# 12. Impacts of Climate Change on Tribal, Indigenous, and Native Lands and Resources

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## Key Messages

1. **Climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, ecosystem changes, ocean acidification, forest loss, and habitat damage, are threatening Native American and Alaska Native access to traditional foods such as salmon, shellfish, wild and cultivated crops, and marine mammals, which have provided sustenance as well as cultural, economic, medicinal, and community health for countless generations.**
2. **A significant decrease in water quality and quantity caused by a variety of factors including climate change, is affecting Native Americans' and Alaska Natives' drinking water supplies, food, cultures, ceremonies, and traditional ways of life. Native communities' vulnerabilities and lack of capacity to adapt to climate change are exacerbated by land-use policies, political marginalization, legal issues associated with tribal water rights, and poor socioeconomic conditions.**
3. **Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and/or loss of homes and settlements, food insecurity from changing availability of wild food sources, and socioeconomic and health impacts from loss of cultures, traditional knowledge, and homelands.**
4. **Alaska Native communities are increasingly exposed to health and livelihood hazards from permafrost thawing and increasing temperatures, which are causing damage to roads, water supply and sanitation systems, homes, schools, ice cellars, and ice roads, and threatening traditional lifestyles.**
5. **Accelerated sea level rise, erosion, permafrost thaw, and/or increased intensity of weather events are forcing relocation of entire tribal and indigenous communities in Alaska, Louisiana, the Pacific Islands, and other coastal locations. These relocations and the lack of governance mechanisms or funding to support them are causing loss of community and culture, health impacts, and economic decline, further exacerbating tribal impoverishment.**

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*We humbly ask permission from all our relatives;*
*our elders, our families, our children, the winged and the insects, the four-legged, the swimmers and all the plant and animal nations, to speak. Our Mother has cried out to us. She is in pain.*
*We are called to answer her cries. Msit No'Kmaq* – All my relations!

## Introduction

The peoples, lands, and resources of indigenous communities in the United States, Including Alaska and the Pacific Rim, face an array of climate change impacts and vulnerabilities that threaten many Native communities. The consequences of observed and projected climate change have and will undermine indigenous ways of life that have persisted for thousands of years. Key vulnerabilities include: the loss of traditional knowledge, forests and ecosystems, food security and traditional foods, and water; Arctic sea ice loss; permafrost thaw; and relocation from historic homelands.

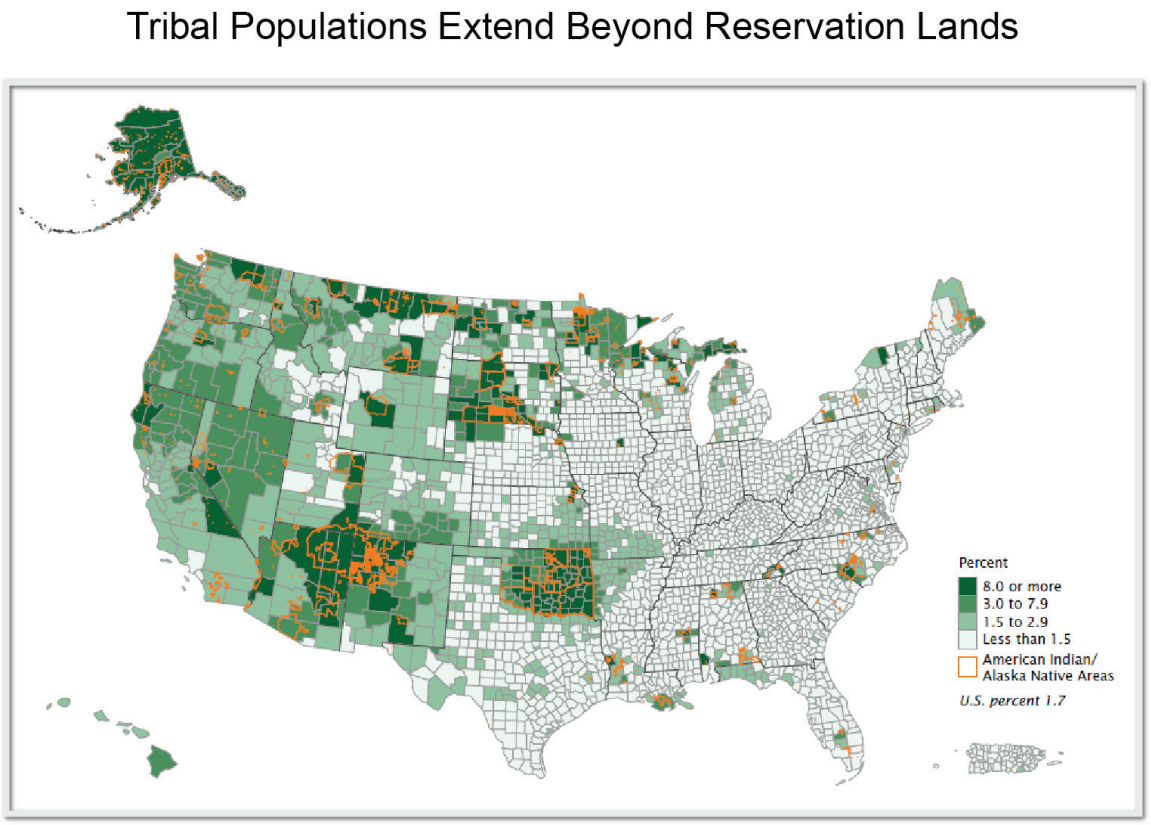


**Figure 12.1:** Tribal Populations Extend beyond Reservation Lands

**Caption:** Census data shows that American Indian and Alaska Native populations are concentrated around but are not limited to reservation lands, like the Hopi and Navajo in Arizona and New Mexico, the Choctaw, Chicasaw, and Cherokee in Oklahoma, and various Sioux tribes in the Dakotas and Montana (Source: U.S. Census Bureau 2010). Not depicted in this graphic is the proportion of Native Americans who live in and around urban centers (such as Chicago, Minneapolis, Denver, Albuquerque, Phoenix, San

Francisco, and Los Angeles) yet still maintain strong family ties to their tribes and tribal lands.

Climate change impacts on the 566 federally recognized tribes and other Indigenous groups in the U.S., including state-recognized and non-federally recognized tribes, are projected to be especially severe. Many Native populations are already challenged by adverse socioeconomic factors, such as extreme poverty and substandard housing, lack of health and community services, food, infrastructure, transportation, education, and employment, plus the high cost of fuel (AIHEC 2006; Honor the Earth 2002; Maynard 2002). Native populations are also vulnerable because of their close relationships with the environment for their physical, mental, intellectual, social, and cultural well-being. In addition, as the risk of intense natural disasters and temperature extremes increases, Native communities are vulnerable because they already face a severe housing shortage, lacking approximately half a million safe, healthy, and affordable homes (NTGBC 2011).

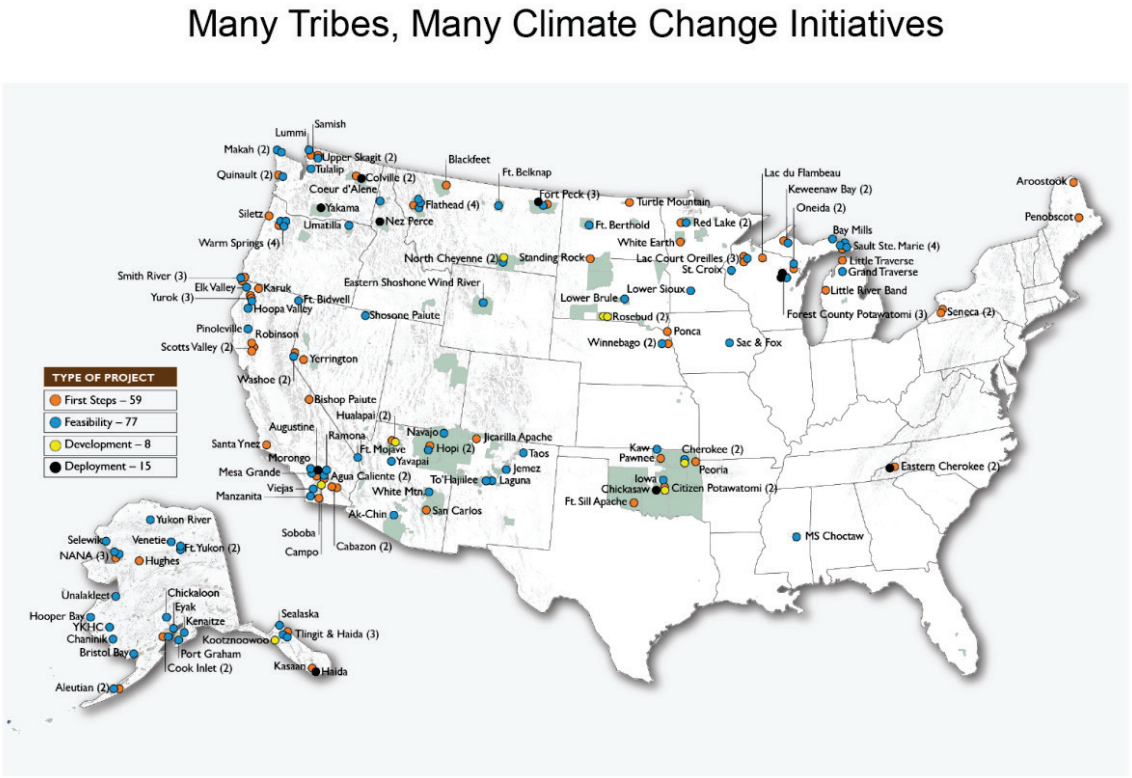


**Figure 12.2:** Many Tribes, Many Climate Change Initiatives

**Caption:** From developing biomass energy projects on the Quinault Indian Nation in Washington to energy efficiency improvement efforts on the Cherokee Indian Reservation in North Carolina, tribes are investigating ways to mitigate and adapt to climate changes. The map shows initiatives by federally recognized tribes only. (Source: DOE 2011)

Of the 5.2 million American Indians and Alaska Natives registered in the U.S. census, approximately 1.1 million live on or near reservations or Native lands, located mostly in the Northwest, Southwest, Great Plains, and Alaska. Tribal lands include approximately 56 million acres (about 3% of U.S. lands) in the 48 contiguous states and 44 million acres held by Alaska Native corporations (U.S. Census Bureau 2010). Most reservations are small and often remote or isolated, with a few larger exceptions such as the Navajo Reservation in Arizona, Utah, and New Mexico, which supports 175,000 residents (U.S. Census Bureau 2010).

Native American, Alaska Native, and other indigenous communities across the U.S. share unique historical and cultural relationships with tribal or ancestral lands. Some climate change adaptation opportunities exist on Native lands, and traditional knowledge can enhance adaptation and sustainability strategies. In many cases, however, adaptation options are limited by poverty, lack of resources, or, for some Native communities, such as those along the northern coast of Alaska or certain low-lying Pacific Islands, because there may be no land left to call their own.

**Climate Change and Traditional Knowledge**

Indigenous traditional knowledge has emerged in national and international arenas as a source of rich information for indigenous and non-indigenous climate assessments, policies, and adaptation strategies. Working Group II of the Intergovernmental Panel on Climate Change Fourth Assessment Report recognized traditional knowledge as an important information source for improving the understanding of climate change and other changes over time and for developing comprehensive natural resource management and climate adaptation strategies (Anisimov et al. 2007).

Traditional knowledge is essential to the economic and cultural survival of indigenous peoples, and, arguably, cultures throughout the world. Traditional knowledge has been defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 1993, 2008). From an indigenous perspective, traditional knowledge encompasses all that is known about the world around us and how to apply that knowledge in relation to those beings that share the world. As the elders of these communities – the "knowledge keepers" – pass away, the continued existence and viability of traditional knowledge is threatened. It is important to preserve the diverse traditional teachings and employ them to strive for balance among the physical, the spiritual, emotional, and intellectual – all things that encompass "wolakota", meaning to be a complete human being (A. White-Hat Sr. 2012, personal communication).

Merideth et al. (1998) suggest that many, if not all, indigenous resource managers believe their cultures already possess sufficient knowledge to respond to climate variation and change. However, there are elements of traditional knowledge that are identified as being increasingly vulnerable with changing climatic conditions. These elements include language, culture and cultural identities, ceremonies, sense of place, all our relations (human and non-human), and traditional ways of life. The use of indigenous and traditional knowledge to solve climate change issues in Indian country has been called "indigenuity" – indigenous knowledge plus ingenuity (Wildcat 2009).

Native cultures are directly tied to Native places and homelands, reflecting the indigenous perspective that includes the "power of place" (Deloria and Wildcat 2001). Many indigenous peoples regard all people, plants, and animals that share our world as relatives, not resources. Language, ceremonies, cultures, practices, and food sources evolved in places. The wisdom and knowledge of Native people resides in songs, dances, art, language, and music. By regarding all things as relatives, not resources, natural laws dictate that people care for their relatives in responsible ways. *"When you say, 'my mother is in pain,' it's very different from saying 'the earth is experiencing climate change'"* (A. White-Hat Sr. 2012, personal communication; Papalii Failautusi Avegalio 2012, personal communication; Souza and Tanimoto 2012). As climate change increasingly threatens Native places, cultural identities, and practices, indigenous relationships with all relations are similarly threatened.

Traditional knowledge has developed tangible and reliable methods for recording historic weather and climate variability and their impacts on native societies (Therrell and Trotter 2011). For example, tribal community historians (winter count keepers) on the northern Great Plains maintained and used pictographs recorded on buffalo hides to remember the sequence of events that marked each year, dating back to the 1600s. These once-reliable methods are becoming increasingly more difficult to maintain and less reliable as time passes (Nickels et al. 2006).

There are recent examples, however, where traditional knowledge and western-based approaches are used together to address climate change and related impacts. For example, the Alaska Native Tribal Health Consortium chronicles climate change impacts on the landscape and on human health, and also develops adaptation strategies. This Consortium employs western science, traditional ecological knowledge, and a vast network of "Local Environmental Observers" to develop comprehensive, community-scaled climate change health assessments (ANTHC 2012). During a recent drought on the Navajo Reservation, traditional knowledge and western approaches were also applied together, as researchers worked with Navajo elders to observe metrological and hydrological changes and other phenomena in an effort to assess and reduce disaster risks (Redsteer et al. 2011).

## *Forests, Fires, and Food*

**Climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, ecosystem changes, ocean acidification, forest loss, and habitat damage, are threatening Native American and Alaska Native access to traditional foods such as salmon, shellfish, wild and cultivated crops, and marine mammals, which have provided sustenance as well as cultural, economic, medicinal, and community health for countless generations.**

The impacts of climate change on forests and ecosystems are expected to have direct effects on culturally important plant and animal species, which will affect tribal sovereignty, culture, and economies. Observed impacts include species loss and shifts in species range (Louisiana Workshop 2012; Swinomish Indian Tribal Community 2010), including northward migration of the boreal forest and changes in the distribution and density of wildlife species (Trainor et al. 2009). Loss of biodiversity, impacts on culturally important native plants and animals, increases in invasive species, bark beetle damage to forests, and increased risk of forest fires have been

observed in the Southwest (ITEP 2011), across much of the West, and in Alaska (Ch. 7: Forestry; Ch. 8: Ecosystems and Biodiversity).

Rising temperatures and hotter drier summers are projected to increase the frequency and intensity of large wildfires (Ch. 20: Southwest; Ch. 2: Our Changing Climate). Warmer, drier, and longer fire seasons and increased forest fuel load will lead to insect outbreaks and the spread of invasive species, dry grasses, and other fuel sources (IPCC 2007; NWF 2011). Wildfire threatens Native and tribal homes, safety, economies, culturally important species, medicinal plants, traditional foods, and cultural sites. *"Fire affects the plants, which affect the water, which affects the fish, which affect terrestrial plants and animals, all of which the Karuk rely on for cultural perpetuity"* (Karuk Tribe 2010).

In interior Alaska, rural Native communities are experiencing new risks associated with climate-induced wildfires in boreal forests and Arctic tundra (Higuera et al. 2008; Mack et al. 2011. See also Ch. 22: Alaska and Arctic). Reliance on local, wild foods and the isolated nature of these communities, coupled with their varied preparedness and limited ability to deal with wildfires, leaves many communities at an increased risk of devastation brought on by cataclysmic fires. While efforts are being made to better coordinate rural responses to wildfires in Alaska, current responses are limited by organization and geographic community isolation (Trainor et al. 2009).

Indigenous peoples have historically depended on a wide variety of local plant and animal species for food (frequently referred to as traditional foods), medicines, ceremonies, community, and economic health for countless generations. These include corn, beans, squash, seals, fish, shellfish, bison, bear, caribou, walrus, moose, deer, wild rice, cottonwood trees, and a multitude of native flora and fauna (ITEP 2010, 2011; Louisiana Workshop 2012; Minnesota Department of Natural Resources 2008; Redsteer et al. 2011a; Riley et al. 2012; Swinomish Indian Tribal Community 2010; Verbrugge 2010). A changing climate affects the availability, tribal access to, and health of these resources (CPR 2011; Guyot et al. 2006; Kaufman 2011; Swinomish Indian Tribal Community 2010; University of Oregon 2011a; Verbrugge 2010). This in turn threatens tribal customs, cultures, and identity.

Medicinal and food plants are becoming increasingly difficult to find or are no longer occurring in historic ranges (Riley et al. 2012). Subsequent shifts from traditional lifestyles and diet, compounded by persistent poverty, food insecurity, the cost of non-traditional foods, and poor housing conditions have led to increasing health problems in communities, thus increasing the risk to food and resource security. Climate change is likely to amplify other indirect effects to traditional foods and resources, including limited access to gathering places and hunting grounds, and environmental pollution (CPR 2011; Kaufman 2011; University of Oregon 2011a; Verbrugge 2010).

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## *Water Quality and Quantity*

**A significant decrease in water quality and quantity, caused by a variety of factors including climate change, is affecting Native Americans' and Alaska Natives' drinking water supplies, food, cultures, ceremonies, and traditional ways of life. Native communities' vulnerabilities and lack of capacity to adapt to climate change are exacerbated by land-use policies, political marginalization, legal issues associated with tribal water rights, and poor socioeconomic conditions.**

Native communities and tribes in different parts of the U.S. have observed changes in precipitation affecting their water resources. On the Colorado Plateau, tribes have been experiencing drought for more than a decade (Ferguson and Crimmins 2009; Garfin et al. 2012). Navajo elders have observed long-term decreases in annual snowfall over the past century, a transition from wet to dry conditions in the 1940s, and a decline in surface water features (Hiza et al. 2011). Southwest tribes have observed impacts on their agriculture and livestock, the loss of springs and medicinal and culturally important plants and animals, and impacts on drinking water supplies (Christensen 2003; Ferguson and Crimmins 2009; Garfin et al. 2012). In the Northwest, tribal treaty rights to traditional territories and resources are being affected by the reduction of rainfall and snowmelt in the mountains, melting glaciers, rising temperatures, and shifts in ocean currents (McNutt 2008). In Hawai'i, Native peoples have observed a shortening of the rainy season, an increasing intensity of storms and flooding, and a rainfall pattern that has become unpredictable (Souza and Tanimoto 2012). In Alaska, water availability, quality, and quantity are threatened by the consequences of permafrost thaw, which has damaged community water infrastructure, as well as by the northward extension of diseases such as Giardia, a result of disease-carriers like beavers moving northward in response to climate warming (Brubaker et al. 2011).

U.S. Native American tribes have unique and significant adaptation needs related to climate impacts on water. There is little available data to establish baseline climatic conditions on tribal lands, and many tribes do not have sufficient capacity to monitor changing conditions (Ferguson et al. 2011). Without scientific monitoring, tribal decision-makers lack the data needed to quantify and evaluate the current conditions and emerging trends in precipitation, streamflow, and soil moisture, and to plan and manage resources accordingly (Collins et al. 2010; Garfin et al. 2012). Water infrastructure is in disrepair or lacking on some reservations (Ojima et al. 2012; Redsteer et al. 2011b). Approximately 30% of the population of the Navajo Nation is not served by municipal systems and must haul water to meet their daily needs (Navajo Nation Department of Water Resources 2011). Furthermore, there is an overall lack of financial resources to support basic water infrastructure on tribal lands (Ferguson et al. 2011). Uncertainty associated with undefined tribal water rights make it difficult to determine strategies to deal with water resource issues (Ojima et al. 2012).

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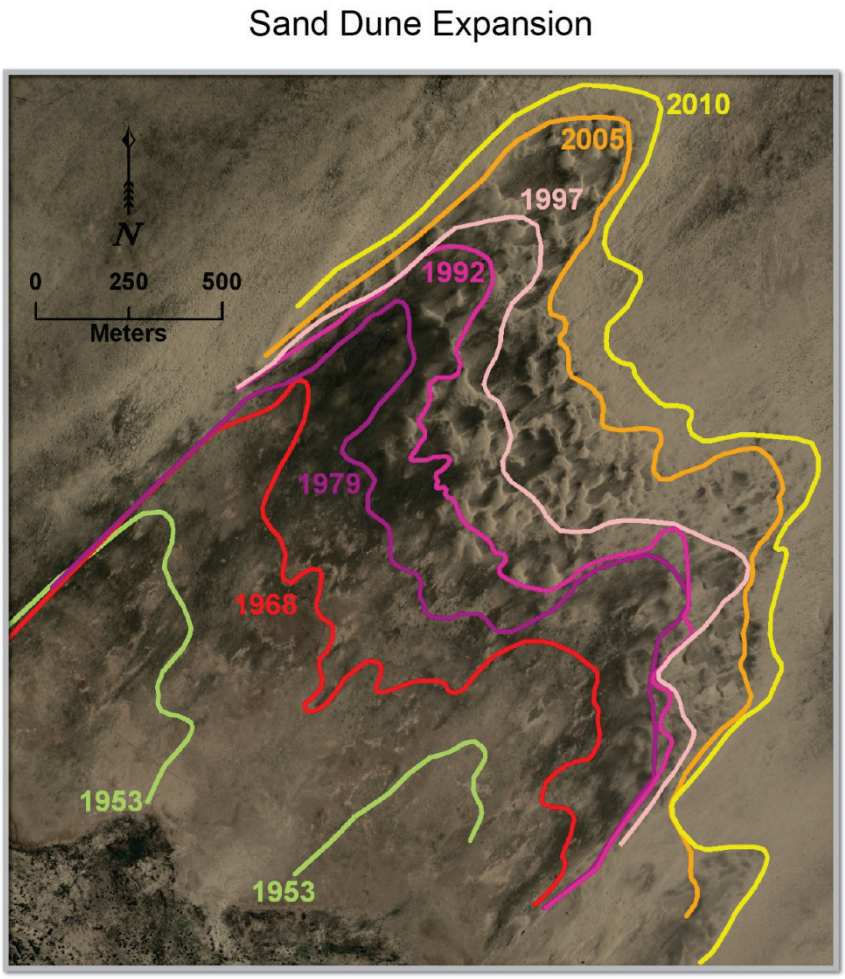


**Figure 12.3:** Sand Dune Expansion

**Caption:** On the Arizona portion of the Navajo Nation, recurring drought and rising temperatures have accelerated growth and movement of sand dunes. Map above shows range and movement of Great Falls Dune Field from 1953-2010. Moving and/or growing dunes can threaten roads, homes, traditional grazing areas, and other tribal assets. (Source: Redsteer et al. 2011a)

## *Declining Sea Ice*

**Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and/or loss of homes and settlements, food insecurity from changing availability of wild food sources, and socioeconomic and health impacts from loss of cultures, traditional knowledge, and homelands.**

*"…since the late 1970s, communities along the coast of the northern Bering and Chukchi Seas have noticed substantial changes in the ocean and the animals that live there. While we are used to changes from year-to-year in weather, hunting conditions, ice patterns, and animal populations, the past two decades have seen clear trends in many environmental factors. If these trends continue, we can expect major, perhaps irreversible, impacts to our communities…."*

(C. Pungowiyi 2009, personal communication)

Scientists across the Arctic have documented regional warming over the past few decades at twice the global rate, and indigenous Arctic communities have been observing the changes in their daily lives. This warming is accompanied by significant reductions in sea ice thickness and extent, increased permafrost thaw, more extreme weather and severe storms, changes in seasonal ice melt/freeze of lakes and rivers, water temperature, flooding patterns, erosion, and snowfall timing and type (Ch.2: Our Changing Climate; C. Pungowiyi 2009, personal communication; Hinzman et al. 2005; Laidler et al. 2009). These climate-driven changes in turn increase the number of serious problems for Alaska Native populations, which include: injury from extreme or unpredictable weather and thinning sea ice, which can trap people far from home; changing snow and ice conditions for predictable and safe hunting, fishing, or herding; malnutrition and food insecurity from lack of access to subsistence food; contamination of food and water; increasing economic, mental, and social problems from loss of culture and traditional livelihood; increases in infectious diseases; and loss of buildings and infrastructure from permafrost erosion and thawing, resulting in the relocation of entire communities (Brubaker et al. 2011; C. Pungowiyi 2009, personal communication; Parkinson 2009).

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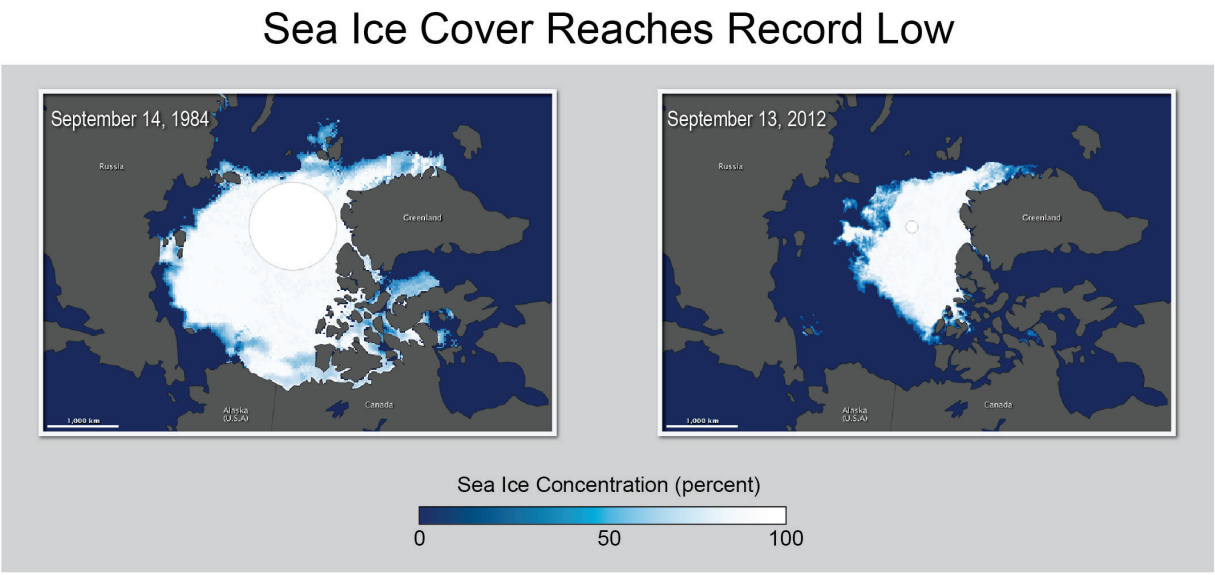


**Figure 12.4:** Sea Ice Cover Reaches Record Low

**Caption:** In August and September 2012, sea ice covered less of the Arctic Ocean than any time since at least 1979, when the first reliable satellite measurements began. The long-term retreat of sea ice has occurred faster than climate models had predicted. The average minimum extent of sea ice for 1979-2000 was 2.59 million square miles. Top image shows Arctic minimum extent from 1984, which was about the average minimum extent for 1979-2000. The image below shows that the extent of sea ice had dropped to 1.32 million square miles at the end of summer 2012. Alaska Native coastal communities rely on sea ice for many reasons, including its role as a buffer against coastal erosion from storms. Source: NASA Earth Observatory (n.d.) World of Change: Arctic Sea Ice, http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php

Alaska Native Inupiat and Yupik experts and scientists have observed stronger winds than in previous decades (C. Pungowiyi 2009, personal communication; Gearheard et al. 2010). They also observe accelerated ice and snowmelt, and movement of ice and marine mammals far beyond hunting access. The thinning sea ice, earlier ice break-up, increasing temperatures, and changes in precipitation (for example, in the timing and amount of snow) also cause changes in critical feeding, resting, breeding, and denning habitats for arctic mammals important as subsistence foods, like polar bears, walrus, and seals (C. Pungowiyi 2006, personal communication; Laidler et al. 2009).

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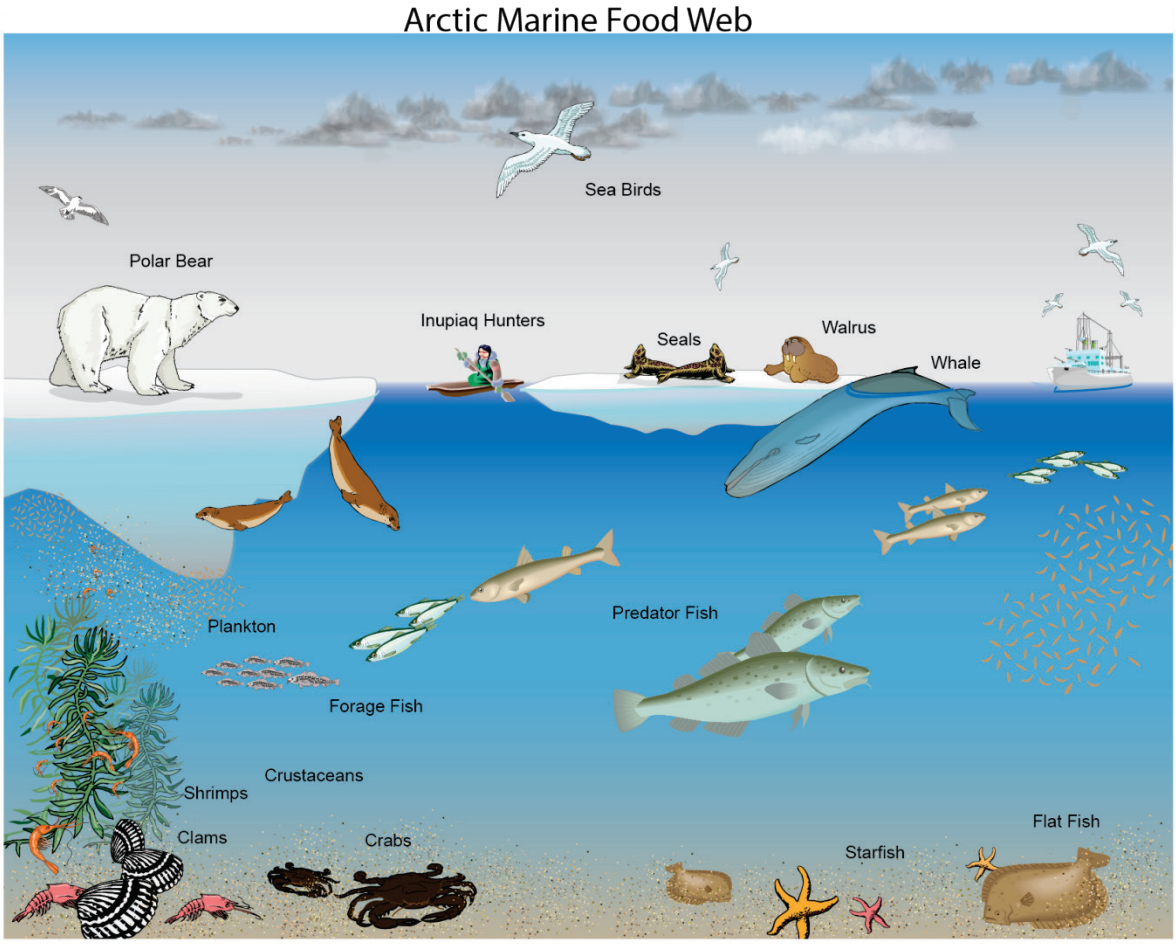


**Figure 12.5:** Arctic Marine Food Web

**Caption:** Dramatic reductions in Arctic sea ice and changes in its timing and composition affect the entire food web, including many Inupiat communities that continue to rely heavily on subsistence hunting and fishing. (Source: NOAA NCDC, 2012)

## *Permafrost Thaw*

**Alaska Native communities are increasingly exposed to health and livelihood hazards from permafrost thawing and increasing temperatures, which are causing damage to roads, water supply and sanitation systems, homes, schools, ice cellars, and ice roads, and threatening traditional lifestyles.**

The increased thawing of permafrost (permanently frozen soil) along the coasts and rivers is an especially potent threat to Alaska Native villages because it causes serious erosion, flooding, and destruction of homes, buildings, and roads (Ch.22, Alaska and Arctic Chapter, Key Message 3). This loss of infrastructure is further exacerbated by loss of land-fast sea ice, sea level rise, and increasingly severe storms (McClintock 2009; University of Oregon 2011b). At this time, more

than 30 Native villages in Alaska (such as Newtok and Shishmaref) are either in need of, or in the process of, relocating their entire village (Bender et al. 2011).

Serious public health issues arise due to damaged infrastructure caused by these multiple erosion threats. Among them are loss of clean water for drinking and hygiene, saltwater intrusion, and sewage contamination that could cause respiratory and gastrointestinal infections, pneumonia, and skin infections (McClintock 2009; Parkinson 2009; Parkinson and Evengård 2009). In addition, permafrost thaw is causing food insecurity in Alaska Native communities due to the thawing of ice cellars or ice houses for subsistence food storage. This in turn leads to food contamination and sickness as well as dependence upon expensive, less healthy, non-traditional "store-bought" foods (Brubaker et al. 2009; Ford and Berrang-Ford 2009; Parkinson and Evengård 2009).

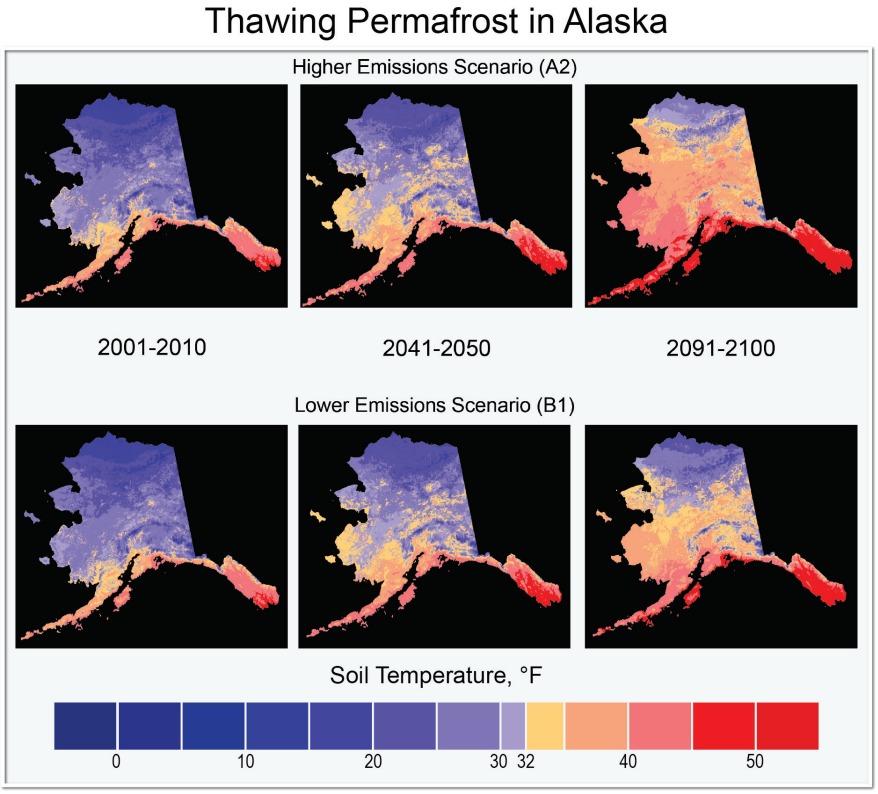


**Figure 12.6:** Thawing Permafrost in Alaska

**Caption:** The maps show projected ground temperature at a depth of about 3 feet assuming continued increases in emissions (top row, A2 scenario) and assuming a substantial reduction in emissions (bottom row, B1 scenario). Many Alaska Natives depend on permafrost for ice cellars to store frozen food, and replacing these cellars with electricity-driven freezers is expensive or otherwise infeasible. Permafrost thawing also affects infrastructure like roads and utility lines. (Source: Permafrost Lab, Geophysical Institute, University of Alaska Fairbanks, 2012)

## *Relocation*

**Accelerated sea level rise, erosion, permafrost thaw, and/or increased intensity of weather events are forcing relocation of entire tribal communities in Alaska, Louisiana, the Pacific Islands. and other coastal locations. These relocations and the lack of governance mechanisms or funding to support them are causing loss of community and culture, health impacts, and economic decline, further exacerbating tribal impoverishment.**

Native peoples are no strangers to relocation and its consequences on their communities. Many eastern and southeastern tribal communities were forced to relocate to Canada or the western Great Lakes in the late 1700s and early 1800s and, later, to Oklahoma, compelling them to adjust and adapt to new and unfamiliar landscapes, subsistence resources, and climatic conditions. Now, Native peoples in Alaska and other parts of the coastal U.S., such as the Southeast, are facing relocation as a consequence of climate change (Bronen 2011; Louisiana Workshop 2012; Shearer 2012)

For example, Newtok, a traditional Yup'ik village in Alaska, is experiencing accelerated rates of erosion caused by the combination of decreased Arctic sea ice, thawing permafrost, and increased intensity of weather events. As a result, the community has lost critical basic necessities and infrastructure. While progress has been made toward relocation, limitations of existing federal and state statutes and regulations have impeded their efforts, and the absence of legal authority and a governance structure to facilitate relocation are significant barriers to the relocation of Newtok and other Alaska Native villages (State of Alaska Division of Community and Regional Affairs Planning and Land Management 2012). Tribal communities in coastal Louisiana are experiencing warming-induced rising sea levels, along with saltwater intrusion and intense erosion and land loss due to oil and dam development, forcing them to either relocate or try to find ways to save their land (Louisiana Workshop 2012). Native Pacific Island communities such as Tuvalu are also being forced to consider relocation plans due to increasing sea level rise and storm surges (IPCC 2007).

Currently, the U.S. lacks an institutional framework to relocate entire communities. National, state, local, and tribal government agencies lack the legal authority and the technical, organizational, and financial capacity to implement relocation processes for communities forcibly displaced by climate change. New governance institutions are needed to specifically respond to the increasing necessity for climate change-induced relocation.

*"In Indigenous cultures, it is understood that ecosystems are chaotic, complex, organic, in a constant state of flux, and filled with diversity. No one part of an ecosystem is considered more important than another part and all parts have synergistic roles to play. Indigenous communities say that "all things are connected" – the land to the air and water, the earth to the sky, the plants to the animals, the people to the spirit."*

Inupiat Leader – Patricia Cochran

# Traceable Accounts

## Chapter 12: Tribal, Indigenous, and Native Lands and Resources

**Key Message Process:** A central component of the assessment process was participation by members of the Chapter Author Team in a number of climate change meetings attended by indigenous peoples and other interested parties focusing on issues relevant to Tribal and Indigenous peoples. These meetings included:

Oklahoma Inter-Tribal Meeting on Climate Variability and Change held on December 12, 2011 at the National Weather Center, Norman, OK, attended by 73 people (Riley et al. 2012).

Indigenous Knowledge and Education (IKE) Hui Climate Change and Indigenous Cultures forum held in January 2012 in Hawai'i and attended by 36 people. (Souza and Tanimoto 2012)

Alaska Forum on the Environment held from February 6-10, 2012 at the Dena'ina Convention Center in Anchorage, Alaska and attended by about 1400 people with approximately 30 to 60 people per session.

Stories of Change: Coastal Louisiana Tribal Communities' Experiences of a Transforming Environment; Workshop held from January 22-27 in Pointe-au-Chein, Louisiana and attended by 47 people (Louisiana Workshop 2012).

American Indian Alaska Native Climate Change Working Group 2012 Spring Meeting held from April 23–24, 2012 at the Desert Diamond Hotel-Casino in Tucson, Arizona and attended by 80 people.

In developing key messages, the Chapter Author Team engaged in multiple technical discussions via teleconferences from August 2011 to March 2012 as they reviewed more than 200 technical inputs provided by the public, as well as other published literature and professional judgment. Subsequently, the chapter author team teleconferenced weekly between March and July 2012 for expert deliberations of draft key messages by the authors wherein each message was defended by the entire author team before the key message was selected for inclusion in the Chapter Report. These discussions were supported by targeted consultation with additional experts by the lead author of each message, and they were based on criteria that help define "key vulnerabilities."

| **Key message #1/5** | **Climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, ecosystem changes, ocean acidification, forest loss, and habitat damage, are threatening Native American and Alaska Native access to traditional foods such as salmon, shellfish, wild and cultivated crops, and marine mammals, which have provided sustenance as well as cultural, economic, medicinal, and community health for countless generations.** |
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| **Description of evidence base** | The key message and supporting chapter text summarize extensive evidence documented in more than 200 technical input reports on a wide range of topics which were received and reviewed as part of the Federal Register Notice solicitation for public input.<br><br>Numerous peer-reviewed publications describe loss of biodiversity, impacts on culturally important native plants and animals, increases in invasive species, bark beetle damage to forests and increased risk of forest fires that have been observed in the Southwest U.S. and across much of the West (ITEP 2011).<br><br>Climate drivers associated with this key message are also discussed in the climate science chapter.<br><br>There are also many relevant and recent peer-reviewed publications (Trainor et al. 2009) describing the northward migration of the boreal forest and changes in the distribution and density of wildlife species that have been observed.<br><br>Observed impacts on plant and animal species including species loss and shifts in species range is well documented (Louisiana Workshop 2012; Swinomish Indian |

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| | Tribal Community 2010). |
| **New information and remaining uncertainties** | A key uncertainty is how indigenous people will adapt to climate change, given their reliance on local, wild foods and the isolated nature of some communities, coupled with their varied preparedness and limited ability to deal with wildfires. Increased wildfire occurrences may affect tribal homes, safety, economy, culturally important species, medicinal plants, traditional foods, and cultural sites.<br><br>There is uncertainty as to the extent that Native American and Alaska Natives' access to traditional foods such as salmon, shellfish, crops, and marine mammals, which have provided sustenance as well as cultural, economic, medicinal, and community health for countless generations will be affected by climate change. |
| **Assessment of confidence based on evidence** | Based on the evidence, confidence is **very high** that climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, ecosystem changes, ocean acidification, forest loss and habitat damage, are threatening Native American and Alaska Natives' access to traditional foods such as salmon, shellfish, crops, and marine mammals, which have provided sustenance as well as cultural, economic, medicinal, and community health for countless generations. |

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| **CONFIDENCE LEVEL** | | | |
|---|---|---|---|
| **Very High** | **High** | **Medium** | **Low** |
| Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus | Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus | Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought | Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts |

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# Chapter 12: Tribal, Indigenous, and Native Lands and Resources

**Key Message Process:** See key message #1.

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| **Key message #2/5** | **A decrease in water quality and quantity, caused by a variety of factors including climate change, is affecting Native Americans and Alaska Natives' drinking water supplies, food, cultures, ceremonies, and traditional ways of life. Native communities' vulnerabilities and lack of capacity to adapt to climate change are exacerbated by land-use policies, political marginalization, legal issues associated with tribal water rights, and poor socioeconomic conditions.** |
| **Description of evidence base** | The key message and supporting chapter text summarizes extensive evidence documented in more than 200 technical input reports on a wide range of topics which were received and reviewed as part of the Federal Register Notice solicitation for public input.<br><br>There are numerous examples of Tribal observations of changes in precipitation, and impacts on surface water features, agriculture, grazing, medicinal and culturally important plants and animals, water resources, rainfall patterns and storm intensity. (Christensen 2003; Ferguson and Crimmins 2009; Garfin et al. 2012; Hiza et al. 2011).<br><br>Examples of ceremonies are included in the Oklahoma Inter-Tribal Meeting on Climate Variability and Change, Meeting Summary Report (Riley et al. 2012). Water is used for some ceremonies, so it can be problematic when there is not enough at the tribe's disposal (Riley et al. 2012). More than one tribe at the meeting also expressed how heat has been a problem during ceremonies, since the older citizens cannot go into non-air conditioned lodges (Riley et al. 2012). |
| **New information and remaining uncertainties** | There is limited data to establish baseline climatic conditions on tribal lands, and many tribes do not have sufficient capacity to monitor changing conditions (Ferguson et al. 2011). Without monitoring, tribal decision-makers lack the data needed to quantify and evaluate the current conditions and emerging trends in precipitation, streamflow, and soil moisture, and to plan and manage resources accordingly (Collins et al. 2010; Garfin et al. 2012).<br><br>Water infrastructure is in disrepair or lacking on some reservations (Ojima et al. 2012; Redsteer et al. 2011b). There is an overall lack of financial resources to support basic water infrastructure on tribal lands (Ferguson et al. 2011).<br><br>Uncertainty associated with undefined tribal water rights make it difficult to determine strategies to deal with water resource issues (Ojima et al. 2012).<br><br>Tribes that rely on water resources to maintain their cultures, religions, and lifeways are especially vulnerable to climate change. Monitoring data is needed to establish baseline climatic conditions and to monitor changing conditions on tribal lands. Uncertainty associated with undefined tribal water rights make it difficult to determine strategies to deal with water resource issues. |
| **Assessment of confidence based on evidence** | Based on the evidence, confidence is **very high** that decreases in water quality and quantity are affecting Native Americans and Alaska Natives' drinking water supplies, food, cultures, ceremonies, and traditional ways of life. |

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| CONFIDENCE LEVEL | | | |
|---|---|---|---|
| **Very High** | **High** | **Medium** | **Low** |
| Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus | Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus | Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought | Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts |

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# Chapter 12: Tribal, Indigenous, and Native Lands and Resources

**Key Message Process:** See key message #1.

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| **Key message #3/5** | **Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and/or loss of homes and settlements, food insecurity from changing availability of wild food sources, and socioeconomic and health impacts from loss of cultures, traditional knowledge, and homelands.** |
| **Description of evidence base** | The key message and supporting chapter text summarizes extensive evidence documented in more than 200 technical input reports on a wide range of topics which were received and reviewed as part of the Federal Register Notice solicitation for public input.<br><br>Evidence that summer sea ice is rapidly declining is based on satellite data, and other observational data and is incontrovertible. Although there is disagreement among models about the rate of sea ice loss projected ice free summers by 2100, more recent CMIP5 models that most accurately reconstruct historical sea ice loss do project that late-summer sea ice will disappear by the 2030s (see Climate Science and Alaska Chapters).<br><br>Evidence that sea ice loss is altering marine ecosystems; allowing for greater ship access and new development; increasing Native community vulnerabilities due to changes in sea ice thickness and extent; destroying housing, village sanitation and other infrastructure (including entire villages); increasing food insecurity from lack of access to subsistence food and loss of cultural traditions are all well-documented in field studies, Indigenous knowledge, and scientific literature (C. Pungowiyi 2006, personal communication, 2009, personal communication; Gearheard et al. 2010; Laidler et al. 2009). |
| **New information and remaining uncertainties** | A key uncertainty is how Indigenous peoples will be able to maintain historical subsistence ways of life which include hunting, fishing, harvesting, and sharing and sustain the traditional relationship with the environment given the impacts from sea ice decline and changes. Increased sea ice changes and declines are already causing increasingly hazardous hunting and traveling conditions along ice edges, damage to homes and infrastructure from erosion, changes in habitat for subsistence foods and species and with overall impacts on food insecurity, and species necessary for medicines, ceremonies, and other traditions. The effects of sea ice loss are exacerbated by other climate change driven changes such as changes in snow and ice, weather, and in-migration of people, poverty, lack of resources to respond to changes, and contamination of subsistence foods.<br><br>Additional observations and monitoring are needed to more adequately document ice and weather changes. |
| **Assessment of confidence based on evidence** | Based on the evidence, there is **very high** confidence that loss of sea ice is affecting the traditional life ways of Native communities in a number of important ways such as increased hazardous travel and hunting conditions along the ice edge, erosion damage to homes, infrastructure, sanitation facilities (including loss of entire villages), changes in ecosystem habitats and, therefore, impacts on food security, and socioeconomic and health impacts from cultural and homeland losses. |

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| CONFIDENCE LEVEL | | | |
|---|---|---|---|
| **Very High** | **High** | **Medium** | **Low** |
| Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus | Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus | Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought | Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts |

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# Chapter 12: Tribal, Indigenous, and Native Lands and Resources

**Key Message Process:** See key message #1.

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| **Key message #4/5** | **Alaska Native communities are increasingly exposed to health and livelihood hazards from permafrost thawing and increasing temperatures, which are causing damage to roads, water supply and sanitation systems, homes, schools, ice cellars, and ice roads, and threatening traditional lifestyles.** |
| **Description of evidence base** | The key message and supporting chapter text summarizes extensive evidence documented in more than 200 technical input reports on a wide range of topics which were received and reviewed as part of the Federal Register Notice solicitation for public input.<br><br>Numerous peer-reviewed publications describe evidence that incontrovertible permafrost thaw is taking place, and models project an increased rate for at least the next 100 years.<br><br>There are also many relevant and recent peer-reviewed publications (McClintock 2009; University of Oregon 2011b) describing the impact of permafrost thaw on Alaska Native villages. Over 30 Native villages in Alaska are in need of or in the process of being moved. Recent work (Bender et al. 2011; Parkinson and Evengård 2009) documents public health issues such as contamination of clean water for drinking and hygiene and food insecurity through thawing of ice cellars for subsistence food storage. |
| **New information and remaining uncertainties** | Improved models and observational data (see Alaska Chapter) confirmed many of the findings from prior Alaska assessment; see (http://www.globalchange.gov/publications/reports/scientificassessments/us-impacts/regional-climate-change-impacts/alaska).<br><br>A key uncertainty is how Indigenous peoples in Alaska will be able to sustain traditional subsistence life ways when their communities and settlements on the historical lands of their ancestors are collapsing due to permafrost thawing, flooding, and erosion combined with loss of shore fast ice, sea level rise, and severe storms, especially, along the coasts and rivers.<br><br>Another uncertainty is how indigenous communities can protect the health and welfare of the villagers from permafrost thaw-caused public health issues of drinking water contamination and loss of traditional food storage and potential contamination.<br><br>It is uncertain how Native communities will be able to effectively relocate and maintain their culture, particularly because there are no institutional frameworks, legal authorities or funding to implement relocation for communities forced to relocate. |
| **Assessment of confidence based on evidence** | Based on the evidence, confidence is **very high** that Alaska Native communities are increasingly exposed to health and livelihood hazards from permafrost thawing and increasing temperatures, which are causing damage to roads, water supply and sanitation systems, homes, schools, ice cellars, and ice roads, and threatening traditional lifestyles. |

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| CONFIDENCE LEVEL | | | |
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| **Very High** | **High** | **Medium** | **Low** |
| Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus | Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus | Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought | Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts |

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# Chapter 12: Tribal, Indigenous, and Native Lands and Resources

**Key Message Process:** See key message #1.

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| **Key message #5/5** | **Accelerated sea level rise, erosion, permafrost thaw, and/or increased intensity of weather events are forcing relocation of entire tribal and indigenous communities in Alaska, Louisiana, the Pacific Islands, and other coastal locations. These relocations and the lack of governance mechanisms or funding to support them are causing loss of community and culture, health impacts, and economic decline, further exacerbating tribal impoverishment.** |
| **Description of evidence base** | The key message and supporting chapter text summarizes extensive evidence documented in more than 200 technical input reports on a wide range of topics which were received and reviewed as part of the Federal Register Notice solicitation for public input.<br><br>There is well-documented evidence that Tribal communities are vulnerable to coastal erosion that could force them to relocate. (Galloway McLean 2009; GAO 2009). For example, tribal communities in Alaska, such as Newtok, Kivalina and Shishmaref, are experiencing accelerated rates of erosion caused by the combination of decreased Arctic sea ice, thawing permafrost, and increased intensity of weather events, resulting in loss of basic necessities and infrastructure (Bronen 2011; Shearer 2012).<br><br>Tribal communities in Coastal Louisiana are experiencing climate-induced rising sea levels, along with saltwater intrusion and intense erosion and land loss due to oil and dam development, forcing them to either relocate or try to find ways to save their land (Louisiana Workshop 2012).<br><br>Native Pacific Island communities are being forced to consider relocation plans due to increasing sea level rise and storm surges. |
| **New information and remaining uncertainties** | A key uncertainty is the extent that the combination of other impacts (e.g., erosion caused by dredging for oil pipelines or second-order effects from adaptation-related development projects) will coincide with sea level rise and other climate-related issues to increase the rate at which communities will need to relocate.<br><br>Another key uncertainty is how communities will be able to effectively relocate, maintain their communities and culture and reduce the impoverishment risks that often go along with relocation. The United States lacks an institutional framework to relocate entire communities, and national, state, local, and tribal government agencies lack the legal authority and the technical, organizational, and financial capacity to implement relocation processes for communities forcibly displaced by climate change. |
| **Assessment of confidence based on evidence** | Based on the evidence, there is **very high** confidence that Tribal communities in Alaska, Coastal Louisiana, Pacific Islands, and other coastal locations are being forced to relocate due to sea level rise, coastal erosion, melting permafrost, and/or increased intensity of weather events. |

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| CONFIDENCE LEVEL | | | |
|---|---|---|---|
| **Very High** | **High** | **Medium** | **Low** |
| Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus | Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus | Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought | Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts |

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