Climate Change Impacts in the United States

CHAPTER 12
INDIGENOUS PEOPLES, LAND, AND RESOURCES

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12 INDIGENOUS PEOPLES, LAND, AND RESOURCES

Key Messages

1. **Observed and future impacts from climate change threaten Native Peoples' access to traditional foods such as fish, game, and wild and cultivated crops, which have provided sustenance as well as cultural, economic, medicinal, and community health for generations.**

2. **A significant decrease in water quality and quantity due to a variety of factors, including climate change, is affecting drinking water, food, and cultures. Native communities' vulnerabilities and limited capacity to adapt to water-related challenges are exacerbated by historical and contemporary government policies 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 loss to settlements, food insecurity, 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 increasing temperatures and thawing permafrost, which are damaging critical infrastructure, adding to other stressors on traditional lifestyles.**

5. **Climate change related impacts are forcing relocation of tribal and indigenous communities, especially in 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.**

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!

— Indigenous Prayer

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 in the face of rapidly changing ecological conditions, increased food insecurity due to reduced availability of traditional foods, changing water availability, Arctic sea ice loss, permafrost thaw, and relocation from historic homelands.[1,2,3,4]

Climate change impacts on many of the 566 federally recognized tribes and other tribal and indigenous groups in the U.S. are projected to be especially severe, since these impacts are compounded by a number of persistent social and economic problems.[6,7] The adaptive responses to multiple social and ecological challenges arising from climate impacts on indigenous communities will occur against a complex backdrop of centuries-old cultures already stressed by historical events and contemporary conditions.[8] Individual tribal responses will be grounded in the particular cultural and environmental heritage of each community, their social and geographical history, spiritual values, traditional ecological knowledge, and worldview. Furthermore, these responses will be informed by each group's distinct political and legal status, which includes the legacy of more than two centuries of non-Native social and governmental institutional arrangements, relationships, policies, and practices. Response options will be informed by the often limited economic resources available to meet these challenges, as well as these cultures' deeply ingrained relationships with the natural world.[9,10,11,12]

The history and culture of many tribes and indigenous peoples are critical to understand before assessing additional climate change impacts. Most U.S. Native populations already face adverse socioeconomic factors such as extreme poverty; substandard and inadequate housing; a lack of health and community services, food, infrastructure, transportation, and education; low employment; and high fuel costs; as well as historical and current institutional and policy issues related to Native resources.[7,11,12,13] The overwhelming driver of these adverse social indicators is pervasive poverty on reservations and in Native communities, as illustrated by an overall 28.4% poverty rate (36% for families with children) on reservations, compared with 15.3% nationally.[13] Some reservations are far worse off, with more than 60% poverty rates and, in some cases, extremely low income levels (for example, Pine Ridge Reservation has the lowest per capita income in the U.S. at $1,535 per year).[14]

These poverty levels result in problems such as: a critical housing shortage of well over two hundred thousand safe, healthy, and affordable homes;[15] a homeless rate of more than 10% on reservations;[16] a lack of electricity (more than 14% of reservation homes are without power, ten times the national average, and, on the Navajo Reservation, about 40% of homes have no electricity[17]); lack of running water in one-fifth of all reservation homes and for about one-third of people on the Navajo Reservation (compared with 1% of U.S. national households);[18,19,20] and an almost complete lack of modern telecommunications – fewer than 50% of homes have phone service, fewer than 10% of residents have Internet access, and many reservations have no cell phone reception.[21] In addition, Native populations are also vulnerable because their physical, mental, intellectual, social, and cultural well-being is traditionally tied to a close relationship with the natural world, and because of their dependence on the land and resources for basic needs such as medicine, shelter, and food.[22,23] Climate changes will exacerbate many existing barriers to providing for these human needs, and in many cases will make adaptive responses more difficult.

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 (about 42% of Alaska's land base) held by Alaska Native corporations.[5] 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 has 175,000 residents.[5]

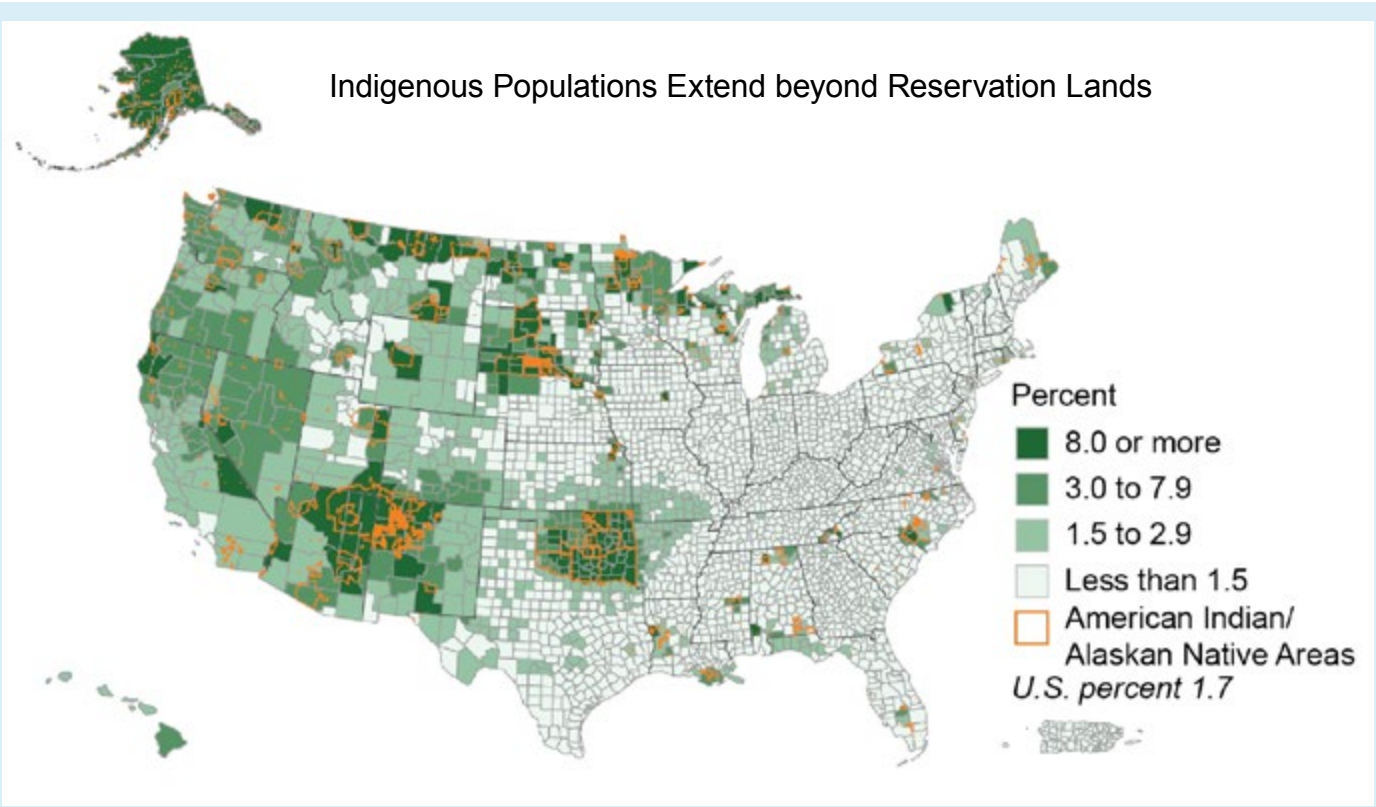

Figure 12.1. Census data show that American Indian and Alaska Native populations are concentrated around, but are not limited to, reservation lands like the Hopi and Navajo in Arizona and New Mexico, the Choctaw, Chickasaw, and Cherokee in Oklahoma, and various Sioux tribes in the Dakotas and Montana. Not depicted in this graphic is the proportion of Native Americans who live off-reservation and in and around urban centers (such as Chicago, Minneapolis, Denver, Albuquerque, and Los Angeles) yet still maintain strong family ties to their tribes, tribal lands, and cultural resources. (Figure source: Norriset al. 2012[5]).

House being built on Pine Ridge Reservation

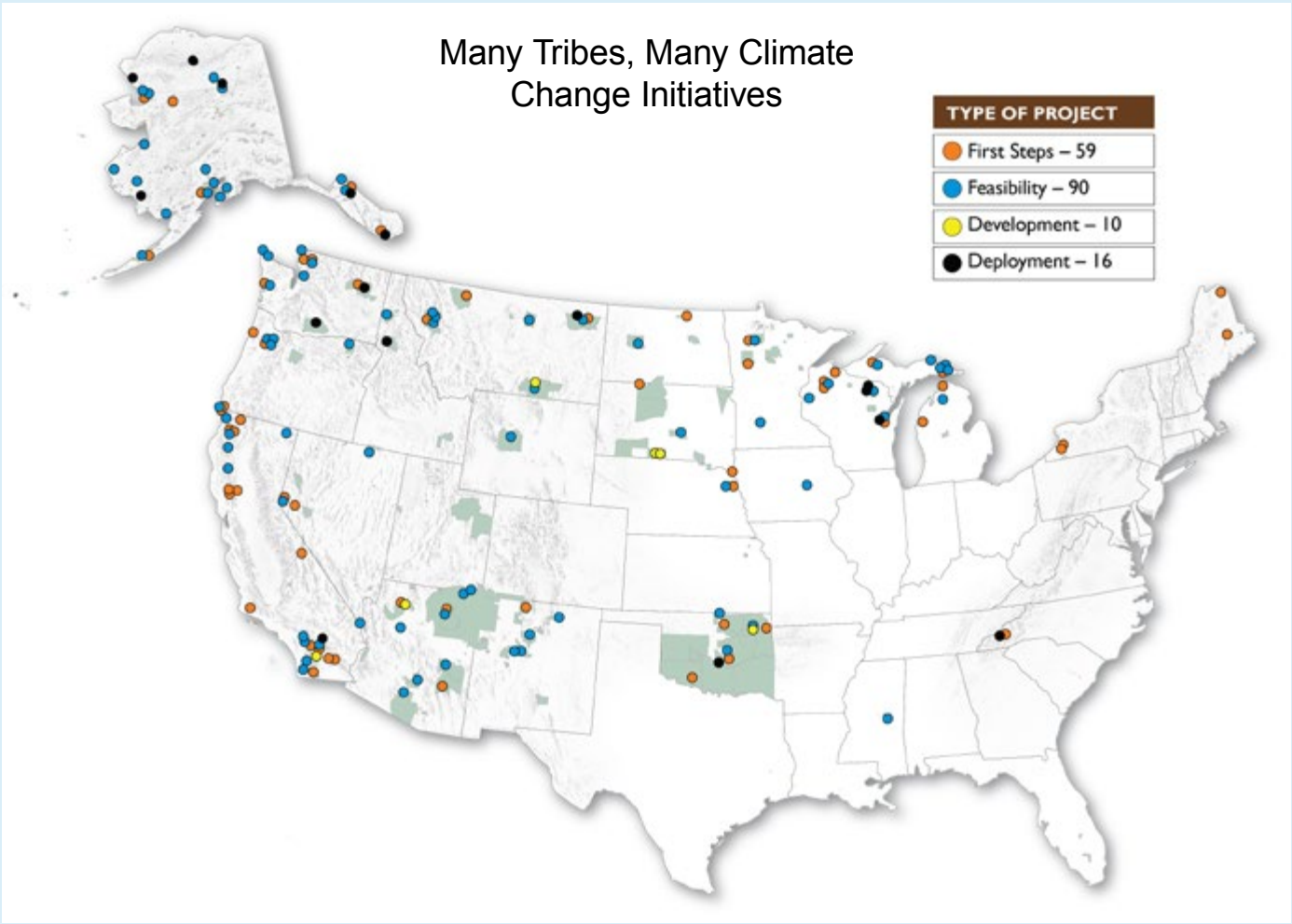

Figure 12.2. From developing biomass energy projects on the Quinault Indian Nation in Washington and tribal and intertribal wind projects in the Great Plains,[24] to energy efficiency improvement efforts on the Cherokee Indian Reservation in North Carolina and the sustainable community designs being pursued on the Lakota reservations in the Dakotas (see also Ch. 19: Great Plains),[25] tribes are investigating ways to reduce future climate changes. The map shows only those initiatives by federally recognized tribes that are funded through the Department of Energy. (Figure source: U.S. Department of Energy 2011[26]).

Native American, Alaska Native, and other indigenous communities across the U.S. share unique historical and cultural relationships with tribal or ancestral lands, significantly shaping their identities and adaptive opportunities.[11] 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 constrained by public lands or on certain low-lying Pacific Islands – because there may be no land left to call their own. Conversely, for these same reasons, Native communities – especially in the Arctic – are also increasingly working to identify new economic opportunities associated with climate change and development activities (for example, oil and gas, mining, shipping, and tourism) and to optimize employment opportunities.[1,27,28]

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.[29]

Traditional knowledge is essential to the economic and cultural survival of indigenous peoples, and, arguably, cultures throughout the world.[30,31] 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."[1,12,32] 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.[12,33] As the elders of these communities – the "knowledge keepers" – pass away, the continued existence and viability of traditional knowledge is threatened. Programs are needed to help 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.[34]

Many, if not all, indigenous resource managers believe their cultures already possess sufficient knowledge to respond to climate variation and change.[30,35] However, there are elements of traditional knowledge that are increasingly vulnerable with changing climatic conditions,[4] including cultural identities, ceremonies, and traditional ways of life.[36] The use of indigenous and traditional knowledge to address climate change issues in Indian country has been called "indigenuity" – indigenous knowledge plus ingenuity.[33]

Native cultures are directly tied to Native places and homelands, reflecting the indigenous perspective that includes the "power of place."[6,36,37] Many indigenous peoples regard all people, plants, and animals that share our world as relatives rather than resources. Language, ceremonies, cultures, practices, and food sources evolved in concert with the inhabitants, human and non-human, of specific homelands.[1,33] The wisdom and knowledge of Native people resides in songs, dances, art, language, and music that reflect these places. 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.'"*[38,39] As climate change increasingly threatens these Native places, cultural identities, and practices, documenting the impacts on traditional lifestyles would strengthen adaptive strategies.

Traditional knowledge has developed tangible and reliable methods for recording historic weather and climate variability and their impacts on native societies.[40] For example, tribal community historians (winter count keepers) on the northern Great Plains recorded pictographs 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.[41]

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.[1] 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.[42] 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 meteorological and hydrological changes and other phenomena in an effort to assess and reduce disaster risks.[43]

Key Message 1: Forests, Fires, and Food

Observed and future impacts from climate change threaten Native Peoples' access to traditional foods such as fish, game, and wild and cultivated crops, which have provided sustenance as well as cultural, economic, medicinal, and community health for generations.

Climate change impacts 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.[2,4] Warmer temperatures and more frequent drought are expected to cause dieback and tree loss of several tree and plant species (such as birch, brown ash, and sweet grass) important for Native artistic, cultural, and economic purposes, including tourism.[22] Tribal access to valued resources is threatened by climate change impacts causing habitat degradation, forest conversion, and extreme changes in ecosystem processes.[44]

Observed impacts from both the causes and consequences of climate change, and added stressors such as extractive industry practices on or near Native lands, include species loss and shifts in species range.[1,45,46,47] There have also been observed changes in the distribution and population density of wildlife species, contraction or expansion of some plant species' range, and the northward migration of some temperate forest species.[4,48] For example, moose populations in Maine and similar locations are expected to decline because of loss of preferred habitat and increased winter temperatures, which are enabling ticks to survive through the winter and causing damage from significant infestation of the moose.[22]

Harvesting traditional foods is important to Native Peoples' culture, health, and economic well being. In the Great Lakes region, wild rice is unable to grow in its traditional range due to warming winters and changing water levels.

Loss of biodiversity, changes in ranges and abundance of 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, across much of the West, and in Alaska (see also Appendix 3: Climate Science Supplement, Figure 31; Ch. 7: Forests; Ch. 8: Ecosystems).[4,30,48,49] Changes in ocean temperature and acidity affect distribution and abundance of important food sources, like fish and shellfish (Ch. 2: Our Changing Climate; Ch. 24: Oceans).

Rising temperatures and hotter, drier summers are projected to increase the frequency and intensity of large wildfires (see Ch. 7: Forests).[44] 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 (see Ch. 7: Forests). 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."*[50]

In interior Alaska, rural Native communities are experiencing new risks associated with climate change related wildfires in boreal forests and Arctic tundra (see also Ch. 22: Alaska).[1,51] 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 fires. While efforts are being made to better coordinate rural responses to wildfires in Alaska, current responses are limited by organization and geographic isolation.[48]

Indigenous peoples have historically depended on the gathering and preparation of a wide variety of local plant and animal species for food (frequently referred to as traditional foods), medicines, ceremonies, community cohesion, and economic health for countless generations.[2,52] 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.[2,45,47,49,52,53,54,55,56,57] A changing climate affects the availability, tribal access to, and health of these resources.[1,2,4,47,57,58,59,60] This in turn threatens tribal customs, cultures, and identity.

Medicinal and food plants are becoming increasingly difficult to find or are no longer found in historical ranges.[2,56] For example, climate change and other environmental stressors are affecting the range, quality, and quantity of berry resources

for the Wabanaki tribes in the Northeast.[2,61] The Karuk people in California have experienced a near elimination of both salmonids and acorns, which comprise 50% of a traditional Karuk diet.[62] In the Great Lakes region, wild rice is unable to grow in its traditional range due to warming winters and changing water levels, affecting the Anishinaabe peoples' culture, health, and well-being.[54]

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, also increasing the risk to food and resource security.[1,2,16] 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.[4,57,59]

Human-caused stresses such as dam building have greatly reduced salmon on the Klamath River.

Key Message 2: Water Quality and Quantity

A significant decrease in water quality and quantity due to a variety of factors, including climate change, is affecting drinking water, food, and cultures. Native communities' vulnerabilities and limited capacity to adapt to water-related challenges are exacerbated by historical and contemporary government policies 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.[63,64] 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.[20] Changes in long-term average temperature and precipitation have produced changes in the physical and hydrologic environment, making the Navajo Nation more susceptible to drought impacts, and some springs and shallow water wells on the Navajo Nation have gone dry.[43] Southwest tribes have observed damage to their agriculture and livestock, the loss of springs and medicinal and culturally important plants and animals, and impacts on drinking water supplies.[63,64,65,66] 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.[52,58,67] In Hawai'i, Native peoples have observed a shortening of the rainy season, increasing intensity of storms and flooding, and a rainfall pattern that has become unpredictable.[38] 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 those caused by the *Giardia* parasite, a result of disease-carriers like beavers moving northward in response to rising temperatures.[68] The impact of historical federal policies, such as the late 1800s allotment policy and practices regarding Native access to treaty-protected resources,[69] reverberate in current practices, such as states and the government permitting oil drilling and hydraulic fracturing on lands in and around reservations but outside of tribal jurisdiction (for example, a 2013 pipeline spill upstream of tribal reservations in Western North Dakota, and others). Such policies and practices exacerbate the threat to water quality and quantity for Native communities.

Coal plant and fishermen, Navajo Reservation

Native American tribes have unique and significant adaptation needs related to climate impacts on water.[66] 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.[63] Without scientific monitoring, tribal decision-makers lack the data needed to quantify and evaluate current conditions and emerging trends in precipitation, streamflow, and soil moisture, and to plan and manage resources accordingly.[10,64,66] However, some existing efforts to document climate impacts on water resources could be replicated in other regions to assess hydrologic vulnerabilities.[58]

Water infrastructure is in disrepair or lacking on some reservations.[43,70] Approximately 30% of people on the Navajo Nation are not served by municipal systems and must haul water to meet their daily needs.[19,43] Longer-term impacts of this lack of control over water access are projected to include loss of traditional agricultural crops.[19,43] Furthermore, there is an overall lack of financial resources to support basic water infrastructure on tribal lands.[63] Uncertainty associated with undefined tribal water rights make it difficult to determine strategies to deal with water resource issues.[70] Potential impacts to treaty rights and water resources exist, such as a reduction of groundwater and drinking water availability and water quality decline, including impacts from oil and natural gas extraction and sea level rise-induced saltwater intrusion into coastal freshwater aquifers (see also Ch. 3: Water).[7] New datasets on climate impacts on water in many locations throughout Indian Country, such as the need to quantify available water and aquifer monitoring, will be important for improved adaptive planning.

Sand Dune Expansion

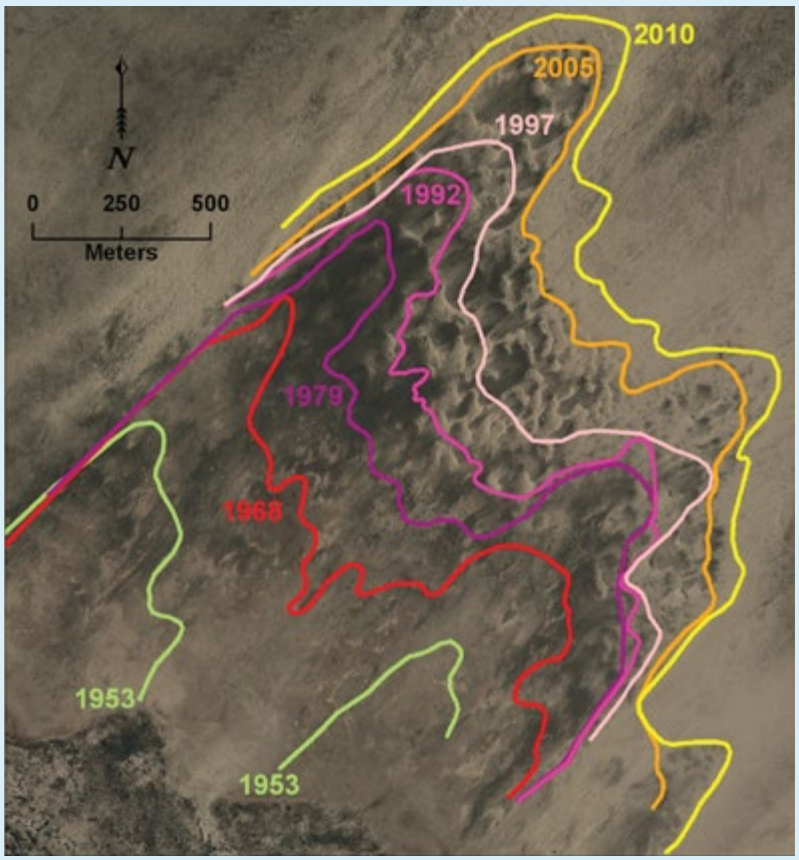

Figure 12.3. On the Arizona portion of the Navajo Nation, recurring drought and rising temperatures have accelerated growth and movement of sand dunes. Map above shows range and movement of Great Falls Dune Field from 1953 to 2010. Moving and/or growing dunes can threaten roads, homes, traditional grazing areas, and other tribal assets. (Figure source: Redsteer et al. 2011[55]).

Key Message 3: Declining Sea Ice

Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and loss to settlements, food insecurity, 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, personal communication[71]

Scientists across the Arctic have documented rising regional temperatures over the past few decades at twice the global rate, and indigenous Arctic communities have observed these changes in their daily lives.[1] This temperature increase – which is expected to continue with future climate change – is accompanied by significant reductions in sea ice thickness and extent, increased permafrost thaw, more extreme weather and severe storms, and changes in seasonal ice melt/freeze of lakes and rivers, water temperature, sea level rise, flooding patterns, erosion, and snowfall timing and type (see also Ch. 2:

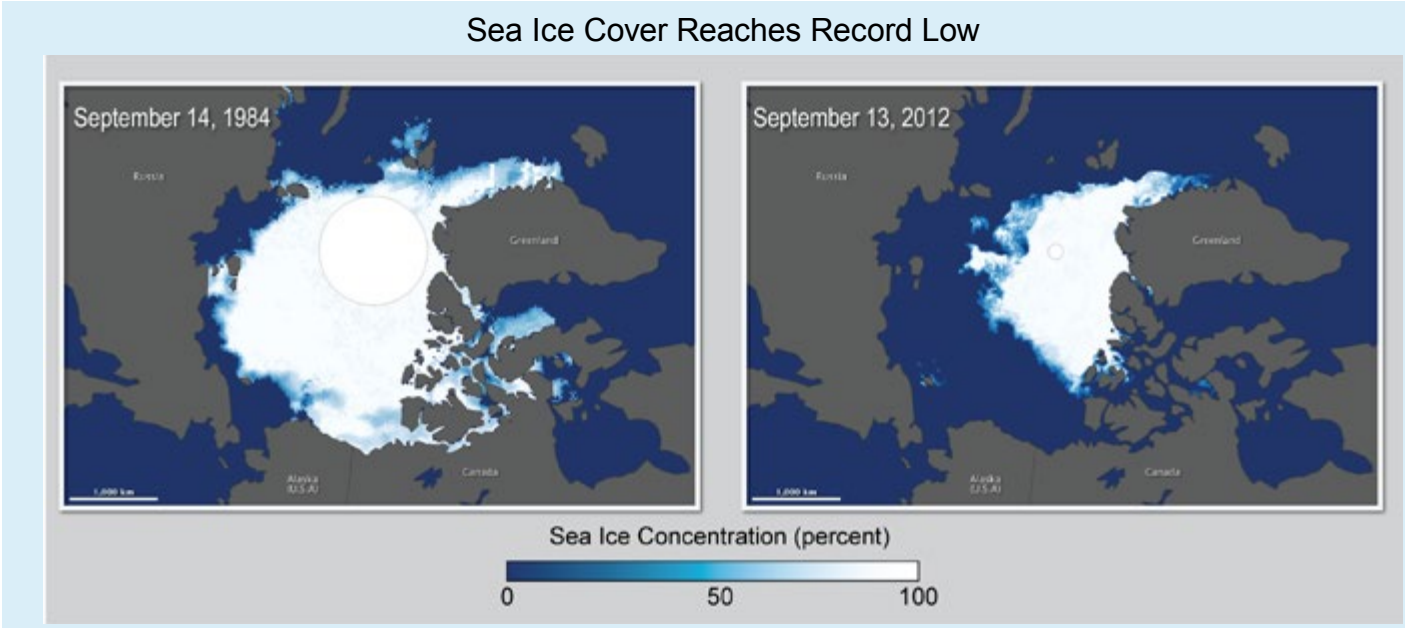

Figure 12.4. In August and September 2012, sea ice covered less of the Arctic Ocean than any time since the beginning of reliable satellite measurements (1979). The long-term retreat of sea ice has occurred faster than climate models had predicted. The average minimum extent of sea ice for 1979-2000 was 2.59 million square miles. The image on the left shows Arctic minimum sea ice extent in 1984, which was about the average minimum extent for 1979-2000. The image on the right 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. (Figure source: NASA Earth Observatory 2012[77]).

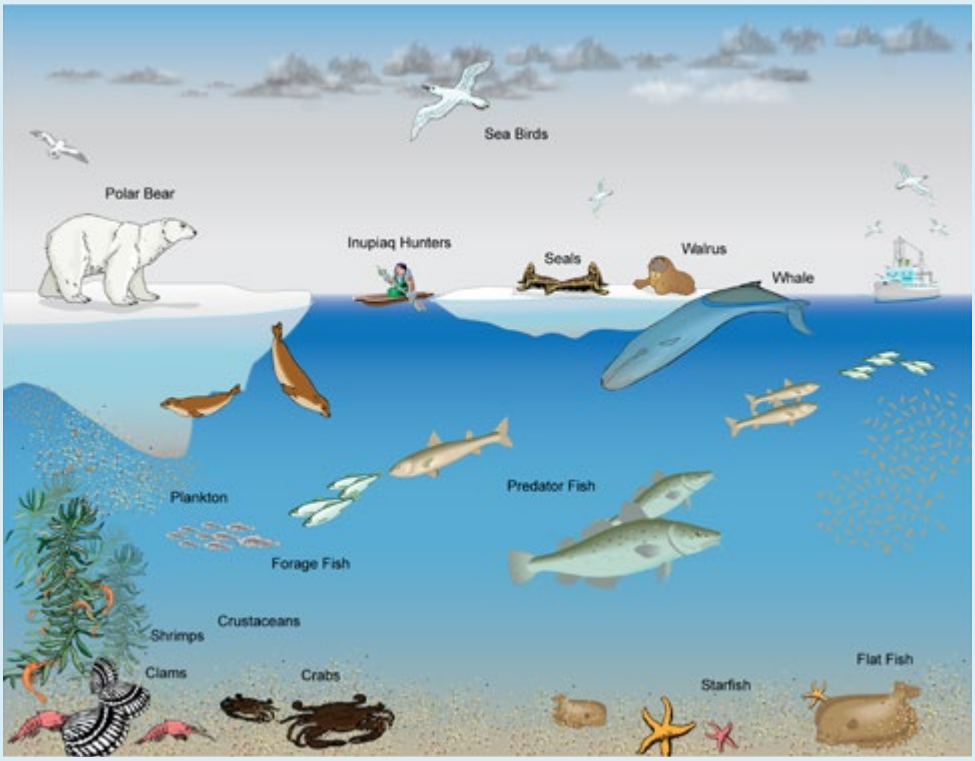

Figure 12.5. Dramatic reductions in Arctic sea ice and changes in its timing and composition affect the entire food web, including many Inupiaq communities that continue to rely heavily on subsistence hunting and fishing. (Figure source: NOAA NCDC).

Our Changing Climate).[71,72,73,74,75] 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 that limit safe hunting, fishing, or herding practices; 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 the loss of buildings and infrastructure from permafrost erosion and thawing, resulting in the relocation of entire communities (Ch. 22: Alaska).[1,68,71,75,76]

Alaska Native Inupiat and Yup'ik experts and scientists have observed stronger winds than in previous decades,[71,75,78] observations

that are consistent with scientific findings showing changing Arctic wind patterns, which in turn influence loss of sea ice and shifts in North American and European weather.[79] They also observe accelerated melting of ice and snow, and movement of ice and marine mammals far beyond accessible range for Native hunters.[1] 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.[1,73,75,80]

Key Message 4: Permafrost Thaw

Alaska Native communities are increasingly exposed to health and livelihood hazards from increasing temperatures and thawing permafrost, which are damaging critical infrastructure, adding to other stressors on 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 from differential settlement, slumping, and/or collapse of underlying base sediments (see Ch. 2: Our Changing Climate; Ch.22: Alaska, Key Message 3).[81] This loss of infrastructure is further exacerbated by loss of land-fast sea ice, sea level rise, and severe storms.[1,82,83] 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.[1,84]

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.[1,76,82,85] In addition, permafrost thaw is causing food insecurity in Alaska Native communities due to the thawing of ice cellars or ice houses used 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.[1,85,86]

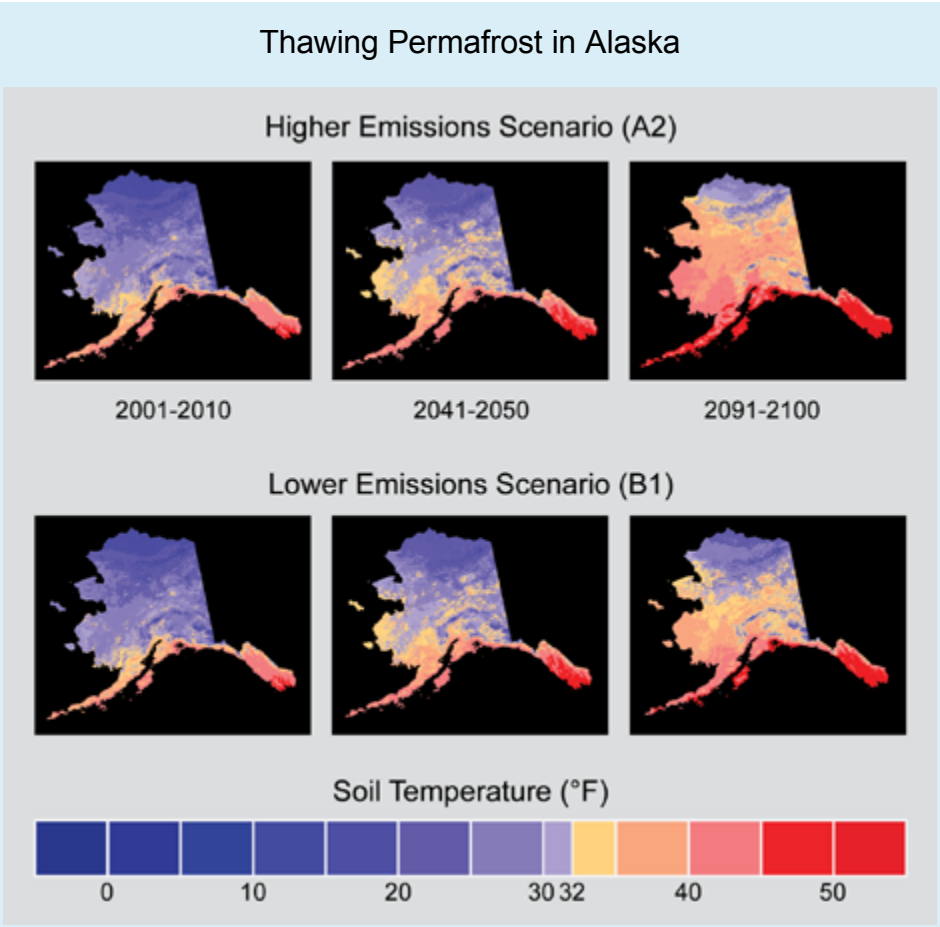

Figure 12.6. The maps show projected ground temperature at a depth of 3.3 feet assuming continued increases in emissions (A2 scenario) and assuming a substantial reduction in emissions (B1 scenario). Blue shades represent areas below freezing at a depth of 3.3 feet and yellow and red shades represent areas above freezing at that depth (see Ch. 22: Alaska for more details). 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. (Figure source: Permafrost Lab, Geophysical Institute, University of Alaska Fairbanks).

Key Message 5: Relocation

Climate change related impacts are forcing relocation of tribal and indigenous communities, especially in 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. Forced relocations have continued into more recent times as well.[87] Now, many Native peoples in Alaska and other parts of the coastal United States, such as the Southeast and Pacific Northwest, are facing relocation as a consequence of climate change and additional stressors, such as food insecurity and unsustainable development and extractive practices on or near Native lands; such forms of displacement are leading to severe livelihood, health, and socio-cultural impacts on the communities.[1,3,23,38,45,88,89,90,91]

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 extreme weather events (Ch. 22: Alaska).[1,3] 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.[3,88,92] Tribal communities in coastal Louisiana are experiencing climate change induced rising sea levels, along with saltwater intrusion, subsidence, and intense erosion and land loss due to oil and gas extraction, levees, dams, and other river management techniques, forcing them to either relocate or try to find ways to save their land.[3,45] Tribal communities in Florida are facing potential displacement due to the risk of rising sea levels and saltwater intrusion inundating their reservation lands.[93] The Quileute tribe in northern Washington is responding to increased winter storms and flooding connected with increased precipitation by relocating some of their village homes and buildings to higher ground within 772 acres of Olympic National Park that has been transferred to them; the Hoh tribe is also looking at similar options for relocation.[90,94,95] Native Pacific Island communities, including those in Hawai'i and the U.S. affiliated Pacific Islands, are also being forced to consider relocation plans due to increasing sea level rise and storm surges.[38,96] While many Native communities are not necessarily being forced to relocate, they are experiencing other social and cultural forms of displacement. For example, rising sea levels are expected to damage Native coastal middens (sites reflecting past human activity such as food preparation) as well as Wabanaki coastal petroglyphs, leading to loss of culture and connection to their past for Northeast tribes.[22]

Rising temperatures are causing damage in Native villages in Alaska as sea ice declines and permafrost thaws. Resident of Selawik, Alaska, and his granddaughter survey a water line sinking into the thawing permafrost, August 2011.

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.[3,12] New governance institutions, frameworks, and funding mechanisms are needed to specifically respond to the increasing necessity for climate change induced relocation.[3,88] To be effective and culturally appropriate, it is important that such institutional frameworks recognize the sovereignty of tribal governments and that any institutional development stems from significant engagement with tribal representatives.[12]

"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."

– Patricia Cochran, Inupiat Leader[97]

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SUPPLEMENTAL MATERIAL

TRACEABLE ACCOUNTS

Process for Developing Key Messages:

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.[56]

Indigenous Knowledge and Education (IKE) Hui Climate Change and Indigenous Cultures forum held in January 2012 in Hawai'i and attended by 36 people.[38]

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.[27]

Stories of Change: Coastal Louisiana Tribal Communities' Experiences of a Transforming Environment, a workshop held from January 22-27, 2012, in Pointe-au-Chien, Louisiana, and attended by 47 people.[45]

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.[98]

First Stewards Symposium. First Stewards: Coastal Peoples Address Climate Change. National Museum of the American Indian, Washington DC. July 17-20, 2012.[30]

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. Each key message was defended by the entire author team before being selected for inclusion in the chapter report. These discussions were supported by targeted consultation with additional experts by the lead author of each message.

Key message #1 Traceable Account

Observed and future impacts from climate change threaten Native Peoples' access to traditional foods such as fish, game, and wild and cultivated crops, which have provided sustenance as well as cultural, economic, medicinal, and community health for generations.

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 that were received and reviewed as part of the Federal Register Notice solicitation for public input.

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 across the United States.[4,7,22,49,52,58]

Climate drivers associated with this key message are also discussed in Ch. 2: Our Changing Climate.

There are also many relevant and recent peer-reviewed publications[1,2,4,48,52,58,66] describing the northward migration of the boreal forest and changes in the distribution and density of wildlife species that have been observed.

Observed impacts on plant and animal species important to traditional foods, ceremonies, medicinal, cultural and economic well-being, including species loss and shifts in species range, are well-documented.[1,2,4,6,7,22,45,46,47,52]

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.

There is uncertainty as to the extent that climate change will affect 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.

Assessment of confidence based on evidence

Based on the evidence and remaining uncertainties, confidence is **very high** that observed and future impacts from climate change, such as increased frequency and intensity of wildfires, higher temperatures, changes in sea ice, and ecosystem changes, such as 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.

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

Key message #2 Traceable Account

A significant decrease in water quality and quantity due to a variety of factors, including climate change, is affecting drinking water, food, and cultures. Native communities' vulnerabilities and limited capacity to adapt to water-related challenges are exacerbated by historical and contemporary government policies 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 that were received and reviewed as part of the Federal Register Notice solicitation for public input.

There are numerous examples of tribal observations of changes in precipitation, rainfall patterns, and storm intensity and impacts on surface water features, agriculture, grazing, medicinal and culturally important plants and animals, and water resources.[2,4,6,7,43,52,55,58,63,64,65,66]

Examples of ceremonies are included in the Oklahoma Inter-Tribal Meeting on Climate Variability and Change Meeting Summary Report.[56] Water is used for some ceremonies, so it can be problematic when there is not enough at the tribe's disposal.[52,56,66] More than one tribe at the meeting also expressed how heat has been a problem during ceremonies because the older citizens cannot go into lodges that lack air conditioning.[56]

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.[10,52,63,66] 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.[10,52,64,66]

Water infrastructure is in disrepair or lacking on some reservations.[43,70] There is an overall lack of financial resources to support basic water infrastructure on tribal lands, such as is found in the Southwest.[63]

Tribes that rely on water resources to maintain their cultures, religions, and life ways 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 makes it difficult to determine strategies to deal with water resource issues.[70]

Assessment of confidence based on evidence

Based on the evidence and remaining uncertainties, confidence is **very high** that decreases in water quality and quantity are affect-

ing Native Americans and Alaska Natives' drinking water supplies, food, cultures, ceremonies, and traditional ways of life. Based upon extensive evidence, there is **very high** confidence that Native communities' vulnerabilities and lack of capacity to adapt to climate change are exacerbated by historical and contemporary federal and state land-use policies and practices, political marginalization, legal issues associated with tribal water rights, water infrastructure deficiencies, and poor socioeconomic conditions.

Key message #3 Traceable Account

Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and loss to settlements, food insecurity, 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 that were received and reviewed as part of the Federal Register Notice solicitation for public input.

Evidence that summer sea ice is rapidly declining is based on satellite data and other observational data and is incontrovertible. The seasonal pattern of observed loss of Arctic sea ice is generally consistent with simulations by global climate models, in which the extent of sea ice decreases more rapidly in summer than in winter (Ch. 2: Our Changing Climate). Projections by these models indicate that the Arctic Ocean is projected to become virtually ice-free in summer before mid-century, and models that best match historical trends project a nearly sea ice-free Arctic in summer by the 2030s.[74] Extrapolation of the present observed trends suggests an even earlier ice-free Arctic in summer. (Ch. 2: Our Changing Climate and Ch. 22: Alaska).

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); and increasing food insecurity due to lack of access to subsistence food and loss of cultural traditions. Evidence for all these impacts of sea ice loss is well-documented in field studies, indigenous knowledge, and scientific literature.[1,2,3,71,73,75,78]

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, with overall impacts on food insecurity and for species necessary for medicines, ceremonies, and other traditions.[1] The effects of sea ice loss are exacerbated by other climate change driven impacts such as changes in snow and ice, weather, in-migration of people, poverty, lack of resources to respond to changes, and contamination of subsistence foods.[1,2]

Additional observations and monitoring are needed to more adequately document ice and weather changes.

Assessment of confidence based on evidence

Based on the evidence and remaining uncertainties, 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 more hazardous travel and hunting conditions along the ice edge; erosion damage to homes, infrastructure, and 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.

Key message #4 Traceable Account

Alaska Native communities are increasingly exposed to health and livelihood hazards from increasing temperatures and thawing permafrost, which are damaging critical infrastructure, adding to other stressors on 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 that were received and reviewed as part of the Federal Register Notice solicitation for public input.

Given the evidence base and uncertainties, confidence is high that rising temperatures are thawing permafrost and that this thawing is expected to continue (Ch. 2: Our Changing Climate) Permafrost temperatures are increasing over Alaska and much of the Arctic. Regions of discontinuous permafrost (where annual average soil temperatures of already close to 32°F) are highly vulnerable to thaw (Ch. 2: Our Changing Climate).[81]

There are also many relevant and recent peer-reviewed publications[1,3,82,83] describing the impact of permafrost thaw on Alaska Native villages. Over 30 Native villages in Alaska are in need of relocation or are in the process of being moved. Recent work[1,84,85] 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 Ch. 22: Alaska) confirmed many of the findings from the prior 2009 Alaska as-

sessment chapter, which informed the 2009 National Climate Assessment.[99]

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.[1]

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, loss of traditional food storage, and potential food contamination.[1]

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.[1,3,12]

Assessment of confidence based on evidence

Based on the evidence and remaining uncertainties, 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.

Key message #5 Traceable Account

Climate change related impacts are forcing relocation of tribal and indigenous communities, especially in 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 that were received and reviewed as part of the Federal Register Notice solicitation for public input.

There is well-documented evidence that tribal communities are vulnerable to coastal erosion that could force them to relocate.[1,3,23,38,88,89] 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 extreme weather events, resulting in loss of basic necessities and infrastructure (see also Ch. 22: Alaska).[1,3,88,91]

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 gas extraction and river management, forcing them to either relocate or try to find ways to save their land (see also Ch. 25: Coasts and Ch. 17 Southeast).[3,45] Tribal communities in Florida are facing potential displacement due to the risk of rising sea levels and saltwater intrusion inundating their reservation lands.[93] The Quileute tribe in northern Washington is relocating some of their village homes and buildings to Olympic National Park in response to increased winter storms and flooding connected with increased precipitation; the Hoh tribe is also considering similar options.[90,94]

Native Pacific Island communities are being forced to consider relocation plans due to increasing sea level rise and storm surges (see also Ch. 23: Hawai'i and Pacific Islands).[38]

New information and remaining uncertainties

A key uncertainty is the extent to which the combination of other impacts (for example, 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.[1,3,38]

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.[1,3,38] 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.[3,12]

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 extreme weather events. There is **very high** confidence that 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.