in Point Hope this spring had to be butchered in the water, a less efficient process.

Watching for bowhead.
Photo courtesy of Charles Wohlforth

Recommendations: The emergency beacon program implemented by the North Slope Borough is a model for injury prevention, providing rescuers with immediate information about the location of individuals in peril. Increased cell phone access will also provide safety benefits. More research is needed on the implications of changing snow, ice, and weather conditions on infrastructure and health. Point Hope would benefit from participation in an expanded Arctic dialogue on sea ice changes and adaptation.

"The storms have been very bad. Lots of wind and blowing snow. Hunters are using locator beacons that are tracked by Search and Rescue in Barrow. These result in rescues and saved lives."

Willard Hunnicutt

WATER & SANITATION

Observed change: *reduced drinking water source quality and quantity.*
Health concerns: *water shortages, water availability, water quality, increased cost for treatment.*
Projected change: *fewer lakes, sea rise increases vulnerability to salt water intrusion.*
Potential adaptation: *source water monitoring & assessment, emergency water shortage plan.*

Despite projections of increased precipitation, significantly more water will be leaving the Arctic landscape in the future and most of Alaska is expected to become 10-30% drier by the end of the century (O'Brien & Oya, 2009). In Point Hope, summer warming combined with decreased precipitation has caused tundra ponds to dry up, impacting water availability and quality. During the summers of 2007 and 2008, water operators measured reduced quality in the raw water from the source lake. There was no evidence of change in the quality of water provided to residents, nor was there evidence of waterborne illness (Davenport, A., 2009). There was, however, a significant increase in operator labor.

Point Hope acquires water from 7 Mile Lake, a small tundra lake that is recharged each year from snow melt and precipitation. There is a limited time frame when the lake is ice-free, and when water can be pumped, treated, and transferred to above ground tanks for use throughout the year. From late June until early September, water is piped from the lake to the water treatment plant where it is filtered prior to chlorination. During this period, operators work around the clock to produce enough water (about eight million gallons) to last the whole year. As reported by Point Hope water operators, low precipitation and high temperatures during the summer of 2007 and 2008 contributed to source water quality problems. The water level in 7 Mile Lake was lower than normal and other tundra ponds located in the vicinity dried up completely. Other lakes are expanding, perhaps due to the addition of melt water

Andrew Frankson and Water Filters.
Mike Brubaker, 2009

"There have been lots of mosquitoes and mosquito larvae. They plug up the bag filters and we have to change them every five to twenty minutes."

Andrew Frankson, Water Operator

from the surrounding permafrost. Lake change as measured from past satellite images is shown in Figure 9. Raw water temperatures at the Point Hope treatment plant were between 50°F and 60°F, 10°F warmer then normal (Frankson, A., 2009).

In their log books, operators reported increases in the amount of biologic slime collecting in the water treatment bag filters. Consequently, the number of filter changes increased dramatically, to the point where it was interrupting operations. Typically operators clean the bag filters about four times per day. In 2008, the number of changes at times rose to almost 50 times per day. On July 27, 2008, at the peak of the source water quality problem, Point Hope operators were spending approximately eight hours, or one-third of each 24-hour shift performing filter maintenance (Figure 8). The slime is suspected to be organic growth including insect larvae and algae. Scientists from UAA's Environmental and Natural Resources Institute are coordinating with water operators in Point Hope to test water samples. Temperature is a limiting factor for algae growth and warm temperatures may have caused conditions to pass a tipping point, changing lake biology

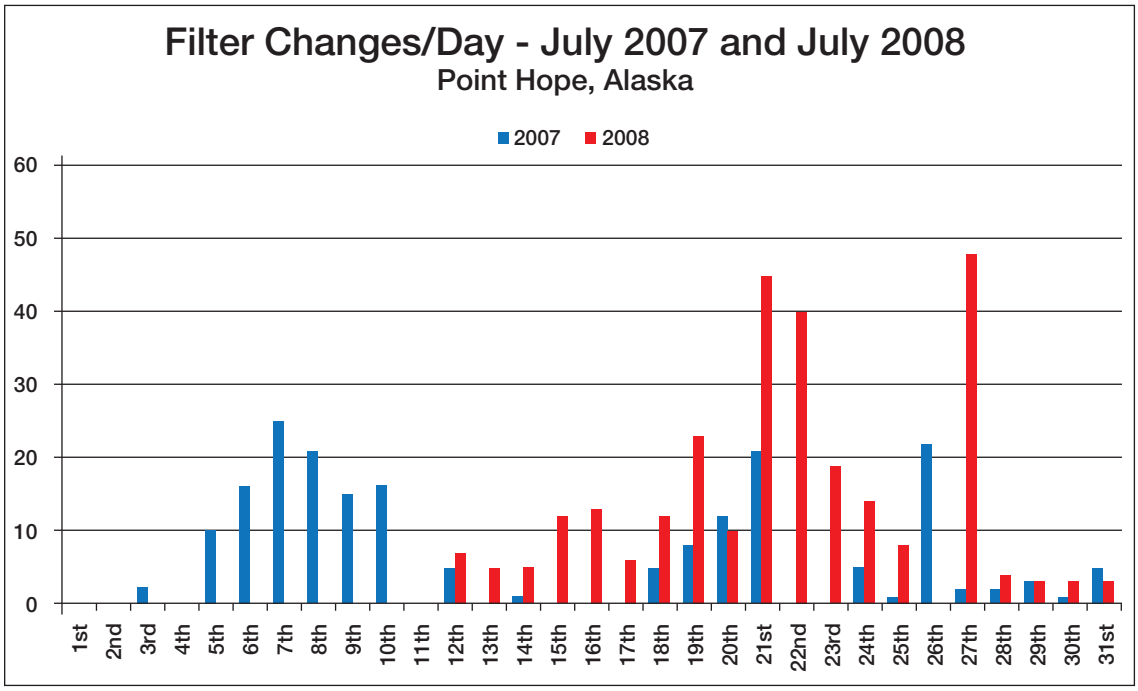


Figure 8. Number of times operators clean filters per day.
Alicia Rolin, 2009

"The water temperature in the plant gets as warm as 50 to 60 degrees. It used to be 40 to 50."

Andrew Frankson, Water Operator

and encouraging rapid algae growth. Wind events stir lake water and can transport solids to the water system intake.

Recommendation: Point Hope is susceptible to hydrologic changes including water shortages influenced by alterations to annual precipitation and temperature. Thawing of permafrost may also contribute to increased organics into the lake water with a resultant change in water chemistry. Under a projected warming future, adaptation strategies will be needed to ensure efficient operation of the water system. Continued log recording and regular monitoring of the source water physical, chemical, and biological conditions is recommended. Additionally, a source water assessment would evaluate lake water conditions and quality. Sampling and analysis of the filter contents and lake water conditions would be part of this assessment (Brubaker et al., 2009b).

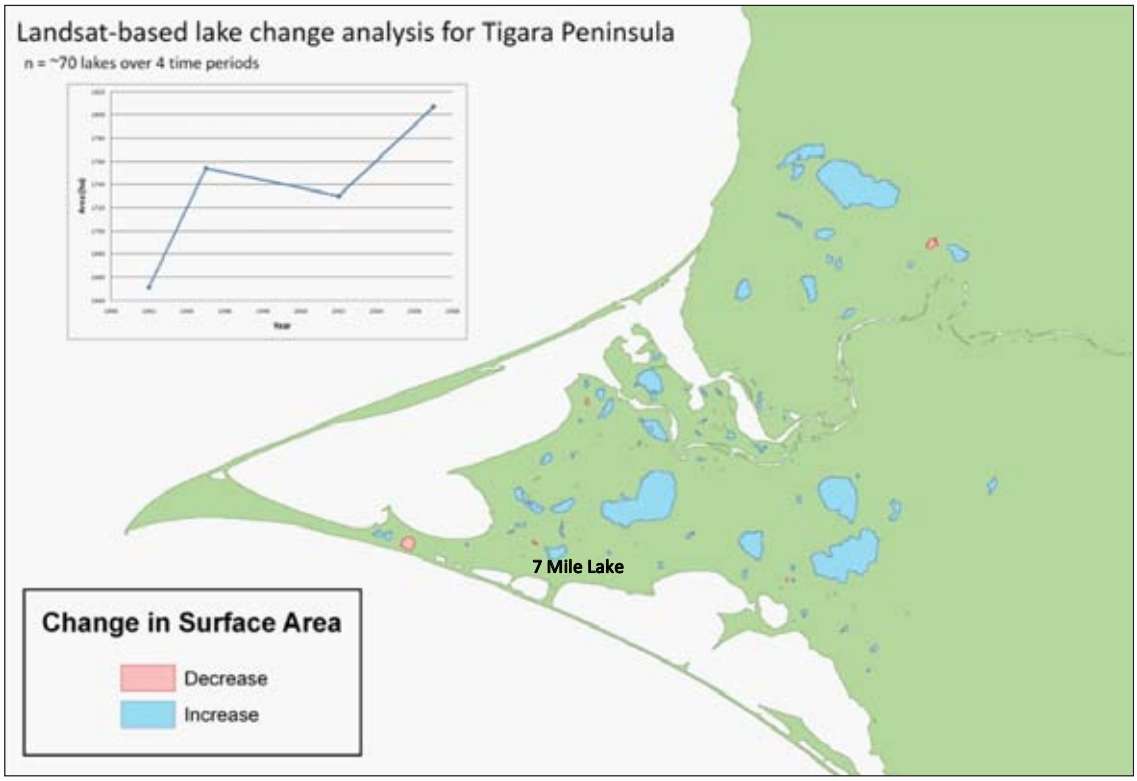


Figure 9. Tigara Peninsula Lake changes
Ben Jones, USGS 2010

"The last few summers, some lakes have dried up completely."

Eldon Hunnicutt, Water Operator

FOOD SECURITY

Observed change: *warming is affecting harvest of fish & sea mammals; traditional cellars are thawing.*
Health concerns: *changes in food quality & harvest may contribute to hunger, malnutrition, & disease.*
Projected change: *fewer ice dependent species, more invasive boreal species.*
Potential adaptation: *assess community diet, food storage & food distribution, adaptive subsistence.*

Food safety refers to the practice of harvesting, preparing, and storing foods in ways that prevent foodborne illness. Food security means having nutritious foods and not having to live in hunger. In Point Hope, climate change is increasing exposure to unsafe foods and to food insecurity. The traditional subsistence lifestyle and diet provides protection against cardiovascular disease, hypertension, type 2 diabetes, stroke, obesity, osteoporosis, and some cancers. Traditional foods provide a wide range of essential micronutrients including iron and vitamins A, D, and E (Bersamin et al., 2007). The fruit and leaves of Arctic berries contain high levels of antioxidants (Thiem, 2003) and may help reduce incidence of obesity and type 2 diabetes. Northern fish and sea mammals are also high in omega-3 fatty acids, an important anti-inflammatory substance (Murphy et al., 1995).

The percentage of wildlife harvested for subsistence in rural Alaska is about 60% fish, 20% marine mammals, 14% land mammals, 2% shellfish, 2% birds, and 2% wild plants (ADFG, 2000). There are substantial regional differences but harvest percentages have remained fairly consistent since the 1980s, although the amount harvested has decreased. A 2004 statewide dietary study documented an Alaska Native trend toward increased use of market foods (Ballew et al., 2004). Inupiat communities have the knowledge about a high number of food species (Kuhnlein et al., 2004) and Point Hope residents utilize a wide range of traditional foods in their diet including chum, pink and silver salmon, dolly Varden (trout), grayling, tom cod, beluga whale,

Ice conditions impact the harvest of whales, walrus and ice seals.
Mike Brubaker, 2010

"The ice conditions have been bad. We can't hunt walrus these last four years. They go right by before we have an opportunity to hunt."

Ray Koonuk Sr.

bowhead whale, bearded and spotted seal, walrus, polar bear, caribou, moose, and various ducks, geese, other birds, berries and greens. Alaska Department of Fish and Game records indicate a daily wild food harvest of 1.4 pounds per person or 514 pounds per person, per year in Point Hope. Climate change is expected to dramatically alter the species that are available for harvest in the Arctic coastal plain and the coastal marine environment (Martin et al., 2008).

As soil temperatures rise, the traditional cold storage cellars are less likely to prevent pathogens that cause foodborne illness from getting into traditionally stored foods. The most common types of foodborne illnesses in humans are caused by bacteria such as botulism, campylobacter, salmonella and e-coli, and viruses such as norovirus. Pregnant women, infants, the elderly, and those with weakened immune systems are at higher risk for severe infections. There were no reports of a change in the number of cases of food-related illnesses in Point Hope. However, health aides and other residents expressed concern about decreasing food quality, increasing spoilage, and the safety of stored whale meat and blubber. Health aides in Point Hope described a rise in cases of malnutrition and anemia, particularly in elders, and speculated that it may in part be related to availability of sea mammals (Davenport, A., 2009). Few walrus have been harvested in Point Hope since 2006 and whale harvests have been affected by ice conditions. Also, new species of salmon are being observed, contrasted by reduced harvest of other fish species like tom cod (Frankson, T., 2009) .

Butchering Spring Bowhead
photo courtesy of Charles Wohlforth

Recommendation: A food survey would be beneficial to establish baseline conditions and food security issues, including analysis of adaptation strategies that could improve community food storage and distribution. Continued research is needed on food security and safety including causes of resource decline and susceptibility to zoonotic (animal to human) diseases. Point Hope should work closely with researchers and wildlife managers to improve capacity for observation and monitoring of the Arctic Coastal Plain environment and its subsistence resources.

"We are seeing vitamin deficiency because of less native food. We hear reports of lack of food and we see thin elders and more anemia in the younger population."

Amy Davenport, Health Aide

CONCLUSION

Point Hope is experiencing a broad range of climate change effects that are increasing vulnerability and exposure to injury and disease, and damaging or disrupting critical infrastructure. Appendix C summarizes current and potential future health impacts in Point Hope, characterized in terms of likelihood of occurrence and vulnerability.

Summary of Point Hope Findings

1. Between 1949 and 2006, average annual temperatures in Kotzebue increased by about 3.2°F. Annual temperatures are projected to continue rising in Kotzebue and in Point Hope, with the greatest increase occurring during winter months. In 50 years, it is projected that no winter months will have an average below 0°F; but rather temperatures range from 5°F to 30°F.

2. Average annual precipitation has increased in Kotzebue, and is projected to increase in Point Hope. Despite higher annual precipitation, a considerably drier summer environment is expected with dramatic effects to the physical, natural and human environment, including changes in subsistence diet, and decreased water availability for community use.

3. Point Hope is at risk from floods during seasonal storm events. Sea level rise and coastal erosion is increasing this risk. Some climate models project that mean sea level will be above the level of the community within 50 to 100 years. However, soil from coastal erosion and from the banks of the Kukpuk and other rivers may change coastal dynamics and cause beach building in some areas. Increased flood risk can increase risk of injury and vulnerability to disease if critical infrastructure is damaged and services are disturbed.

4. No structures or facilities at the new town site are currently considered to be at risk from erosion. However, outlying areas are at risk, including traditional food cellars, cultural sites, the air strip, and 7 Mile Road. Evacuation routes are vulnerable to erosion and flooding.

Community Adaptation Plans should identify valued local resources, such as subsistence areas, cultural sites, critical water sources, and develop plans to protect them.

5. During the past two decades, sea ice has been forming later in the fall and departing earlier in the spring. Thick multi-year sea ice is being replaced by thinner first-year ice. This results in a shorter season for over-ice transportation and ice-based hunting, as well as disruption of sea mammal harvest, and increased vulnerability to coastal erosion and ice-related injury.

6. Thawing permafrost is undermining food security by increasing the temperature in traditional cold cellars. Inadequate storage conditions are resulting in spoiled meat and blubber and are increasing the risk for foodborne illnesses.

7. Health Aides describe a rise in cases of malnutrition and anemia, particularly in elders. This may be related to decreases in subsistence harvest and food security. Few walrus have been harvested since 2006, and whale harvests have been affected by diminishing ice conditions.

8. Low precipitation and high temperatures during the summer of 2007 and 2008 contributed to decreased water quality at 7 Mile Lake, the community water source. An increase in organic material in the raw water fouled filters and interrupted water making operations.

9. Long-term water availability for drinking and other uses is threatened by decreased precipitation, increased evaporation and transpiration, melting permafrost, groundwater recharge, and the potential for storm surge and salt water intrusion.

Thin ice conditions on the Chukchi coast.
Mike Brubaker 2010.

Considerations for climate impacts on erosion, flooding, subsistence, water availability, and transportation should be incorporated into planning, and new infrastructure siting and design.

Recommendations for Adaptation in Point Hope

Adapting to a new climate and a changing environment will require significant investments of time, energy, and financial resources if community, social, and economic health is to be sustained. New outside sources of revenue will be needed, as well as the technical assistance of agencies and institutions that have expertise in climate adaptation.

Fortunately, the resources that can provide assistance to Point Hope are growing, and should continue to grow in the near future. Currently, the State of Alaska is completing a multi-agency process to develop a climate change strategy that will help to guide statewide climate policy. Alaska will also be receiving a new federally funded Climate Change Response Center that will be administered by the U.S. Geologic Survey.

In the North Slope Region there is extensive climate research capacity including the Global Climate Research Center located in Barrow. The University of Alaska is also a global center for Arctic environment and climate research. These types of resources can assist Arctic communities as they interpret the climate changes of today, and begin to chart a course for the future.

Point Hope will need to facilitate the adaptation process by increasing communication and cooperation with resource agencies, and by developing local capacity for monitoring and managing climate impacts. Specific actions could include:

1. Developing collaborations for an integrated village-based monitoring program that includes climate and environmental monitoring including observer programs for weather, erosion, wildlife, subsistence, permafrost, and water resources.

2. Sharing data with other village and regional monitoring programs, as many of the emerging threats, such as wildlife diseases, are shared throughout the region.

3. A new Point Hope flood study could be undertaken that includes projections for sea level rise, coastal erosion, and flood prevention measures.

4. Surveying changes along river systems (bank erosion, water conditions, navigability, and critical habitat) could also be systematically undertaken.

Coastal emergencies are inevitable and disaster response and recovery capacity, including evacuation routes, emergency response plans, drills, and shelters, should be reviewed and kept current.

5. Continuing flood prevention, emergency preparedness and evacuation planning efforts with the North Slope Borough should be ongoing. Point Hope is currently at risk from flooding, and the risk is rising due to extreme weather, erosion, and sea level.

6. Community water shortage contingency plans should be revisited based on current flood studies. Climate models project increased vulnerability due to changes in water balance and salt water intrusion.

7. Working with the North Slope Borough to explore expanded practices for monitoring source water conditions at 7 Mile Lake, including water level, temperature, pH, turbidity, and other measures of source water quality and quantity. Scientists from the University of Alaska have offered assistance in evaluating source water conditions, including biological analysis.

8. Exploring options for improving food storage and assessing community-wide food security. The Center for Climate and Health can provide assistance in exploring options for improving food storage.

9. In the event of a wildlife die-off, perform testing for contaminants and disease pathogens. The Center for Climate and Health and the Center for Disease Control can provide assistance in identifying resources for infectious disease surveillance.

10. Incorporate climate awareness into health services at the local and regional level. The Center for Climate and Health, Maniilaq Association, and the North Slope Borough Health Department can explore options for improving surveillance of climate related health effects.

11. Increasing dialogue with other Arctic communities about strategies for climate adaptation. Through statewide venues such as the Alaska Forum on the Environment, and international forums such as the Inuit Circumpolar Conference and the Arctic Council's Sustainable Development Working Group, Point Hope could engage and share in the broader Arctic climate adaptation efforts.

Point Hope would benefit from increased participation in weather, coastal zone and wildlife observation and monitoring programs, expanded collaborations with researchers, and increased local capacity for climate change coordination and management.

12. Advocating for a regional climate change advisory group or developing a local advisory group. Planning for climate change will require a community-wide approach, as different entities develop capacity to address impacts within their own professional sphere. A climate change advisory group could represent different stakeholders and provide guidance to interested support organizations.

13. Establishing a community climate office to coordinate climate-related activities and record local observations. A climate change coordinator could help facilitate discussion, advocate for needed resources, and increase observations and data collection. This person could also expand dialogue with other parts of Alaska and other Arctic regions experiencing similar climate impacts. The Environmental Protection Agency authorizes tribes that are funded by the Indian General Assistance Program (IGAP) to work on climate change activities, including hiring of staff that can focus on climate change adaptation.

14. Establish a time-line to revisit and update local climate projections. Climate models for weather (UAF's Scenario Network for Alaska Planning), erosion (U.S. Army Corp of Engineers), sea level rise (State of Alaska, North Slope Borough), and flooding (Federal Emergency Management Agency) among others are updated regularly as new information becomes available and the climate models improve. Each agency can provide guidance for timing of updating projection data.

This report raises awareness about current, emerging, and potential, future climate change affects in Point Hope. It is hoped that this will help citizens make informed planning decisions, within community appropriate development strategies to achieve a safe, healthy, and sustainable future for the people of Point Hope.

For more information, contact the Center for Climate and Health: akaclimate@anthc.org, (907) 729-2464 or (907) 729-4493.

In the community of Point Hope, subsistence resources, food security, drinking water quality, and infrastructure are vulnerable to impacts from climate change.

APPENDIX A

Community Contributors – Point Hope, Alaska

Name	Title/Status	Organization	Interview Date
Canyon, Caroline	Representative	Maniilaq Board of Directors	04-07-09
Davenport, Amy	Session II Health Aide	Point Hope Health Clinic	04-30-09
Dirks, Michael	Assistant Operator	Point Hope Water Plant	04-30-09
Dowdy, Liz	Assistant Principal	Tikigaq School	04-30-09
Frankson, Andrew	Chief Operator	Point Hope Water Plant	04-30-09
Frankson, Teddy	Wildlife and Parks Director	Native Village of Point Hope	08-13-09
Hunnicutt, Eldon	Assistant Operator	Point Hope Water Plant	04-30-09
Hunnicutt, Willard	Fire Chief	Point Hope Fire Dept	04-30-09
Koenig, Midas	Assistant Fire Chief	Point Hope Fire Dept.	04-30-09
Koonook, Angie	Whaling Captain's Wife	Point Hope	05-03-09
Koonook Sr., Luke	Whaling Captain Retired	Point Hope	05-02-09
Koonuk Sr., Ray	Environmental Coordinator	Native Village Point Hope	04-29-09
Kowuna, Jeffery	Tribal Council Member	Native Village of Point Hope	06-28-10
McCarthy, Toren	Counselor	Tikigaq School	05-04-09
Mitchell, Florence	Session IV Health Aide	Maniilaq Association	04-30-09
Oomittuk, Steve	Mayor	City of Point Hope	04-30-09
Oktolik, Iris	Environmental Coordinator	Native Village Point Hope	04-29-09
Oviok, Reggie	Assistant Operator	Point Hope Water Plant	04-30-09
Sage, Daisy	Mayor	City of Point Hope	06-15-10
Schmidt, Kurt	Science Teacher	Tikigaq School	05-03-09
Sharp, Scott	Police Officer	Point Hope Police Dept	05-04-09
Stone, Delia	Elder	Point Hope	06-28-10
Stone, Kimberly	Village Services Supervisor	North Slope Borough	05-04-09
Teayouneak, Tillie	Elder	Point Hope	06-28-10
Towksjhea, Joe	Whaling Captain	Retired	05-01-09
Tuzroyluke, David	Youth	Point Hope	06-28-10
Tuzroyluke, Lily	Executive Director	Native Village Point Hope	04-29-09
Tuzroyluke, Sayers	President	Tikigaq Corporation	06-28-10
Victor, Lloyd	Artist	Point Hope	05-04-09
Weber, Karen	Assistant Environmental Coordinator	Native Village of Point Hope	06-26-10

APPENDIX B

Topic	Resource	Location
Point Hope Profile	State of Alaska Community Database	http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm
Point Hope Climate Data	Archive 1991-present (temp/precipitation)	http://paot.arh.noaa.gov/
Point Hope Climate Data	Archive 1924-1954 (temp/precipitation)	www.wunderground.com
Point Hope Erosion Data	USACE Community Erosion Report, 2009	www.poa.usace.army.mil/AKE/Home.html
Point Hope Permafrost	UAF Permafrost Laboratory	www.gi.alaska.edu/snowice/Permafrost-lab/
Point Hope Flood Data	USACE Flood Hazard Database	http://www.poa.usace.army.mil/en/cw/fld_haz/point_hope.htm
Point Hope Temperature Precipitation Projections	Alaska Center for Climate Assessment & Policy	www.uaf.edu/accap/
Point Hope Climate and Health Impacts Reports	ANTHC, Center for Climate and Health-	www.anthc.org/chs/ces/climate/links.cfm
Point Hope Capital Improvements	Roads, erosion prevention, flood prevention, etc. North Slope Borough Public Works Dept.	http://www.co.north-slope.ak.us/departments/publicworks/cipm.php
Local Weather Observations	NWS Precipitation Observation System "Cocorahs". Contact: Harry Lind, NWS in Kotzebue. (training and equipment).	http://www.cocorahs.org.
Regional Climate Data	Temperature and Precipitation Data, Kotzebue 1930s-present	climate.gi.alaska.edu/
Regional Climate Data	Center for Global Change and Arctic System Research (UAF)	www.cgc.uaf.edu/
Regional Climate Data	Global Climate Research Center (Barrow)	www.arcticscience.org/
Regional Climate Data	Google Earth climate impact layers	earth.google.com/intl/en/index.html
Regional Weather Data	Extreme Weather Watches, Warnings Advisories, National Weather Service	www.arh.noaa.gov/
Regional River Flood Data	Advanced Hydrologic Prediction Service National Weather Service	http://aprfc.arh.noaa.gov/ahps2/index.php?wfo=pafg3
Regional Health Data	Maniilaq Association, Kotzebue	www.maniilaq.org/
Regional Health Profile	Alaska Native Tribal Health Consortium EpiCenter	www.anthc.org/chs/epicenter/upload/Regional_Health_Profile_Maniilaq_0408.pdf
Federal Climate Response	Alaska Climate Change Response Center	http://alaska.usgs.gov/
State Climate Response	State of Alaska Climate Strategy	www.climatechange.alaska.gov/
Community Based Monitoring - Weather	National Weather Service Weather/Coastline Observer Program	www.nws.noaa.gov/om/coop/index.htm
Community Based Monitoring - Diet	Nutritional and Food Security Baseline Survey	www.anthc.org/chs/epicenter/upload/traditional_diet.pdf
Community Based Monitoring – Seasonality	U.S. Geological Survey-National Phenology Network	www.usanpn.org/
Community Based Monitoring – Wildlife	National Oceanographic and Atmospheric Administration – Marine Stranding	www.fakr.noaa.gov/protectedresources/strandings.htm

APPENDIX C

Community Vulnerability to Health Effects

		Community Vulnerability to Health Effects		
		Beneficial	***Detrimental*** **Less Vulnerable**	***Detrimental*** **More Vulnerable**
Likelihood of Occurrence	***Uncertain***	Improved diet from new subsistence resources (e.g. improved salmon harvest). Improved mental health due to decreased environmental stressors (e.g. warm, sunny days).	Injury or illness from extreme events (e.g. flood, storm-surge). Illness from consuming food stored in thawing ice cellar. Increased exposure to heat /cold event injury (e.g. hypothermia or heat exhaustion) Increased incidence of allergic reaction (e.g. plants, insects). Increased or new infectious disease (e.g.. giardia). Diminished health services from stressed public resources or damaged infrastructure (e.g.. operation of water system). Increased respiratory infection (e.g.. water service interruption).	Increased acute or chronic disease (e.g. infections from contaminant exposure). Increased acute or chronic disease from a less healthy diet. (e.g. substituting hot dogs for whale).
	Likely	Shortened infectious disease season (e.g. cold/flu). Improved aspects of health service. (e.g. extended season for water treatment).	Injury from changes in physical environment (e.g. cold water exposure, falls through ice).	Impaired mental health from environmental stressors (e.g. stress related to flood risk or changes in food availability).
	Certain		Impaired functioning of health infrastructure (e.g. decreased water availability/quality).	Decreased food security (e.g. inadequate food storage).

APPENDIX D

General Climate Change Adaptation Guidelines

Local and regional government is challenged with preparing for climate-related impacts, and the need to develop comprehensive adaptation plans. The following are 10 basic principals that are recommended for integrating climate change planning into local decision-making. Other principals may be developed by the community as local residents engage in the planning process.

1. Protection of human life and health is the top priority.

2. Traditional values should guide local and regional decision making.

3. Development should follow the principles of sustainability "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

4. Community Adaptation Plans should identify valued local resources, such as subsistence areas, cultural sites, critical water sources, and develop plans to protect them.

5. Critical ecological systems, wetlands, and subsistence resource areas should be protected where possible.

6. Considerations for climate impacts on erosion, flooding, subsistence, water availability, and transportation should be incorporated into planning, and new infrastructure siting and design.

7. Cost-benefit analyses should be applied to evaluate the social and environmental costs of building and maintaining coastal protection structures.

8. Phased abandonment of at-risk areas should be considered.

9. Coastal emergencies are inevitable and disaster response and recovery capacity, including evacuation routes, emergency response plans, drills, and shelters, should be reviewed and kept current.

10. Building capacity to participate in monitoring, research, and advocacy is critical to facilitate development of effective adaptation strategies.

REFERENCES

ADFG, 2000. Alaska Department of Fish and Game-Division of Subsistence (ADFG). Caribou Harvest Studies. Community Profile Database (CPDB) and Community Subsistence Info System (CSIS) accessed at: http://www.subsistence.adfg.state.ak.us/geninfo/publctns/cpdb.cfm#USING and http://www.subsistence.adfg.state.ak.us/CSIS/

Alaska Division of Community Advocacy, 2009. Point Hope detailed information. In: Community Database, accessed at: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.cfm. 2009.

Alaska Emergency Management, 2007. All-Hazard Risk Mitigation Plan. Alaska Department of Military and Veteran Affairs, October 2007.

AOOS, 2009. Alaska Ocean Observing System, Map by Darcy Dugan.

Arctic Sounder, Drifting ice strands whaling party, Combined rescue effort recovers 30 men, $100,000 of equipment, Tamar Ben-Yosef, May 22, 2008.

Brubaker, M., Bell, A., Rolin, A., 2009a. Climate change effects on traditional Inupiaq food cellars. CCH Bulletin No. 1, June 26th, 2009. Center for Climate and Health, ANTHC. Available: http://www.anthc.org/chs/ces/climate/cchbulletins.cfm

Brubaker, M., Rolin, A., Bell, A., Warren, J., 2009b. Source drinking water challenges resulting from changes to an arctic tundra lake. CCH Bulletin No. 2, July 24th, 2009. Center for Climate and Health, ANTHC. Available: http://www.anthc.org/chs/ces/climate/cchbulletins.cfm

Ballew, C., Ross, A., Wells, R., Hiratsuka, V., 2004. Final Report on the Alaska Traditional Diet Survey. Alaska Native Epidemiology Center: Anchorage, Alaska. Available: http://www.anthc.org/chs/epicenter/upload/traditional_diet.pdf

Bersamin, A., Zidenberg-Cherr, S., Stern, J.S., Luick, B.R., 2007. Nutrient intakes are associated with adherence to a traditional diet among Yup'ik Eskimos living in remote Alaska native communities: The CANHR study. International Journal of Circumpolar Health, 66 (1): 62-70.

Clark, P.U., A.J. Weaver, E. Brook, E.R. Cook, T.L. Delworth, and K. Steffen, 2008: Executive Summary. In: Abrupt Climate Change. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Geological Survey, Reston, VA, p. 9.

Comiso, J C., 2002. A rapidly declining Arctic perennial ice cover, Geophys Res. Letts., 29, doi:10.1029/2002GL015650.

DCCED, 2009. State of Alaska Department of Community Commerce and Economic Development, Community Profiles, Point Hope, Alaska. http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm

Davenport, Amy, 2009. Personal Communication, 04-30-09. Occupation: Session II Health Aide, Point Hope Health Clinic.

Fitzpatrick J., Alley R., Brigham-Gretto J., Miller G., Polyak L., Serreze M., 2008. Preface: Why and how to use this synthesis and assessment report. In: Past Climate Variabiity and Change in the Arctic and at High Latitude. Synthesis and Assessment Product 1.2. U.S. Geological Survey, Reston, VA, pp. 8-21.

Frankson, Andrew, 2009. Personal Communication, 4-30-09. Occupation: Chief Operator, Point Hope Water Plant.

Frankson, Teddy, 2009. Personal Communication, 8-13-09. Occupation: Wildlife and Parks Director, Native Village of Point Hope.

Google Earth, 2009. Point Hope Map @ 68”20’54.56”N 166”44’00.58”W, Eye @1.61 Km. Imagery Date: June 13th, 2006. Google Earth Computer Program. Available for download: http://earth.google.com/download-earth.html

Heberger, M., Cooley, H., Hererra, P., Gleick, P., Moore, E., 2009. Impacts of Sea Level Rise on the California Coast. Pacific Institute: California Climate Change Center. Available: http://www.pacinst.org/reports/sea_level_rise/

Hunnicutt, Williard, 2009. Personal Communication, 4-30-09. Occupation: Fire Chief, Point Hope Fire Department.

IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007. Synthesis Report, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland. pp 104.

Jones, B.M., Arp, C.D., Jorgenson, M.T., Hinkel, K.M., Schmutz, J.A., Flint, P.L., 2009. Increase in the rate and uniformity of coastline erosion in Arctic Alaska. Geophysical Research Letters, 36, doi:10.1029/2008GL036205.

Kuhnlein, H., Receveur, O., Soueida, R., Egeland, G., 2004. Arctic Indigenous Peoples Experience the Nutrition Transition with Changing Dietary Patterns and Obesity. Journal of Nutrition 124: 1447–1453.

Leiserowitz, Anthony, Occupation: Climate Researcher, Yale University, Personal Communication, April 28, 2009.

Lettenmaier, D., Major, D., Poff, L., Running, S., 2008. Water resources. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States [Backlund, P., et al. (eds.)]. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 121-150.

Martin, P., Jenkins, J., Adams J., Jorgenson T., Matz A., Payer, D., Reynolds P.,Tidwell, A., Zelenak, J., 2008. Wildlife Response to Environmental Arctic Change, Predicting Future Habitats of Arctic Alaska, Report from the Wildlife Response to Environmental Arctic Change (WildREACH), University of Alaska Fairbanks (UAF).

McCarthy, Toren, 2009. Personal Communication, 5-04-09. Occupation: Counselor, Tikigaq School.

Murphy, N.J., Schraer, C.D., Thiele, M.C., Boyko, E.J., Bulkow, L.R., Doty, B.J., Lanier, A.P., 1995. Dietary change and obesity associated with glucose intolerance in Alaska Natives. Journal of the American Dietetic Association. 95:676-682

O'Brien, B. & Loya, W., 2009. Climate Change Impacts on Water Availability in Alaska. University of Alaska Fairbanks (UAF): Wilderness Society Publication.

Parson, E.A., 2001. Chapter 10: Potential consequences of climate variability and Change for Alaska. In: Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Report for the US Global Change Research Program, Cambridge University Press, Cambridge UK, 620pp. 2001.

Point Hope Water Plant, Water Treatment Log Book, 2006-2008.

Rodrigues J., The Increase of the Ice-free Season as Further Indication of the Rapid Decline of the Arctic sea ice. American Geophysical Union, Fall Meeting 2008. abstract #C51A-0542.

Sharp, Scott, 2009. Personal Communication, 5-04-09. Police Officer, Point Hope Police Department.

Shulski, M. Climatological Data and Trends for Kotzebue, Presentation at Workshop: Planning and Preparing for Climate Change in the Northwest Arctic, Alaska Climate Research Center, Geophysical Institute, University of Alaska Fairbanks, Nov 19-20, 2007.

Shimada, K., T. Kamoshida, M. Itoh, S. Nishino, E. Carmack, F. McLaughlin, S. Zimmermann, and A. Proshutinsky (2006), Pacific Ocean inflow: Influence on catastrophic reduction of sea ice cover in the Arctic Ocean,Geophys. Res. Lett., 33, L08605, doi:10.1029/2005GL025624.

Shirasawai, K., Eicken, H., Tateyama, K., Takatsuka, T., Kawamura, T., 2009. Sea-ice thickness variability in the Chukchi Sea, spring and summer 2002-2004. Deep Sea Research Part II: Topical Studies in Oceanography, Volume 56, Issue 17: 1182-1200, The Western Arctic Shelf-Basin Interactions (SBI) Project, Vol.2

SNAP: Scenarios Network for Alaska Planning. University of Alaska Fairbanks. Community Charts. 2010.

Stone, Kimberly, 2009. Personal Communication, 5-04-09. Occupation: Village Services Supervisor, North Slope Borough.

Thiem, B., 2003. Rubus Chamaemorus L.- a Boreal Plant rich in biologically active metabolites: a review. Biology Letters, 40(1):3-13. Available: http://www.biollett.amu.edu.pl/biollett_40_1_3_13.pdf

Towksjhea, Joe, 2009. Personal Communication, 05-01-09. Occupation: Retired Whaling Captain.

USACE, 2009. Alaska Baseline Erosion Assessment, Erosion Information Paper – Point Hope, Alaska, March 10, 2008. Alaska District U.S. Army Corp of Engineers.

USACE, 2006. Relocation Planning Project Master Plan, Final Report, Kivalina, Alaska. U.S Army Corps of Engineers, June 2006.

USACE, 1972. Point Hope Beach Erosion: Point Hope, Alaska. Alaska District, U.S. Army Corps of Engineers.

U.S. Global Change Research Program, 2009. Global Climate Change Impacts in the United States. Cambridge University Press. Available: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/download-the-report

USARC (United States Arctic Research Commission), 2003. Climate Change, Permafrost, and Impacts on Civil Infrastructure. U.S. Arctic Research Commission. Available: http://www.arctic.gov/publications/permafrost.pdf

K. Yosikawa, 2009. Occupation: Permafrost Researcher, UAF, Personal Communication.

Walsh, J, 2005a, Cryosphere and Hydrology. In: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, p 234, http://www.acia.uaf.edu/pages/scientific.html

Walsh, J, 2005b, Cryosphere and Hydrology. In: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, p 193, http://www.acia.uaf.edu/pages/scientific.html

Margaret Killigivuk and her son working in their cold cellar about 1960.
Photo by Berit Arnestad Foote

We gratefully acknowledge the assistance provide by these organizations:

The City of Point Hope
Native Village of Point Hope
Tikigaq Corporation
Maniilaq Association
Northwest Arctic Borough
North Slope Borough
Alaska Center for Climate Assessment and Policy
Alaska Climate Research Center
Scenario Network for Alaska Planning
University of Alaska Fairbanks Geophysical Institute
University of Alaska Anchorage Environment and Natural Resources Institute
National Weather Service
National Oceanographic and Atmospheric Administration
United States Geologic Survey
U.S. Army Corps of Engineers
U.S. Centers for Disease Control Arctic Investigations Program
Alaska Ocean Observing System
Yale University School of Forestry
Kasitsna Bay Laboratory
State of Alaska Department of Community Commerce and Economic Development
State of Alaska Department of Fish and Game
Cold Climate Housing Research Center
State of Alaska Division of Homeland Security and Emergency Management.

For more information please contact:
Center for Climate and Health
Alaska Native Tribal Health Consortium
(907) 729-2464

Find this report and other information about climate and health at our website:
http://www.anthc.org/chs/ces/climate/index.cfm

Cite as: Brubaker M., Berner J., Bell J., Warren J., Rolin A., Climate Change in Point Hope, Alaska, Strategies for Community Health. ANTHC Center for Climate and Health, August 2010.
http://www.anthc.org/chs/ces/climate/climateandhealthreports.cfm

Funded by United States Indian Health Service Cooperative Agreement No. AN 08-X59