



Climate Change in **Levelock**, Alaska

Strategies for Community Health



ANTHC Center for Climate and Health

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ANTHC recognizes all of our technical advisors for this report. Thank you for your support.

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The writing team would like to thank all of the community and regional contributors to this project. We appreciate your time and support.

Achieving wellness through awareness and adaptation



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SUMMARY

Climate change refers to change over time due to natural variability or as a result of human activity (IPCC, 2008). Alaska is experiencing a wide range of impacts from climate change and communities seek adaptive strategies that encourage wellness and sustainability. This report documents climate change impacts as described by community residents and climate change effects or potential effects as interpreted through the lens of public health. It is the seventh report in a series describing climate change in communities across Alaska, and the third report to focus on the Bristol Bay region.

In the Alutiiq and Yupik community of Levelock, Alaska, residents report changes to the weather, seasons, landscape, plants, and wildlife with important implications for community health. Understanding the local impact of climate change is important for assessing negative and positive effects, and developing appropriate adaptation strategies. Levelock is in an area characterized by sandy soils that are vulnerable to erosion. The changes in the timing of the seasons, temperature, precipitation, wind, and extreme events like flooding are all impacts that may influence erosion, with important implications for infrastructure. Some subsistence resources such as caribou have been declining and there are concerns about the year-to-year variability of berry harvest and other foods. Rising air temperatures and precipitation in summer and fall raises concerns about conditions for preparation of subsistence foods. River change related to low water level in the warm season and poor ice conditions after freeze up, is

resulting in travel related hazards and need for adaptive measures to prevent injury.



*Erosion is washing away Levelock's history.
Sue Flensburg, 2013.*

The climate change assessment project in Bristol Bay began at a workshop in Dillingham in 2011 with tribal environmental managers from throughout the region. An advisory team was established including the Bristol Bay Native Association (BBNA), Bristol Bay Area Health Corporation (BBAHC), the University of Alaska Fairbanks

This Climate Change Health Assessment was performed based on requests from tribal health representatives and from local and regional leadership. Information about local climate, environment, and health conditions was gathered with the help of local and regional government, universities, industry, and state and federal agencies.

(UAF) Seagrant Program, the U. S. Fish and Wildlife Service (FWS), and the Alaska Native Tribal Health Consortium (ANTHC). In 2012, baseline information on climate change vulnerabilities were compiled and weighted, and three communities representing different biomes (river, coastal, lake) were selected for on-site assessments. Levelock, a river community, was identified as Priority Level 1 based on economic factors and vulnerability to erosion. Upon receiving a resolution from the Native Village of Levelock (the tribal government), an assessment team was established including Sue Flensburg from BBNA, Greg and Shirley Andrew of Levelock Village Council, Brandon Parker and Jennifer Skarada of BBAHC, and Mike Brubaker from ANTHC. Site visits were performed in June 2012 and July 2013. Survey and report preparation was based on guidance from the village council and a multi-agency advisory team.

This report was prepared by ANTHC's Center for Climate and Health in partnership with members of the advisory team. Funding was provided by the Western Alaska Landscape Conservation Cooperative, and the United States Environmental Protection Agency. In-kind contributions were provided by all project partners. Information sources include the observations of local residents, reports from government agencies, and scientific findings gathered from published sources.



Figure 1.
Bristol Bay Native
Association (BBNA)
service area.

This report includes observations, experience and knowledge shared by a wide range of local experts. Predictions and projections on future conditions such as climate, flooding, and erosion are based on available information and limited by the quality of current scientific data and the uncertainties inherent in models. Research and model development is ongoing in Alaska and new information will be available in the near future.

COMMUNITY

Levelock is located on the west shore of the Kvichak River, ten miles from the mouth of Kvichak Bay. The river flows southwest from Lake Iliamna, about 45 miles discharging into Kvichak Bay. Levelock is situated about 40 miles north from Naknek, 60 miles east of Dillingham and 278 miles southwest of Anchorage. As of 2012, there were about 88 residents, mostly Alaska Native people of Alutiiq and Yupik descent. The Alutiiq people (also known as Sugpiaq or Pacific Yupik) are a southern coastal people who speak a Yup'ik branch of the Eskimo languages. The Yup'ik people have traditionally lived as far north as the Yukon River and as far south as the Alaska Peninsula. Both the Yup'ik and Alutiiq have a common origin with people who arrived in Alaska some 10,000 years ago.

At the time preceding first contact with outside cultures, the Yupik population probably numbered about 11,000 (Oswalt, 1967). Then, the native people in Southwest Alaska lived



*Old fish camp on the Kvichak.
Photo by Mike Brubaker, 2013.*

*The people of Levelock are Alaska
Natives of Alutiiq and Yupik descent.*



Figure 2. Google view of Levelock and region.

mostly in permanent winter villages but moved with the seasons to camps for trapping, hunting, fishing, and gathering berries and wild plants. River people trapped small animals in the spring, caught salmon at fish camp in the summer, and hunted for caribou and trapped beaver in the fall (VanStone, 1984). For the coastal people, the hunting of sea mammals including seal, walrus and beluga whale was also important. Many of these traditions are still practiced. Levelock, with its river access inland, tidal influence, and proximity to the coast, enjoys benefits of both the river and coastal environments.

Written records about Levelock date back to the Russian period, when the village was referred to as “Kvichak.” In 1818, the Russian American Company sent an exploration party under Petr Korsiovskii to the area. They crossed the Alaska Peninsula to Lake Iliamna and then descended the Kvichak River all the way to Bristol Bay. The following summer a trading post was established at the mouth of Nushagak River. It had twenty employees, a Russian Orthodox Church and a mission to develop trade relations with native communities in the area.

The village of Levelock was referred to as “Kvichak” during the Russian period in the early 1800s.

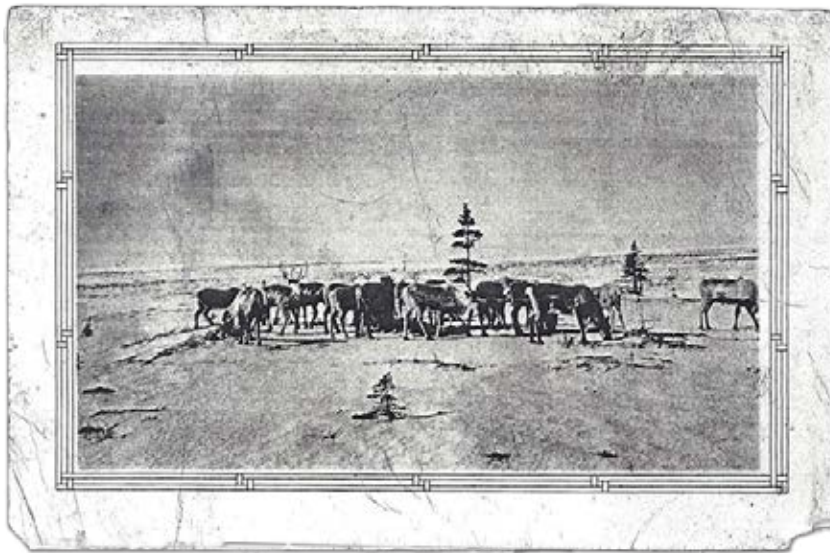


In the years that followed, trade relations expanded throughout the region with all the benefits and consequences that came with exposure to western goods. Exposure to outsiders also brought disease and Bristol Bay native populations were decimated time and again by small pox, measles, influenza, and tuberculosis (Fortuine R., 1992). Kvichak was mentioned during the 1890 census and in 1908 a survey of Russian missions identified “Lovelock’s Mission” at this site (DCCED, Community Profiles). Koggiung Packers operated a cannery at Levelock in 1925-26. It was lost to fire but a second cannery operated from 1928-29. In 1930 the first school was built, and a post office was established in 1939. During the early 1950s, another cannery was in operation.

The location on the banks of the Kvichak River provides excellent fishing, hunting, and berry and plant harvest in season. Snow machines and ATVs are used for travel in the winter, and ATVs, small skiffs and commercial fishing boats used in summer. For Levelock, the annual practice of harvesting salmon is an essential part of their lives and cultural identity. The community relies heavily on the Bristol Bay salmon fishery to sustain its economy. Activities in commercial salmon fisheries date back to the early 1900s, when fisherman traversed the Lower Kvichak in double-ended sailing dories. Commercial fishing continues to be the primary source of employment, mostly cannery work in Naknek and fishing on small commercial boats

in Bristol Bay. A subsistence harvest of salmon is caught locally during the summer and fall.

There are several miles of roads in Levelock and residents travel to other villages by water, trails or on ice roads. There is also a 3,281 foot gravel runway with regular air service. Residents rely



Reindeer at Levelock - 1930.
Photo courtesy of Native Village of Levelock.

“There used to be no trees, just tundra. Now we got too much. I want to go with a chain saw and cut it all down.”

Ella Charley



*Levelock from the air.
Mike Brubaker, 2013.*

upon barge transport and air service for store-bought food, fuel, and other supplies. Seasonal commercial fishing is a major source of income, but residents are also employed in construction, mining, health care, education, traditional crafts, and other businesses and government services. Subsistence is also an important economy and a range of fish, sea mammals, birds, plants, berries and wildlife are harvested.

Local facilities include the tribal administrative offices, a school, a community center, a church, and a bulk fuel storage facility. The health clinic is operated by the Bristol Bay Area Health Corporation. Residents travel to the regional hospital in Dillingham or Anchorage for more advanced medical care. Homes are typically heated by fuel oil. Water is provided by private wells and sewage is piped to private septic tanks. A sewage lagoon near the dump site is used for septic tank waste. Electricity is provided by the Levelock Electric Cooperative, Inc.

*“I would like to see something
done about the erosion. Levelock
is going to wash away.”*

Ernie Setuk



ECOSYSTEM

Ecosystems are areas that share similar climate, geographic conditions and communities of plants and animals. Levelock is part of the “Bristol Bay Lowlands”, Bering Taiga ecosystem of Western Alaska. (Spencer et al. 2007). Coastal areas in Bristol Bay are characterized generally by wetlands and tundra, largely treeless and dotted by thousands of lakes. The forests areas extend inland along the river valleys with a variety of trees including alder, spruce, willow cottonwood and birch. Shaped by glaciers, the lowlands have large terminal moraines and outwash plains.

Balsam poplar stands are common along the rivers and the slopes support communities of dwarf birch and alder. Higher elevations are covered with shrub tundra and lichens, and the lowland wetlands support sedge-tussok and sedge-moss bogs, and willows along the small steams (Spencer et al. 2007). Walrus, seals and sea lions, and beluga inhabit the coastal areas; rivers support productive salmon fisheries and habitat for moose and beaver. The wetlands are thick with waterfowl while caribou, wolves, and bears can be found in the uplands.

Levelock residents describe changes to this ecosystem including increases in willow and alder shrubs which have developed today into trees and small forests. Trees and grasses are encroaching into tundra areas. Also described are changes in timing of the seasons such as freeze-up, break-up and green-up. Residents have observed new types of wildlife. These include



*Aerial view of landscape near Levelock.
Mike Brubaker, 2013.*

Coastal areas in Bristol Bay are characterized generally by wetlands and tundra, largely treeless and dotted by thousands of lakes.

unusual animals (wood frogs), birds and insects. Residents also describe changes to the landscape including river erosion that has resulted in the loss of historic sites and infrastructure, and erosion expedited by vehicle traffic that has converted shrub tundra and lichens to sand dunes.

Climate change is impacting the landscape and the ecosystem in the Levelock area and has the potential to affect the fish and wildlife resources including subsistence species that the community relies upon.

Levelock residents expressed concern about invasive species and about changes in predators, including wolves and bears. Community health concerns related to wildlife include food harvest, public safety, mental health concerns (e.g. wildlife interactions, subsistence challenges and success), and zoonotic diseases such as rabies, which can be transmitted from wildlife to people. The bear concerns were connected with the vegetation change over the past few decades as the tundra and shrub environment has been replaced by alder and willow trees that make it more difficult to see wildlife. Residents expressed concerns about the cover that trees now provide for dangerous wildlife, the loss of the open view across the community, and risks related to decreased visibility of vehicle traffic.

Computer models consider future “cliomes,” areas where temperature and precipitation reflect certain kinds of wildlife and vegetation. Bristol Bay’s current cliome “boreal forest with coastal influence and intermixed grass and tundra,” is expected to shift north and largely disappearing by 2090. It may be replaced by “prairie and grasslands,” a cliome that does not currently occur in Alaska, and is characteristic southeastern Alberta in Canada (Fresco et al. 2012).



Increased foliage growth creates better coverage for predators.

Residents expressed concerns about the cover that trees now provide for dangerous wildlife, the loss of the open view across the community, and risks related to decreased visibility of vehicle traffic.



CLIMATE

Observed change: increases in temperature, precipitation, and weather variability;
Community impacts: changes in seasons, travel conditions, landscape, plants and wildlife;
Health concerns: injuries, heat illness, mental health, changes to harvest, diet and nutrition;
Adaptations: self-sufficiency & emergency preparedness plan based on emerging risks.

The climate is warmer and wetter than in the past.

The climate of this region is characterized by cold damp winters and cool summers along the coast, and warmer summers and colder winters up river and inland. Levelock is in a climatic transition zone; it is primarily maritime but the continental climate also affects the weather. Average summer temperatures range from 30 to 66°F; winter temperatures average from 4 to 30°F. Annual rainfall averages 26 inches, with 70 inches of snow. Fog and low clouds are common during the summer. The river is generally ice-free from June through mid-November, although break-up has been occurring earlier in recent years, and freeze-up as late as March.



*Temperature increases have shortened winter travel season.
Mike Brubaker, 2013.*

“The river usually freezes in November or December. One year it stayed open until March. The ice conditions can make it more dangerous.”

Greg Andrew

Annual average temperature at the regional weather station at Iliamna has been increasing since the early 1940s (Alaska Climate Research Center). Extreme temperature events have also been increasing with more really hot days and fewer really cold days, especially in the spring and winter (Stewart 2011). Long-term weather records from King Salmon indicate that between 1949 and 2008, average annual temperatures increased by 3.8°F, with most occurring in winter (+8.1°F) and the least occurring in fall (+0.6°F). Levelock models show higher temperatures in every month (SNAP 2013).

Residents observe that high summer temperatures have negatively affected their ability to dry fish, sometimes causing inadequate preservation and loss of harvest. During the summer of 2013 temperatures hovered in the 70s and 80s for weeks. In Levelock and other areas of Bristol Bay, facilities are designed for cold climate and though the temperatures are not considered extreme by Lower 48 standards, lack of air conditioning and ventilation can result in interior temperatures that are uncomfortable or unhealthy. On July 26, 2013, the temperature in Levelock reached a high of 78°F. A commercial flight from Levelock to Anchorage had inadequate ventilation and no water for passengers. Interior temperatures reached the high

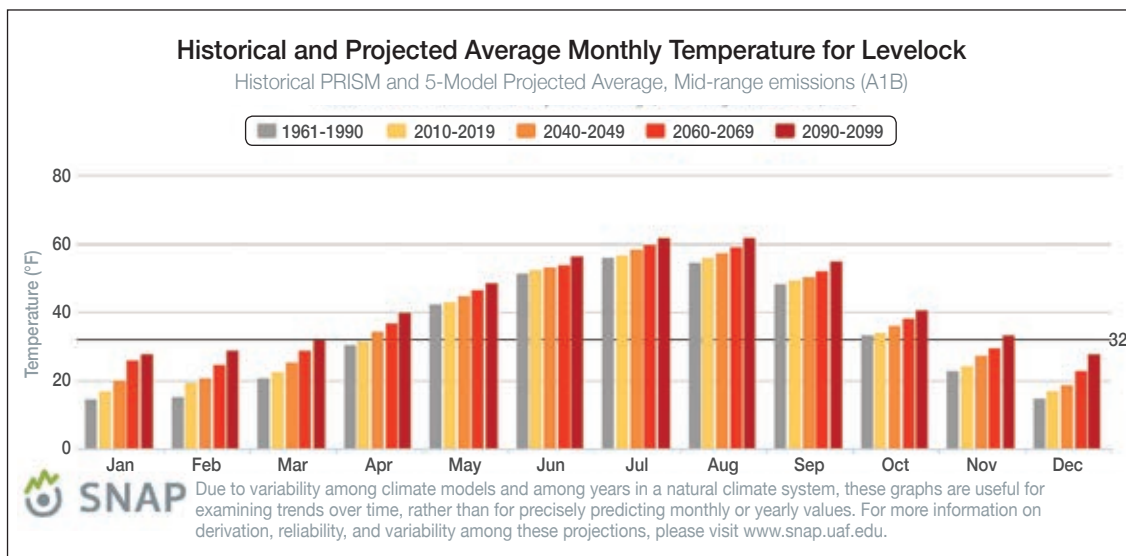


Figure 3. Historic & Projected Average Monthly Temperature, Levelock, Alaska. UAF, Scenario Network for Alaska Planning, 2013.

“When the wind blows, it gets really dusty. If you leave the window open the sand comes right in.”

Ella Charley

90s°F. Like the design of homes and other buildings, aircraft and other vehicles are designed for operation in cold climates and may be unsuitable as temperatures become more extreme.

Over the past half century, precipitation in Levelock has increased in most months of the year (SNAP). The majority of precipitation occurs in August and September and the least in February and March. In Southwest Alaska, the frequency of extreme, three-day rain events in the summer has also increased (Stewart, 2011). Levelock residents observe more rainfall in the winter months and less snow. The snow day fraction (a measure of days of snow versus rain) was 30 to 40 in the 1990s. The projection through 2019 is for more precipitation in the winter and summer months, and for decreases in the spring and fall (SNAP 2013), and for winters to become increasingly rain rather than snow dominated (McAfee, 2013). Ice conditions on the river affect resident’s ability to travel in winter, and poor ice conditions can seriously interfere with subsistence activities.



Recommendation: The long-term projections are for continued warming and variations in the timing of freeze-up, break-up and green-up. Increases in the frequency and intensity of

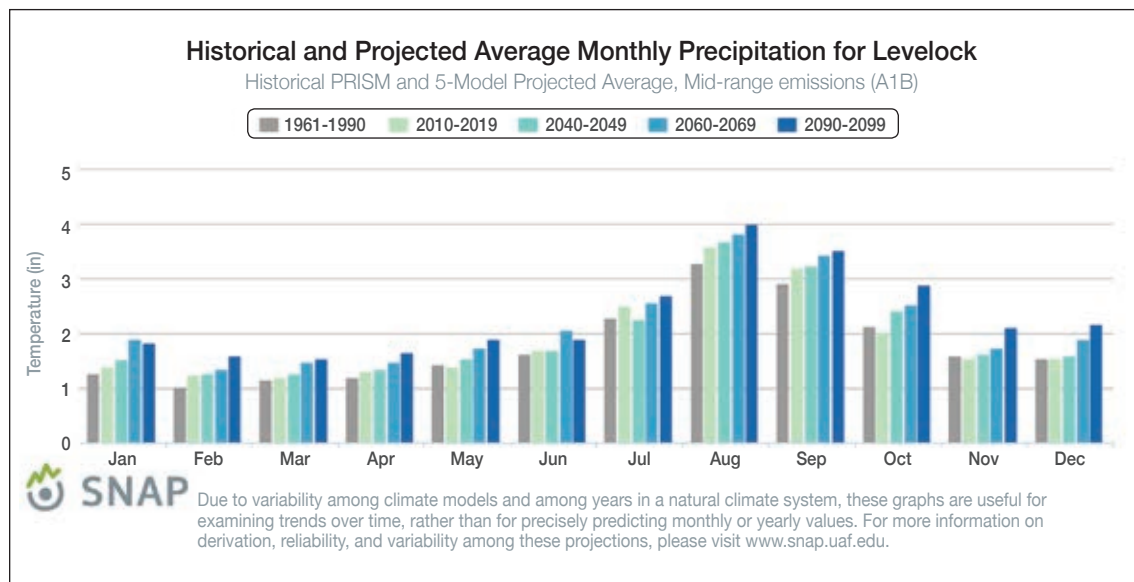


Figure 4. Historic & Projected Average Monthly Precipitation, Levelock, Alaska. UAF, Scenario Network for Alaska Planning, 2013.

“Now we have rain and wind in the summer. That is supposed to be fall time.”

Ida Apokedak



*High tide on the Kvichak river.
Mike Brubaker, 2013*

extreme weather are also expected. Precipitation is expected to increase in winter and summer and decrease in the spring and fall. Community emergency plans should be reviewed and efforts made to incorporate changes in the type, season, frequency and intensity of weather and natural events such as wildfire, storms and floods. Public education is recommended on prevention of heat illness. Measures to allow for appropriate ventilation and cooling of structures and vehicles during periods of hot weather is also recommended. Key Contacts: Tribal Government, National Weather Service, Alaska Center for Climate Assessment and Policy, BBNA, BBAHC.

“Our river is low on water. We could not even get up river. There are sand bars where they never used to be.”

Ella Charley

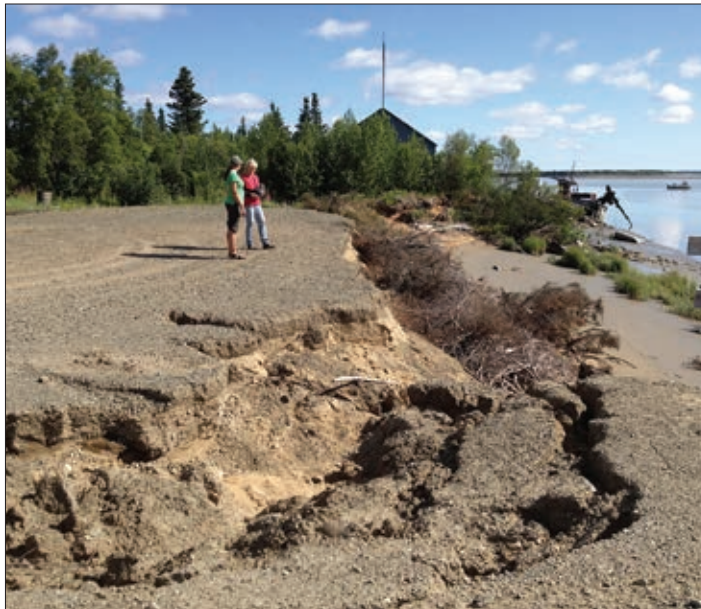


RIVER

Observed change: changes in water depth & channel locations, eroded river banks, unusual ice conditions;
Community impacts: loss of infrastructure & pollution related to bank erosion, decreased navigability;
Health concerns: safety, injury, food security, emotional stress;
Adaptations: monitor change, phased relocation of infrastructure, cleanup of contaminated site near river.

Erosion is causing the loss of homes and infrastructure.

The Kvichak River is 80 miles long, stretching from its mouth at Lake Illiamna to its terminus at Kvichak Bay. The word Kvichak in Yupik means “up to the great water,” a reference to Illiamna, which is the largest lake in Alaska. The entire river is navigable and there are two communities on its shores: Iguigig up river by Lake Illiamna, and Levelock about ten miles from the mouth of the bay. These are some of the most productive waters for salmon in the world as well as for trout, pike, Arctic char and other types of fish. At Levelock, the river is tidally influenced and in summer beluga whales are seen on the incoming tide feeding on salmon.



*Bank erosion near the bulkhead.
Mike Brubaker, 2013.*

The Kvichak is a restless river and it has been moving closer to Levelock with each passing year. Levelock is located on a bluff above the river and flooding has not been a big concern historically, except when it leads to more bank erosion. A review of USACE public flood event data indicated that the last recorded flood event in Levelock was caused by a coastal flood in August 1980 (USACE). However, flood risk may be changing due to erosion, seasonal ice

“The bank has eroded about 75’ since 1984. The erosion is gradual and year round. It is mostly driven by the wind and the river water.”

Howard Nelson



Erosion is removing Levelock's embankment.
Google Maps, 2013.

conditions, and sea level rise. High water events and spring break-up accelerate the ongoing erosion caused by wind, river flow, ice, and rain. Residents report that since 1984 the bank has eroded by 75 feet—an average rate of over 2.5 feet per year. This has resulted in the loss of several homes and other structures. Some residents have repeatedly moved their homes back from the river bank.

The fact that the Army Corp of Engineers (USACE) has classified Levelock in a group with 69 communities “not significant enough to require immediate action,” underlines the scale of erosion problems in Alaska communities. Since the report was published in 2005, several homes have been relocated away from the river bank and some structures have fallen off the bank and littered the river bed beneath. Currently the community bulkhead, a warehouse, roads, the fuel

“The channel has moved to our side of the river and so much erosion. We first moved the porch to the other side of the house. Then we moved the house. And then we moved it again.”

Ida Apokedak



Erosion of the community bulkhead.
Mike Brubaker, 2013.



Greg Andrews installing a time lapse camera on the Levelock bulkhead.
Mike Brubaker, 2013.

header, and several homes are at risk of being lost to erosion. An old BIA tank farm with two vertical (now empty) gasoline storage tanks and significant soil contamination is located approximately 65 feet from the eroding bluff and should be a priority for clean up and demolition (AEDC, 2013).

The influence of climate change on erosion in Levelock is uncertain. Soil temperatures at a depth of one meter are not cold enough to support permafrost (UAF-GI). An increase in the frequency or intensity of extreme weather may accelerate erosion, along with changes in the ice season. However, warmer temperatures may result in a less aggressive or damaging breakup in the spring, which could help to prevent flooding and erosion. An important emerging factor is sea level change. Current tidal station data shows sea level rise as much as 4 feet per century in some parts of the United States (NOAA, 2014). But, tide station data for Western Alaska is very limited and there is no data available on the actual rate of sea level change in Bristol Bay. In Kodiak, the sea level is actually dropping at a rate of 3.42 feet per century, related to glacial melt and rebound of the underlying landmass (NOAA, 2014). In Sand Point, the sea level is rising at a rate of 0.3 feet per century. These rates could change and the tidal influence of the Kvichak River at Levelock and coastal flood history indicates a pre-existing vulnerability.

Recommendations: A Detailed Erosion Assessment (DEA) is recommended including estimates for future river bank erosion and guidance on arresting erosion. Planners should encourage an adequate setback based on projections and plan for continued relocation of homes and other structures away from the river bank as needed. The time lapse

“The river used to be navigable even at low tide. The last several years it has become very shallow about 5 miles downstream. I think it is filling with silt.”

Greg Andrew



*Erosion threatens old warehouse.
Mike Brubaker, 2013.*

camera installed at the bulkhead should be maintained as a long-term record of the river bank (ANTHC 2014). Installation of a regional tide station should be encouraged to provide better sea level change trend data for the area. Repairs to the community bulkhead are necessary to prevent catastrophic loss. Clean-up of the retired bulk fuel facility is a priority, as well as the removal or relocation of homes and structures along the river bank edge to prevent contamination of the Kvichak River watershed. Key contacts: City and Tribal Government, Lake and Peninsula Borough, ADEC, ANTHC, BBEDC, BBNA, NOAA, USACE.

“When we were kids, there was 100-200 feet of land in front of the warehouse. We had a smokehouse and fish racks.”

Ida Apokedak

VEGETATION

Observed change: loss of vegetation to river and wind erosion, invasive plants, rapid tree growth;
Community impacts: dust, loss of viewscape, decreased visibility for seeing bears & other wildlife hazards;
Health concerns: stress from wildlife & traffic hazards, increased pollen levels, allergies, & respiratory problems;
Adaptations: cut vegetation to widen roads & improve viewscape, management plan to control invasive plants.

The tundra is being replaced by forest.

Fifty years ago, Levelock was a village on the tundra with a scattering of black spruce trees. Across the community, residents enjoyed a virtually uninterrupted view of the village and the river, but a number of factors have contributed to change in the vegetation of Levelock. The sandy soils are vulnerable to erosion by rain, from wind and the passage of vehicles. The advent of motorized vehicles has transformed the town center from the tundra trails of years past, to today's ATV roads inches deep with sand and river silt. The sand may be made



Road through the trees in Levelock.
Mike Brubaker, 2013.

“It is difficult to see when you are driving, because there are lots of blind corners.”

Ernie Setuk

airborne by wind or vehicle traffic and is a respiratory irritant. Tree growth, perhaps aided by warmer air and soil temperatures, has also transformed the community. These trees may actually benefit air quality by reducing the wind effect and helping to suppress road dust. Road dust and smoke from wildfires have been observed as factors affecting air quality in Levelock. Another concern as trees encroach on roads and properties is the decreased visibility in the community. Bears frequent Levelock during the salmon season and residents expressed safety concerns over the cover that vegetation provides for wildlife. Travel in the community is also made more hazardous by trees now growing close to the roads, which make the roads narrow and create blind spots on turns. Looking at benefits, tree growth may be improving forage areas for moose, an important subsistence resource for Levelock.



*Road dust and smoke from wildfires are two factors affecting air quality in Levelock.
Mike Brubaker, 2013.*

The emergence of forest in Levelock also raises questions about the effect of tree pollen and related allergies. Alaska has some of the highest pollen levels in the world (Demain J., personal communication) and with increases in allergy-causing events in Alaska there is potential for more people to develop asthma and allergies, and for clinics to see more patients seeking treatment for respiratory problems. The pollen season for alder, willow, birch and spruce all occur between April and June, with peaks occurring typically in May. Grass pollen generally occurs later in June and July. Warm conditions in recent years have caused extreme pollen levels in some parts of Alaska and climate driven changes in the timing of spring and summer has resulted in years with early or late pollen events.

“It was never sandy in our day. We walked everywhere. Now with four-wheelers everything is turning to sand.”

Ella Charley

No reports of tree disease were recorded in the Levelock vicinity in 2012 (USFS 2012). Forest diseases have however, been reported related to spruce bark beetles and birch and willow tree defoliation near Lake Iliamna and King Salmon. Levelock residents reported spruce rust events on the Kvichak (Climate Change Assessment Public meeting July 24, 2013). Outbreaks are triggered by cool, wet weather in May, when fungal spores from Labrador tea (the alternate host) infect newly emerging spruce needles. Damage from spruce needle rust rarely results in tree mortality, since only current-year needles are affected and conditions for severe infection usually do not occur in the same location in consecutive years (FS-R10-FHP. 2013).

Historically, Alaska's cold climate prevented non-native plants from becoming established. However, in recent years there has been an influx of meadow hawkweed, Canada thistle, and spotted knapweed; now all have localized populations in Alaska. Other species such as reed canary grass and white sweetclover are very widespread (Carlson et al. 2007). The invasive plants watch list for Levelock includes yellow toadflax and oxeye daisy, which are present along the road system in Dillingham and Aleknagik (BBNA). In Levelock, there is a small infestation of orange hawkweed (Jennifer Robinette, 2013). Species documented during a July 2013 site visit include narrowleaf hawkweed and fall dandelion.



Recommendation: Climate models predict that the Bristol Bay region will experience rapid ecological change during the next 100 years. This may mean higher susceptibility to diseases and pests along with competition from invasive species. Management plans for controlling and limiting the expansion of invasive plants is recommended, as is selective cutting to expand the view areas around roads to provide protection for people and for wildlife. Clinical staff should expect to see changes in number, intensity and timing of seasonal allergies. Key contacts: AACD, ADF&G, BBNA, BBAHC, FWS, NPS, USFS.



Yellow toadflax.
Mike Brubaker, 2013.

The invasive plants watch list for Levelock includes yellow toadflax and oxeye daisy.



Oxeye daisy.
Mike Brubaker, 2013.

*Historically, Alaska's cold climate
prevented non-native plants from
becoming established.*

SUBSISTENCE

Observed change: decline in caribou & some fish, increase in beluga & seals, variable berry harvest;
Community impacts: decreased reliance on caribou, increased reliance on moose, fish, marine mammals;
Health concerns: food security, food safety, nutrition;
Adaptations: encourage healthy foods, monitor changes in harvest success, areas, seasons & habitat.

The harvests and conditions for preserving foods are changing.

The Levelock area is critical habitat for regional subsistence activities (Brand 2010). Levelock residents expressed concerns about changes to subsistence resources and questions about the relationships with climate change. A wide variety of healthy, nutritious wild foods are harvested in Levelock including land and sea resources. A harvest survey in 2005 found that the per capita annual subsistence harvest was 527 lbs. Residents identified a total of 534 subsistence use areas. The most important community resource was large land mammals (8547 lbs) mostly moose. Second was salmon (5150 lbs) followed by non-salmon fish (1353), marine mammals (1279 lbs) including beluga whale and harbor seal, plants and berries (757 lbs), and then smaller amounts of bird eggs, birds, small land mammals, and marine invertebrates (ADF&G 2005).



*Beluga surfaces on the Kvichak.
Photo by Anna Bryan.*

“The belugas are increasing more than ever. Also we have seal.”

Ella Charley

Changes in subsistence harvest have been noted in particular with fish and small and large land mammals. Harvest trends show increases in the harvest of large land mammals, vegetation, marine invertebrates, and birds and eggs. Declines in harvest trends have been shown for small land mammals, marine mammals, non-salmon fish, and salmon (Braund 2010). Between June and September, all five pacific salmon species spawn in the major rivers and streams of the Kvichak drainage. Residents report that the harvest of kings and silvers have been increasing in recent years. Other important fish species include arctic char, arctic grayling, Dolly Varden, northern pike, lake trout, and rainbow trout. In winter, burbot and whitefish are caught through the ice.

Changing water conditions can stress salmon and other fish species. Climate-driven stress has in some cases been shown to exceed tolerance levels for salmon (Grah and Beaulieu, 2013). Research is underway evaluating the effects of changing turbidity on salmon fry and other forage fish (Shearer, 2010). A 2011 risk analysis ranked climate change as a high threat to all of the watersheds in the Bristol Bay region, including Lake Illiamna and the Kvichak River (SWASHP, 2011). As glaciers, snowpack and the waters they produce decline, a decrease in aquatic habitat is expected in many large river systems impacting fish species that utilize these rivers for spawning (Clark, 2010). Another problem reported in Levelock and throughout the region is the drying of harvested fish for subsistence in years where temperatures are warm or the conditions excessively wet. This has resulted in inadequate drying of fish, spoilage and loss of harvest.



*Salmon is an important part of subsistence living.
Mike Brubaker, 2013.*

“One year it got so hot it took all the fish in the smoke house—500 fish.”

Ella Charley

Moose are reported to have first arrived in the vicinity of Levelock in the 1930s. In 2005, moose was the most important species as measured by pounds harvested. Climate change may be optimizing conditions for moose by increasing the availability of good forage including willow and alder. Residents observed that caribou harvest has continued to decline due to decreased availability and changes in migration routes. The size of the Mulchatna herd is down from an estimated 200,000 animals in 1999 and is now about 30,000 animals (NPS). The reasons are uncertain, but one possible factor is the effect of icing events on caribou forage



Moose are benefitting from the increased growth of willow and alder.

areas. The highest frequency of icing events in Alaska occurs in the southwest, especially at low elevations adjacent to the coast. Some areas have experienced as many as seven events per winter (Wilson et al. 2012). With a lack of current harvest data it is difficult to determine what may be filling the harvest void left by caribou declines and the implications for food security and nutrition. Residents did report increases in beluga and harbor seal, two other important subsistence resources.

Berries are another important food resource and residents observe increased variability in berry harvest. Case in point was

the failure of the blueberry harvest in 2012, followed in 2013 by an unusual abundance in salmon (cloud) berries. Berry bushes are extremely sensitive to temperature, rain, snow and soil conditions, and declining harvest has been attributed to climate change in other northern regions (Zubov L, 2012). Locally harvested species include lowbush cranberry, cloud berry (called salmon berry), crow berry, and highbush cranberry. In 2013, there was an unusual abundance of cloud berries, perhaps related to the late spring followed by hot temperatures.

In 1972, the second most important subsistence resource was caribou, but there has not been a successful harvest in years. The Mulchatna Herd is down from an estimated 200,000 animals in 1999 and is now closer to 30,000 animals.



*The summer of 2013 was very good for salmonberries.
Mike Brubaker, 2013.*

Recommendation: An extensive harvest survey was published as part of the Pebble Mine Environmental Study, by Braund and Associates in 2010. This study provides a comprehensive baseline for measuring changes in subsistence activities in coming years. Climate change will likely have significant impacts on salmon throughout Southwest Alaska. Combined with stresses from other threats, the impact could be very negative and severe, although beneficial changes may also occur as new habitat is opened (SWASHP, 2011). For now, high temperatures in Levelock have in some years affected the conditions for the preservation of salmon and other fish. Change in seasonality may also occur, such as the early salmon run of 2013. Changes in timing and adaptive strategies for drying fish and game may be necessary to prevent spoilage and conservation strategies are recommended to protect salmon habitat. Declines in a primary subsistence resource such as caribou and the increasing cost of store-bought foods raise concerns about food security. Frequent comprehensive subsistence harvest surveys are recommended. Local environmental observers can assist in monitoring the condition of subsistence resources. Key Contacts: icing (Wilderness Society) berries (USGS), harvest surveys (ADF&G), shorezone mapping (NOAA), nutrition (BBAHC), local observers (ANTHC), salmon (SWASHP), science and research priorities (Western Alaska LCC).

*“I have never had so many
salmon berries. It is a good year.
We had a really hot weather.”*

Ella Charley

FINDINGS

It is becoming warmer with an increase in average annual air temperature.

Temperatures have increased in every month of the year. There are also increases in extremely warm days and a decrease in the number of extremely cold days.

It is becoming wetter and the amount of precipitation has increased in eight out of twelve months.

The number of extreme precipitation events is expected to increase.

Warming has resulted in decreases in snow and ice. This is affecting conditions for winter travel on the river and trail system, and preventing some types of subsistence activities.

The river bank is rapidly eroding. Since 1984, Levelock has been losing river bank at a rate of about 2 ½ feet per year. During high water or extreme weather, the rate of erosion is much higher.

Historical sites are disappearing. Residents are concerned by the loss of land, and sites of cultural and historical significance. The old cannery site, homes, and fish camps have been lost to the river.

Erosion caused by river change is threatening critical infrastructure. Some homes have been repeatedly moved back from the river bank. More relocation of facilities and infrastructure is necessary to prevent the interruption of critical services and pollution of the river.

Sea level rise will likely affect flood risk, transportation, subsistence, and erosion rates. Better information about sea level trends is needed through the establishment of regional tide measurement stations.

The community bulkhead is a priority. Erosion on both sides of the bulkhead is increasing and engineering measures are necessary to prevent loss of the structure and related services.

Clean-up of the old BIA tank farm is a priority. At the current rate of erosion the site could be exposed to the river bank in twenty to thirty years. Leachate from soil contamination at the site could become a pollution problem even sooner.

“A few years ago, the housing corporation used a crane to move three of the homes [threatened by bank erosion].”

Greg Andrew

Rapid growth of trees is changing the landscape. The rapid growth of trees, alder and willow, has both positive and negative implications for community health. On one hand it helps to control wind erosion and dust, while on the other it reduces visibility for sighting wildlife and traffic.

Community members are concerned about subsistence changes. There is a perception that changes are affecting subsistence including the abundance, availability, timing, and quality of food resources. Changes are expected continue and Levelock residents will need to find ways to adapt.

Climate change has resulted in poor conditions for food preservation. Residents report that unseasonably warm and wet conditions have resulted in poor conditions for drying fish, spoilage of food and loss of harvest.

Some improvements in subsistence resources are also being observed. Residents report increases in sea mammals including beluga whale and harbor seal. Periodic monitoring of subsistence conditions and measures as per the existing baseline is recommended.

There are invasive plants and reports of new species of wildlife. Residents report a variety of unusual wildlife sightings, new species and invasive plants are also reported. Local Environmental Observers can help to monitor these changes and connect with technical resources.

Climate models project continued rapid change. Residents should expect that some plants and wildlife will be stressed during a period of rapid environmental change, but that new resources and opportunities will emerge that can benefit Levelock.

Change will bring new challenges including natural disasters. As climate and environmental conditions are changing so also are the risks for disasters. Developing an all hazards mitigation plan for Levelock is recommended.

*“We have no swallows this year
and the robins are scarce.”*

Ella Charley



CONCLUSION

Public health considers climate change based on effects to mental health, injury, disease, and food and water safety and security. In Levelock, residents report rapid erosion along the river bank and in the town caused by river change, extreme weather, and vehicle traffic. Erosion is resulting in the loss of critical infrastructure and decreasing air quality with potential effects on public health. Warmer temperatures, increased precipitation and extreme weather may be contributing to erosion. This report raises awareness about current, emerging, and potential future climate change. It is hoped that this will help Levelock make informed planning decisions, find community appropriate development strategies, and pursue a safe, healthy, and sustainable future.

For more information, contact the Center for Climate and Health by e-mail at akaclimate@anthc.org or by phone (907) 729-2464.



Time lapse camera view from bulkhead. The purpose is to monitor river change and bank erosion. Mike Brubaker, 2013.

It is hoped this report will help Levelock make informed decisions and find community appropriate adaptation strategies.

Figure 5. Climate Change Health Assessment Findings, Levelock, Alaska

Topic	Observed Change	Community Impacts	Health Concerns	Adaptations
Temperature	Increases in temperature, variability and extremes	Travel disruptions, infrastructure damage, timing of seasons	Supply shortages, accident and injury, mental stress	Enhance systems for self-sufficiency and emergency preparedness
Precipitation	Extreme weather, increased precipitation, less snow	Travel challenges and disruptions due to extremes and marginal weather	Supply shortages, accident and injury, mental stress, depression	Enhance systems for self-sufficiency and preparedness, encourage social activities
Storms	More storms, extreme and poor weather, and less winter shore ice	Damage to infrastructure, travel challenges and disruptions	Supply shortages, accident and injury, mental stress, depression	Engineer for extremes, phased relocation, encourage social activities
Erosion	Less shore ice, storms and flooding are increasing erosion. Wind and ATV erosion in town.	Damage to roads and associated utilities, and bulkhead	Damage or disruption to critical health infrastructure	Shore hardening activities, engineer for extremes, phased relocation
Landscape	Rapid tree growth, new coastal wetlands, invasive plants	Loss of tundra to woodlands, loss of berry plant habitat	Food security, potential for new or increased pollen allergens, mental health	Monitor changes (LEO); inform clinics on emerging environmental concerns; manage invasive plants
Wildlife	Increasing encounters with bears and wolves, new bird species	Increased caution with children and pets, concerns about invasive species	Food security, public safety, anxiety and related mental health	Monitor wildlife changes and events (LEO), and assess wildlife change causes
Subsistence	Decline in caribou harvest, variable berry harvest, more beluga and seal	Dietary change, increased dependence on moose, fish and sea mammals	Food security and related mental health issues	Monitor subsistence events (LEO), perform comprehensive harvest survey, and encourage healthy food

APPENDIX A

Community and Regional Contributors

Anecdotal data was collected on observations and experiences from local experts in health, wildlife, weather, subsistence, education, sanitation, local governance, law enforcement, and emergency services.

	Name	Position	Association
1	Charles Andrew	Elder	Resident
2	Greg Andrew	Tribal Administrator	Levelock Village Council
3	Shirley Andrew	Environmental Coordinator	Levelock Village Council
4	Hans Apokedak	Solid Waste Coordinator	Levelock Village Council
5	Ida Apokedak	Village Council President	Levelock Village Council
6	Danielle Dobkins	Tribal Council Member	Levelock Village Council
7	Fred Chukwak	Elder	Resident
8	Sue Flensburg	Environmental Planner	Bristol Bay Native Association
9	Jordan Keeler	Community Develop. Coord.	Lake and Peninsula Borough
10	Jenny Nelson	Community Health Aide	Bristol Bay Area Health Corporation
11	Donna Olsen	Community Health Aide	Bristol Bay Area Health Corporation
12	Brandon Parker	Sanitarian	Bristol Bay Area Health Corporation
13	Alex Tallekpalek	Member	Levelock Village Corporation
14	Gusty Tallekpalek	School Maintenance	Bristol Bay School District
15	Louise Tallekpalek	Personal care attendant	Bristol Bay Area Health Corporation
16	Ernie Setuk	Elder	Resident
17	Ella Charley	Elder	Resident
18	Jennifer Skarada	Environmental Health Expert	Bristol Bay Area Health Corporation
19	Laura Woods	Native American Housing Assistance and Self Determination Act of 1996 (NAHASDA) Coordinator	Resident

APPENDIX B

Levelock Climate and Health Web Resources

Topic	Resource	Location
Climate / Health Study	Center for Climate and Health	www.anthc.org/chs/ces/climate/links.cfm
Community Profile	State of Alaska Community Database	http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm
Regional Climate Data	Alaska Climate Research Center, UAF	http://climate.gi.alaska.edu/Climate/Location/TimeSeries/KingSalmon.html
Temperature Charts	Scenario Network for Alaska Planning	http://www.snap.uaf.edu/charts.php
Precipitation Charts	Scenario Network for Alaska Planning	http://www.snap.uaf.edu/charts.php
Extreme precipitation	NOAA Atlas 12	http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_ak.html
Weather Spotters	NWS Extreme Weather Spotter	http://www.weather.gov/skywarn/
Precipitation Monitor	Collaborative Snow, Rain, Hail Program	http://www.cocorahs.org/
Erosion Data	USACE Community Report, 2009	www.poa.usace.army.mil/AKE/Home.html
Flood Data	USACE Flood Hazard Database	http://66.223.166.160/usace_disclaimer.html
Coastal Observations	National Weather Service	www.nws.noaa.gov/om/coop/index.htm
Season Observations	USGS Phenology Network	www.usanpn.org/
Local Observers	LEO - ANTHC	http://www.anthc.org/chs/ces/climate/leo/
Regional Health Profile	Alaska Native Tribal Health Consortium	http://www.anthctoday.org/epicenter/assets/data/bristol_bay/bristolbay_data.html
Regional Climate Studies	Western Alaska LCC	http://www.arcus.org/western-alaska-lcc
Food Harvest Data	Alaska Department of Fish and Game	http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvestCommSelComm
Bristol Bay Environment Resource	Southwest Alaska Salmon Habitat Partnership	http://www.southwestsalmon.org

APPENDIX C

Acronyms

AACD	Alaska Association of Conservation Districts
ACCAP	Alaska Center for Climate Assessment and Policy
ACRC	Alaska Climate Research Center
ANTHC	Alaska Native Tribal Health Consortium
ADF&G	Alaska Department of Fish and Game
ADEC	Alaska Department of Environmental Conservation
BBNA	Bristol Bay Area Native Association
BBAHC	Bristol Bay Area Health Corporation
BBEDC	Bristol Bay Economic Development Corporation
CAHM	Climate and Health Measure
CCH	Center for Climate and Health
CCHA	Community Climate and Health Assessment
CCHRC	Cold Climate Housing Research Center
CDC	Centers for Disease Control
CSIS	Community Subsistence Information System
CVI	Climate Vulnerability Index
DHSS	Department of Health and Social Services
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
GIS	Geographic Information System
GLOF	Glacier Lake Outburst Flood
HIA	Health Impact Assessment
HVA	Hazard Vulnerability Assessment
IPCC	Intergovernmental Panel on Climate Change
L&PB	Lake and Peninsula Borough
LEO	Local Environmental Observer
NOAA	National Oceanographic and Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
SNAP	Scenario Network for Alaska and Arctic Planning
SWAN	Southwest Alaska Network Inventory and Monitoring Program
SWASHP	Southwest Alaska Salmon Habitat Partnership
UAA	University of Alaska, Anchorage
UAF	University of Alaska, Fairbanks
USFWS	United States Department of Fish and Wildlife Service
USG	United States Geologic Service
WALCC	Western Alaska Landscape Conservation Cooperative



*Riverside homes in Levelock are under threat of erosion.
Mike Brubaker, 2013.*

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*Old nets and rails along the shore of the Kvichak river.”
Mike Brubaker, 2013.*



ANTHC would like to express our special thanks to the residents of Levelock and other parts of the Bristol Bay region, who provided their time, knowledge and assistance during this project.

We gratefully acknowledge the assistance provide by these organizations:

*Levelock Traditional Council
The City of Levelock
The Bristol Bay Native Association
Bristol Bay Area Health Corporation
The Lake and Peninsula Borough
The Alaska Center for Climate Assessment and Policy
The Alaska Climate Research Center
The Scenario Network for Alaska Planning
The University of Alaska Fairbanks Geophysical Institute
The State of Alaska Department of Community Commerce & Economic Development
The State of Alaska, Department of Health and Social Services
The State of Alaska Department of Fish and Game
The State of Alaska Division of Homeland Security and Emergency Management
The State of Alaska Department of Environmental Conservation
The National Oceanographic and Atmospheric Administration
The National Weather Service
The United States Geologic Survey
The U.S. Army Corps of Engineers
The U.S. Centers for Disease Control - Arctic Investigations Program
The Environmental Protection Agency
The U.S. Fish and Wildlife Service*



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:
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Cite as: Brubaker M., Andrew G., Andrew S., Flensburg S., Skarada, J.,
Climate Change in Levelock, Alaska, Strategies for Community Health. ANTHC, 2014.
www.anthc.org/chs/ces/climate/climateandhealthreports.cfm

Funded by the Western Alaska Landscape Conservation Cooperative (Western Alaska LCC), and an Indian General Assistance Program grant from the U.S. Environmental Protection Agency.

