To Relocate Villages, Or Not?

At-risk Alaska communities face hard, expensive choices

BY SARA TEEL

A growing number of Alaska communities face the compounding threats of erosion, flooding, and permafrost thaw. In Yup'ik, these combined processes can cause catastrophic ground collapse called *usteq*, or "surface caves in."

When severe enough, *usteq* can cripple village life, health, and economies. Without action, some villages would eventually sink into the softening ground or slide into the ocean or river. (For details on these hazards, see the sidebar on page 10.)

While erosion, flooding, and permafrost thaw can be natural processes, climate change has dramatically accelerated *usteq*. The Arctic is heating at more than double the rate of the rest of the planet. According to the National Oceanic and Atmospheric Administration's Arctic Report Card, the past six years' average temperatures exceeded all previous records.

The costs of climate change grow each year with higher temperatures, rising sea levels, changing weather patterns, and the loss of protective sea ice. According to the University of Alaska Anchorage's Institute of Social and Economic Research, climate change will cost Alaska about $340 million to $700 million per year for the next 30 to 50 years.

***Usteq*: Yup'ik for "surface caves in"**

A catastrophic form of permafrost thaw collapse that occurs when frozen ground disintegrates under the compounding influences of thawing permafrost, flooding, and erosion

These houses in Shishmaref collapsed because of coastal erosion. Permafrost thaw worsens the problem by destabilizing the shoreline. Photo by GRID-Arendal, www.grida.no/resources/1139

Corps listed imperiled villages in 2009, added more in 2019

In 2009, the U.S. Army Corps of Engineers identified 178 Alaska communities "in most imminent danger of becoming uninhabitable" from erosion alone, deeming 26 of them "priority action communities." The Corps predicted that those 26 — mostly majority Alaska Native villages that rely on subsistence — faced severe damage within 10 years. Nearly three-quarters are coastal or near-coastal, and most are on Alaska's western coast.

One reason Western Alaska is so vulnerable is its storms are severe. The North Pacific has one of the most active storm tracks in the northern hemisphere. On the state's western coast, these storms can reach Category 1 hurricane strength — 74 mph to 95 mph winds — but with diameters five to 10 times larger than a typical Category 1 hurricane.

In 2019, the Corps and other groups reevaluated those communities to provide guidance for planners

The 40 in-peril communities the Corps listed as highest-priority in 2019

	Coastal or near-coastal	Not coastal
Elsewhere in Alaska	Utqiagvik	Allakaket, Circle, Eagle, Fort Yukon, Galena, Gulkana, Hughes, Huslia, Lime Village, McGrath,
Western Alaska	Alakanuk, Buckland, Chefornak, Deering, Elim, Emmonak, Golovin, Kivalina, Kotlik, Kotzebue, Newtok, Nome, Port Heiden, Saint Michael, Savoonga, Shaktoolik, Shishmaref, Teller, Tuntutuliak, Unalakleet	Akiak, Bethel, Koyukuk, Kwethluk, Napakiak, Napaskiak, Noatak, Tuluksak

Note: The 10 villages in red are the most at risk from the combined threats of erosion, flooding, and permafrost thaw.

Sources: University of Alaska Fairbanks Institute of Northern Engineering, U.S. Army Corps of Engineers Alaska District and Cold Regions Research and Engineering Laboratory, and Denali Commission

in an updated report for the Denali Commission. The update expanded the main threats to include flooding and permafrost thaw.

Although many of the communities had made significant progress over the decade, the Corps kept nearly all of them on the list and added several more. (See the table above for the 40 communities considered most at risk as of 2019.)

The types of damage these towns face vary by their topographical, geological, and societal characteristics, and so do the best paths forward. But the lack of statewide monitoring is an obstacle for engineers, scientists, and planners, who get most of their information from historical records, disaster declarations, and anecdotal or physical evidence.

Villages face two choices, and both are costly and complicated

Threatened communities have two choices: stay and try to mitigate the damage, or relocate. Both are complicated and expensive, especially for villages that have little to no tax base.

Relocation isn't a new phenomenon for Alaska Native communities, but modern infrastructure costs far more to move or rebuild and requires outside expertise in planning, geotechnical engineering, and construction.

Cost is the biggest hurdle, though, as relocating can run as much as $200 million. The quantifiable costs come from extensive planning and relocating fuel tanks, water and sewer pipes, power plants, and building materials. Relocating brings social costs as well, such as a loss of tribal identity or difficulty subsisting in a new area.

Staying in place means addressing each threat as it arises, and mitigation projects in remote places can range from several hundred thousand to tens of millions of dollars each. Examples include building or reinforcing berms, replacing old infrastructure, finding new sources of potable water, moving or replacing buildings, or setting up for emergency evacuations.

Over time, the sum can exceed the cost of relocation — but for many communities, staying is the only option. That's because it can take decades to secure funding and the necessary permits to move, and the community must continue to pay for schools, utilities, and health clinics in the meantime as well as offset the ongoing damage.

The three main types of threats

Erosion by water

Erosion is the removal of soil, thawed or frozen, by water movement. It can be coastal or on a river, called "riparian," and can be a slow and steady process or a single damaging event, such as a storm. Many Alaska communities experience both. When erosion threatens a community, it leads to structural failure of buildings, utilities, and transportation facilities.

Coastal erosion can be caused by ocean currents, waves, or storm surge, but wave damage is most common. Sea ice protects the coast from storms and minimizes the rate of coastal erosion, but sea ice is disappearing. According to NOAA's annual Arctic Report Card, summer and winter levels of arctic sea ice continue to fall. Last year marked the second-lowest ice level on record for the end of summer and the seventh-lowest for winter, as measured since 1979. Local sea level changes can exacerbate coastal erosion.

Currents are the main cause of riparian erosion. Many Alaska rivers and streams are serpentine, and the current's velocity increases as it passes the outside bend or cut bank, increasing erosion and creating deeper water. This is a natural process, but changing weather patterns and human activity such as boat wakes can accelerate it. Many river communities are situated at or near the cut bank to take advantage of the deeper water for barging in supplies and moving people.

Measures to combat erosion include beach nourishment, bank stabilization, and revetments. Beach nourishment replaces lost sand or sediment. Bank stabilization uses retaining walls or vegetation to secure the banks. A revetment is a slanted structure placed on a bank or cliff that absorbs wave or current energy. Examples include riprap, quarry stone, geotextile sandbag, or wrap. Each can involve significant planning, design, and permitting and run into the millions of dollars.

Flooding

Water levels rising along a coast or river onto usually-dry land can compromise infrastructure or make roads or airstrips impassible. Storm surge is the most common cause of flooding in coastal Alaska, and it's most severe in Norton Sound.

Rising sea levels are increasing the severity. Historically, sea ice has protected communities from flooding by reducing the time spent exposed to a storm surge, but sea ice is dwindling.

Rivers flood due to ice jams, rainstorms, snowpack melt, or dam breakage. Climate change is shifting the conventional rainfall, snowmelt, and ice breakup patterns.

Flood mitigation includes revetments, flood control projects, and warning systems.

Permafrost thaw

Permafrost is any soil or rock that remains at or below 0°C (32° F) for two or more back-to-back years. There are five types: cold, ice-rich, thaw-stable, thaw-unstable, and warm. A structure's design depends on which type of permafrost lies beneath it.

Heat transfer from buildings or other infrastructure, or overall warming, can thaw permafrost. This can damage buildings and infrastructure, cause cellars to flood or warm too much to keep food frozen, or cause landslides and subsidence (a gradual settling or sinking).

Permafrost analysis is typically performed for specific buildings or roads but not regionally, which makes planning difficult.

Just the mention of relocation can make it harder to secure grants, as the state and federal governments can be hesitant to invest in infrastructure for temporary use.

COVID-19 will likely worsen the long-term funding problem, as it's sapped already-strained government revenues. With additional budget cuts, grants may become even more scarce and competitive.

When relocating is an option, it has more benefits than just a fixed cost. It can eliminate the threat, improve residents' health and quality of life, alleviate overcrowding, and create jobs during and after the relocation.

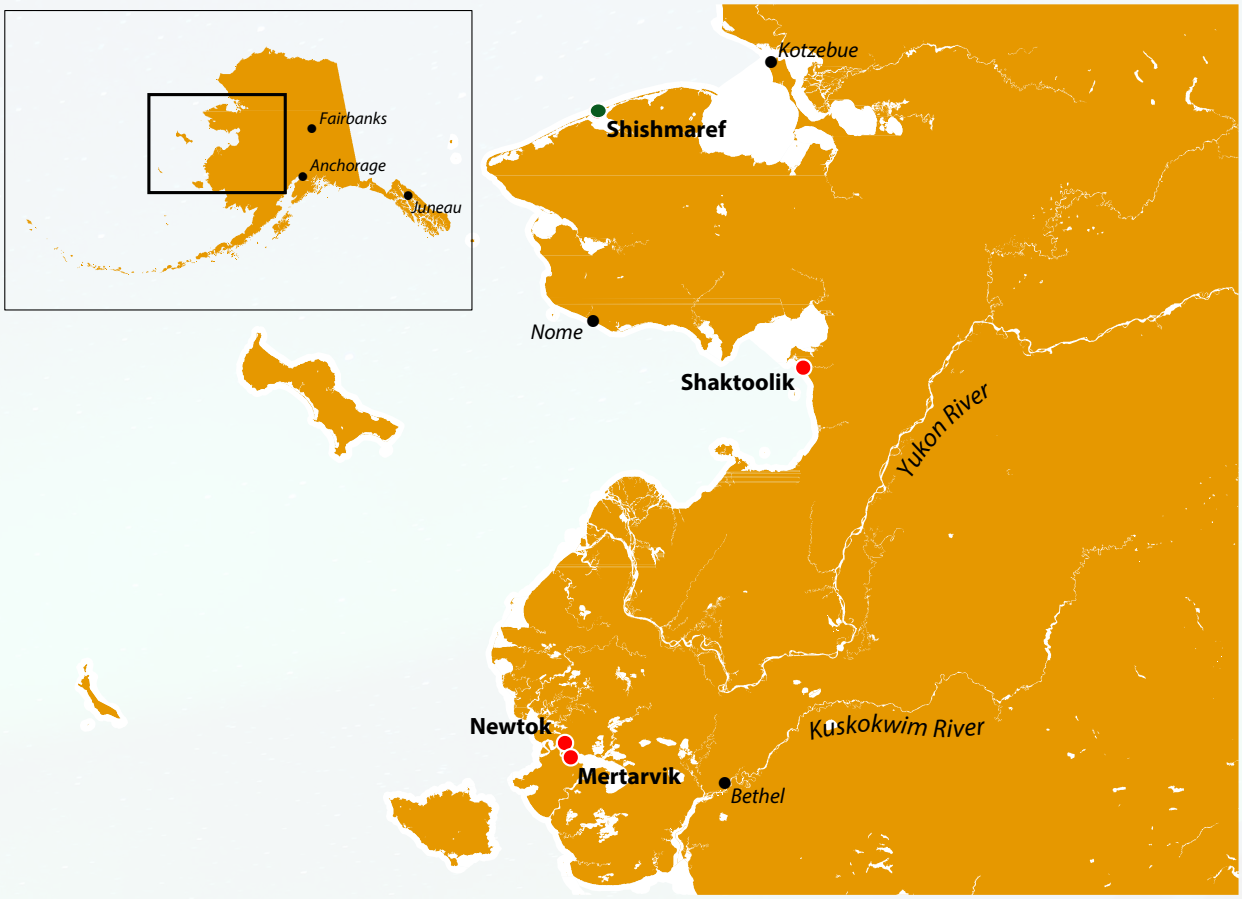
The rest of this article explores two Western Alaska communities that have chosen to deal with *usteq* in opposite ways. Both depend on subsistence and lack a significant tax base.

Shaktoolik, the most at risk, has decided to stay put and manage the problems as they arise. Newtok has spent decades planning to relocate to a new village, called Mertarvik, and is in the middle of that move.

STAY AND DEFEND: Shaktoolik

Shaktoolik, a Malemiut Yup'ik village in the Nome Census Area, sits atop a three-mile sand and gravel spit on the northeastern coast of Norton Sound. The name comes from the Unaliq *suktuliq*, which means "scattered things." The name may have originated with the ancestors who moved around the region continuously for around 6,000 years.

Newtok is moving to Mertarvik, but Shaktoolik will stay in place



Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

Shaktoolik first appeared in the 1880 census with a population of 60. Now, 140 years later, the village has 272 residents. Ninety-four percent are Alaska Native. With a median income of about $18,570, 39 percent of residents live below the federal poverty line.

The original location, inhabited as far back as 1839, was six miles up the Shaktoolik River. In 1933, the U.S. Bureau of Indian Affairs built a school at the mouth of the river, now called the "old site." To use the school, residents moved. That proved temporary, as the area was susceptible to high winds and severe storms. Thirty-four years later, they relocated again, to the current spot.

Shaktoolik is primarily a subsistence village. Unlike many communities, its residents don't need subsistence salmon permits. The community has regular air service via a state-owned gravel airstrip, the Alex Sookiayak Memorial Airstrip, and ships in cargo from Nome.

Shaktoolik levies a sales tax of 4 percent, and in 2019, it collected $87,037, or about $316 per person. The village has two windmills to offset diesel costs and has six satellite dishes, whereas most villages have just one. The dishes provide better internet and access to education and telehealth opportunities.

The Shaktoolik School had 90 students during the 2018-2019 school year. The village has one health clinic, run by the Norton Sound Health Corporation, as well as two stores, a laundromat, and a bed-and-breakfast.

Shaktoolik hosts one of the checkpoints for the famed Iditarod sled dog race. In 2020, the community received the Golden Clipboard Award from the Iditarod Official Finishers Club for providing "the best possible checkpoint in light of restrictions and concerns over COVID-19." Villagers had repurposed an abandoned building to provide room and board for dogs and mushers preparing to cross the frozen Norton Bay.

Shaktoolik is located on a spit and faces threats from both sides: Norton Sound to the west and the Tagoomenik River to the east. Photo by Walter Holt Rose

Usteq effects on Shaktoolik

Flooding and erosion, both river and coastal, are the main problems. To the west, Norton Sound carries driftwood from the Yukon River onto the shore. During severe storms, the driftwood erodes the western shoreline of the spit and batters the sides of homes. The village loses about 38,000 square feet of land each year to erosion.

To the east, the mouth of the Tagoomenik River floods. Storms encroaching on the village from both directions can necessitate evacuation.

When the Army Corps of Engineers first evaluated Shaktoolik in 2009, they predicted erosion damage within 10 years because the natural protections had already dwindled. It was a clear reality by 2019. There's no offshore ice during some winters, which increases the erosion rate and endangers fuel tanks, homes, businesses, and the airport. If erosion turns the spit into an island, the inflow of salt water will contaminate or destroy Shaktoolik's source of fresh water.

Residents have considered another move, but given the expense, they've decided to stay in place and deal with problems as they arise.

What has been and will be done

State engineers envisaged a berm on the western shoreline, but a loss of funding ended state involvement early on. By 2014, Shaktoolik had raised the money on their own and built a berm from gravel and driftwood to gird against storm surges and minimize erosion. A storm took out half the berm in 2019, and the Denali Commission funded the repairs.

In 2019, the National Coastal Resilience Fund awarded Shaktoolik a $1 million grant, in partnership with NOAA, to maintain the berm and begin building a new bulk fuel tank farm, which was completed this fall. Private donors contributed about $5 million.

This year, the U.S. Department of Housing and Urban Development granted Shaktoolik $800,000 to elevate 5,900 horizontal feet of the berm by five feet using local fill, driftwood, and grass.

These projects are among the many listed in Shaktoolik's management plan. Others include an evacuation road, water system improvements such as insulated tanks, floodlights and lighted buoys for the river, a new health clinic (completed in 2019), and an evacuation center. These will likely cost more than $100 million, and none will be permanent fixes.

This photo of Newtok was taken in 2010. Boardwalks, such as this one leading into town, are necessary for supporting weight as permafrost thaw makes the ground increasingly soft. Photo by Flickr user Travis

RELOCATE: Newtok/Mertarvik

The Central Yup'ik village of Newtok (*Niugtaq*, or "rustling of grass") is located in the Yukon Delta National Wildlife Refuge, about 100 miles northwest of Bethel, with the Ninglick River to the south and the Newtok River to the east. It's part of the Nelson Island communities, collectively known as the *Qaluyaarmiut,* or "dip net people." The *Qaluyaarmiut* have lived on the Bering Sea for at least 2,000 years.

The original village, called Old Kealavik, had regular outside contact beginning in the 1920s, which was later than many other villages. That delay helped preserve its traditions and customs.

In 1949, with floods increasing, the village moved to its current location and changed its name to Newtok. Residents spent summers at fish camps on Nelson Island and winters in Newtok until the 1970s, when they widely adopted typical American housing and snowmachines.

Newtok had 339 residents in 2019, 99.5 percent of whom are Alaska Native. The median income is less than $10,000, and 34 percent live in poverty. Like many Alaska Native villages, Newtok's homes are overcrowded, at an average of more than six people per house.

One hundred children attended the local Ayaprun School during the 2018-2019 school year. There is no running water or sewer, but the village has a health clinic operated by the Yukon-Kuskokwim Health Corporation as well as several stores.

The state-owned airstrip, the Newtok Airport, is gravel. In the winter, snowmachiners can follow trails to the nearby villages of Chevak, Tununak, Toksook Bay, Nightmute, and Manaryarapiaq. In the summer, barges deliver cargo.

Usteq effects on Newtok

Permafrost thaw and erosion are Newtok's main threats, but floods intensify the damage. The village is in a flat, low-lying, swampy area and the permafrost is ice-rich. When thawed, the ground can't support much weight, so residents use boardwalks. If you step off, you can end up thigh-deep in the mud.

The Ninglick River is severely eroded, exacerbated by currents and the loss of ice along the riverbank due to rising temperatures. In 1996, the river eroded so much that it turned the free-flowing Newtok River into a slough, hampering waste disposal and commercial boats' ability to reach the village. The village dump also washed into the Ninglick River that year.

The estimated long-term average erosion rate is now at least 70 feet a year, and individual storms can hasten the land loss. For example, in October 2018, a three-day storm cost Newtok an additional 20 feet of shoreline.

Newtok floods almost every year, and the water supply has become contaminated with a mixture of sewage and stagnant water from melting permafrost. Residents suffer from high rates of respiratory and other illnesses caused by black mold and unsafe waste disposal. Conditions have also delayed the construction of critical infrastructure, which has further endangered public health and quality of life.

The barge landing and container storage area succumbed to the river in 2005, and buildings and boardwalks are often partially submerged. Accessing the river for subsistence has become harder, and residents can only reach it during high tide.

What has been and will be done

When Old Kealavik moved to Newtok, residents

quickly realized the new location was prone to erosion.

In 1983, a contractor performed an erosion assessment using aerial photography from 1957, 1974, and 1977 and determined that Newtok would be endangered within 25 to 30 years and that preventing erosion of the Ninglick River would be neither affordable nor permanent.

They still tried. In 1987, residents lined the riverbank with canvas bags filled with cement and Styrofoam, but the river washed the bags away. So in 1994, the Newtok Traditional Council began a relocation plan, and the village voted two years later to move.

The Newtok Planning Group (30 village, regional, state, federal, and educational organizations) was formed in 2006. The following year, geotechnical overviews began and engineers drilled the first water well at the new site, Mertarvik.

Mertarvik, which means "getting water from the spring," is nine miles from Newtok on Nelson Island. The village chose the location for its ground stability, higher elevation, water quality, and access to the natural environment.

The Army Corps of Engineers estimated it would cost $80 million to $130 million to relocate critical infrastructure. Funding has been intermittent, coming from a variety of public and private sources, and other agencies have provided labor. In 2009, the Department of Defense's Innovative Readiness Training program began a five-year collaboration to work on construction projects and blast a quarry site. IRT gives American communities infrastructure support, health care, or training by military personnel.

In 2018, Mertarvik received $25 million from the Denali Commission, which was what they needed to begin the move the following year. They chose a "pioneering" approach, meaning only about a third of the residents made the initial move. That group included those most at risk of losing their homes to the river in Newtok.

Not all core infrastructure is in place, so the pioneering approach will allow Mertarvik residents to teach the young a traditional lifestyle. The residents have new houses with in-home sanitation systems, but they don't yet have running water. Mertarvik will be eligible for additional funding once it's a permanent community, though.

The new village has a small grocery store, a non-commercial airstrip, a power plant and electrical distribution system, a water treatment plant, a bulk fuel tank farm, a landfill, roads, and a communication system.

> Over the last 10 years, many villages have made significant progress, but Newtok has accomplished the most.

Since the move, residents have reported better health due to cleaner indoor and outdoor air and more reliance on subsistence.

In 2019, HUD awarded Mertarvik $800,000 to construct three single-family, four-bedroom houses. This year, Mertarvik plans to use pandemic relief funds from the CARES Act to build five new homes that will initially serve as quarantine quarters for those with COVID-19.

The target date for the complete move to Mertarvik is 2023. For now, both villages must maintain health and safety standards, but Newtok is often ineligible for grants. In the meantime, Newtok's water supply and electrical grid are at risk, and it's not unknown for buildings to slide off their foundations.

Many villages will receive additional funding this year

In June, HUD announced more than $21 million in community infrastructure funds for tribes and Native villages in Alaska, including Mertarvik and Shaktoolik. The funds will support 28 development projects such as the construction of houses, wellness facilities, and electric distribution systems; and the installation of water and sewer lines.

Sara Teel is an economist in Juneau. Reach her at (907) 465-6027 or sara.teel@alaska.gov.