

A Tribal Planning Framework – Climate Change Adaptation Strategies by Sector

American Indians and Alaska Native Tribes face significant threats to their cultural resources and traditional ways of life from climate change. Pro-active strategies in planning for the potential impacts from climate change can assist indigenous communities in being resilient in the face of change. This framework is intended to serve as a resource for American Indian and Alaska Native tribes developing tribal climate change adaptation plans or incorporating climate change adaptation strategies into existing tribal plans and initiatives, including strategic plans or natural resource management plans. This framework can be used in concert with other planning resources, such as the Institute for Tribal Environmental Professionals' Tribal Climate Change Adaptation Plan Template: <http://www4.nau.edu/tribalclimatechange/index.asp>.¹

The Pacific Northwest Tribal Climate Change Project initially developed a framework for the Coquille Indian Tribe of Oregon to serve as a reference for the Tribe as they updated their Tribal Strategic Plan. The framework was subsequently broadened and adjusted to serve as a resource for tribes.

How to Use this Framework

This framework is intended to provide a set of resources to assist tribes address climate change in regards to tribal governance and sectors affected by climate change. For each sector, this framework provides a description of potential climate change impacts, as well as a series of considerations that can help guide tribal leaders and staff in addressing climate change impacts.

Each section of this document concludes with a list of resources for more information regarding climate change considerations within a particular sector. Additionally, a list of general resources is included at the end of the document. Some of the resources are meant to provide background on climate change projections, such as the *United States Global Change Research Program Regional Climate Change Impacts*. Other resources are meant to serve as examples of how tribes and governments are approaching climate change adaptation planning, such as the *Swinomish Climate Change Adaptation Plan*.

Not all of the content included below will be of relevance to every tribe. Conversely, there may be topics of relevance to certain tribes that may be missing from this framework. Ideally, this framework can serve as a starting point for tribes considering adaptation strategies for a range of tribal sectors and resources.

For More Information and Feedback

The PNW Tribal Climate Change Project is interested in feedback on this document. Please email Kathy Lynn at kathy@uoregon.edu if you have questions or suggestions for the framework.

¹ For a description of Climate Change Vulnerability Assessments and for a list of relevant resources, please refer to page 27.

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Natural and Cultural Resources

Forestry

Tribes and Forestry

Forests are vital economic and cultural resources for many of the American Indian and Alaska Native tribes in the United States. There are 18 million acres of tribal forest lands held in trust. Of these, 5.7 million acres are designated for commercial forestry (NCAI). Climate change has the potential to both compromise the health of forests across the country, and increase their productivity. For tribes whose culture, traditions and ways of life may be heavily dependent on forest resources it is important to build an understanding of how climate change may impact forests and other ecosystems.

Climate Projections and Forestry Implications

Climate change will affect temperature and moisture regimes that have important implications for tribal forestry. Every region will be affected differently, but in general, it is likely that temperatures will increase and precipitation patterns will become more extreme in most part of the country (USGCRP I).

Rising temperatures are likely to lead to longer growing seasons for many regions. This, combined with elevated CO² in the atmosphere, is likely to increase the timber productivity of some forests (USEPA). At the same time, some forest species may not adapt well to rising temperatures. Such species will likely adjust their range and/or distribution northward or to higher altitudes to compensate for these changes. For some mountain plant species and coldwater fish, such as salmon, it is highly likely that climate change will lead to significant habitat contractions (USGCRP II). In Alaska, rising temperatures are already demonstrating clear impacts on tundra ecosystems that are being encroached by northward-shifting tree lines, affecting tundra species that depend on this landscape's open character (USGCRP II).

Longer growing seasons and warmer winters will increase the ability of detrimental pests and insects, such as the pine beetle or the hemlock woolly adelgid, to survive year-round, negatively impacting forest health (USEPA). In some regions such as the Southwestern U.S., prolonged periods of drought may compromise forest health and further exacerbate vulnerability to problematic pests (USEPA).

Additionally, prolonged periods of drought combined with rising temperatures are likely to make forests more vulnerable to wildfire (NWF I). Because many regions are experiencing warmer springs and drier summers, studies show that wildfires have increased four-fold since the mid-1980s, the fire season is 78 days longer and individual fires are 30 days longer (NWF II). Certain species are particularly vulnerable to wildfire and struggle to recover from its impacts. In the Midwest, increased wildfire risks could have serious repercussions for important cultural resources such as sugar maple, which is an important food source, and black ash, which is used for basketry (Daigle et al.).

Extreme weather events are also likely to increase in frequency, threatening the stability of forests. Severe storms may damage timber and forest habitats, and cause major erosion on forest floors. In 2005, hurricanes Rita and Katrina damaged a total of 5,500 acres of forest (USEPA).

As climate change impacts combine with other anthropogenic factors to modify forest ecosystems, native forest plant and animal species may be replaced by other species that can better tolerate new ecosystem conditions (USGCRP II). Lacking natural predators, non-native species may thrive in these new conditions, becoming invasive and compromising the stability of forest ecosystems (USEPA).

What can Tribes do?

Tribes can prepare for climate threats by carrying out periodic forest assessments that evaluate observed climate change impacts and species' climate change vulnerability. The Indian Forest Management Assessment Team, which is comprised of representatives from the Bureau of Indian Affairs and the Inter-Tribal Timber Council, developed ten-year reports in 1993 and again in 2003 evaluating the condition of Indian Forests and the effectiveness of tribal forest management strategies on a national level (USFS). These assessments, while not focused on climate change impacts, provide insight into the evolving challenges faced by tribal forest managers. Similar assessments with a specific focus on climate change impacts can be spearheaded at regional or tribal levels. In 2009, the Swinomish Indian Tribal Community of WA carried out a climate change impact assessment to determine the climate change vulnerability of various tribal resources. Their forest resources vulnerability assessment revealed an increased risk of wildfire, especially in the urban/forest interface. The assessment also revealed a stronger potential for the spread of forest pests and diseases as a result of warmer winter temperatures. Additionally, they found that increased drought stress is likely to lead to the proliferation of drought-tolerant species such as fir, while drought-susceptible species such as western red cedar will likely decline (Swinomish).

Forest assessments can be followed by the development of adaptive forest management plans that specify adaptation strategies in response to the projected climate impacts identified in the assessment. When developing such plans, considerations for tribal forestry might include:

- How can forest management plans reflect adaptation strategies related to climate impacts on culturally and economically significant species?
- How can tribal forests be managed to:
 - Decrease the likelihood of catastrophic wildfires?
 - Decrease the likelihood of tree damage from pests and diseases?
 - Reduce the potential for extreme erosion?

Federally recognized tribes can improve forest management strategies in a climate change context by engaging in meaningful government-to-government relationships with relevant federal agencies, such as the U.S Forest Service. An example of this is the 15-Year Report for the Northwest Forest Plan Tribal Effectiveness Monitoring, which examines the extent to which tribes had access to and use of forest species, resources, and places important to tribal culture and economy under the Northwest Forest Plan (NW Forest Plan). This report emphasizes the importance of meaningful government-to-government relationships between tribes and the federal government through the use of effective consultation, as well as collaboration.

Tribes can pursue management initiatives through the Tribal Forest Protection Act. This action gives tribes the opportunity to initiate projects on Federal lands adjacent to tribal trust lands for

the purpose of managing threats to forest resources such as wildfire, pests, erosion or disease. For example, the Mescalero Apache Tribe has initiated the Sixteen Springs Stewardship Project with the Lincoln National Forest, for the purpose of protecting forest health in the Otero and Lincoln Counties in New Mexico, and reducing the risk of wildfire in the Mescalero Apache Reservation, the village of Ruidoso, the 16 Springs community and the forest (ITC). Such partnerships will become increasingly important as climate change exacerbates various forest threats.

References

- Daigle, John; Lake, Frank K.; Lynn, Kathy; Ranco, Darren; Voggeser, Garrit. 2012. Cultural Impacts to Tribes from Climate Change Influences on Forests and Other Ecosystems. Climatic Change Journal. Pending Review.
- Intertribal Timber Council (ITC), Tribal Forest Protection Act - Success Stories: http://www.itcnet.org/about_us/news_room.html
- National Congress of American Indians (NCAI) - Native Resources: <http://www.ncai.org/policy-issues/land-natural-resources/native-resources>
- National Wildlife Federation (NWF I), Facing the Storm - Indian Tribes, Climate-Induced Weather Extremes, and the Future for Indian Country: http://www.tribesandclimatechange.org/documents/nccc/nccc_361.pdf
- National Wildlife Federation (NWF II) - Climate Change Hurts Indian Tribes Disproportionately: <http://www.nwf.org/News-and-Magazines/Media-Center/News-by-Topic/Global-Warming/2011/08-03-11-Climate-Change-Hurts-Indian-Tribes-Disproportionately.aspx>
- Northwest Forest Plan (NW Forest Plan) Interagency Regional Monitoring Program - 15 Year Report for the Northwest Forest Plan, Tribal Effectiveness Monitoring: <http://www.reo.gov/monitoring/reports/15yr-report/tribal/index.shtml>
- Swinomish Climate Change Initiative (Swinomish) - Climate Adaptation Action Plan: http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- U.S. Environmental Protection Agency (USEPA) - Forest Impacts and Adaptation: <http://www.epa.gov/climatechange/impacts-adaptation/forests.html>
- U.S. Forest Service (USFS) Tribal Relations Publications and Reports, Indian Forest Management Assessment Team I and II Report: http://www.fs.fed.us/spf/tribalrelations/pubs_reports/index.shtml
- United States Global Change Research Program Impacts by Sector (USGCRP I) - Key Findings: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/key-findings>
- United States Global Change Research Program (USGCRP II) - Global Climate Change Impacts in the United States: <http://globalchange.gov/what-we-do/assessment/previous-assessments/global-climate-change-impacts-in-the-us-2009>

Fisheries

Tribes and Fisheries

Native fisheries play a vital role in the economies, cultures and subsistence lifestyles of many indigenous groups in the United States. In many regions, native fisheries have been severely impacted by Euro-American land management practices, habitat destruction and resource exploitation. Activities such as the construction of hydroelectric dams, the introduction of non-native species, overharvesting, and the deforestation of stream banks, have dramatically reduced the health and abundance of native fisheries. In the Pacific Northwest, where salmon plays a central role in many tribes' traditional diets and cultures, it is estimated that salmon runs declined nearly 95 percent between the late 1800s and the late 1900s (Lackey). Climate change is likely to exacerbate declines to fisheries by further altering fresh and saltwater ecosystems, affecting culturally significant species and the indigenous communities that depend on them.

Climate Projections and Fisheries Implications

One of the key climate change impacts threatening fisheries is rising water temperatures. Climate change is leading to higher air temperatures in most regions of the country, subsequently leading to elevated water temperatures in streams, lakes and oceans (USGRP I). This may benefit and expand the range of warm water fish, while severely threatening species that depend on cold water to spawn and carry out their life cycles, such as salmon and trout (IPCC). In the Great Lakes region, cold water fish such as brook trout, lake trout, and whitefish are likely to decline, while warm water smallmouth bass and bluegill are likely to thrive and take their place (USGRP III) This has implications not only for the cold-water fish, but also for other fisheries species that depend on cold-water species for food. In Minnesota, culturally vital cool water walleye may not be the most affected species by water temperature increases, but may be affected if one of their primary sources of food, the cold water tullibee, declines drastically as a result of elevated temperatures (MN DNR). This could impact Midwestern tribes for which the walleye is an important resource.

Changing water temperatures may also have impacts on water quality. Warmer waters can extend and intensify thermal stratification in large, deep bodies of water. Thermal stratification, which traps cool, dense water beneath layers of warmer, surface waters in the summer, can lead to oxygen depletion (USGRP I). Warmer waters may also increase the rate of eutrophication—where water accumulates an excess of chemical nutrients, leading to the rapid growth and decay of aquatic plant matter, including detrimental algal blooms, depleting oxygen and reducing water quality in the process (USGRP I).

Climate change is also likely to affect water quantity in a variety of ways. Precipitation extremes are likely to increase throughout most of the country, affecting seasonal streamflow. Strong winter storms may lead to extreme flooding, which can disrupt gravel spawning beds and wash away fish eggs (NWF), while prolonged periods of drought during the summer months may significantly reduce streamflow. Streamflow may also be impacted by decreased snowpack, diminishing glaciers, and earlier and faster spring snowmelt. Reduced stream volumes affect the ability of certain fishes such as salmon to reach their spawning beds and carry out their life cycles, and also lead to shallower, and therefore warmer streams (NWF).

Ocean temperatures are also likely to increase, leading to sea level rise. Rising sea levels may affect the type and distribution of existing estuarine habitats (Glick et al.) These habitats are vital to the life cycle of culturally important fisheries species, such as young salmon and shellfish (Parker et al.) Rising sea levels may also challenge the harvest of fisheries species by making historic harvest sites less accessible (Swinomish).

The elevated levels of atmospheric CO² are affecting oceans by interacting with ocean water and leading to ocean acidification. The impacts of ocean acidification are still not well understood, but it is likely to impact many fisheries species, especially shell-building species and their predators. Washington's Puget Sound now has some of the lowest ocean pH levels worldwide (Suquamish). This has serious repercussions for tribes such as the Suquamish Tribe of WA, which depends on the Sound as a major source of traditional foods. Ocean acidification is likely to affect small organisms that feed culturally important species, and is also likely to directly impact other tribal food sources such as clams, oysters and Dungeness crab (Suquamish).

Alaska fisheries, which are among the nations most productive, are among those most vulnerable in the face of climate change. Many Alaska fisheries species depend on cold water temperatures and the presence of sea ice, both which are already being compromised by climate change (USGCRP II). The retreat of sea ice affects the location and abundance of plankton blooms, which form the base of the marine food web and therefore determine the presence and abundance of many species that are crucial to Alaska Natives (USGCRP II). Additionally, the retreat of sea ice affects the habitat of marine mammals, such as seals and walruses, and compromises the ability of Alaska Natives to hunt these species that form part of traditional diets. In the face of these impacts, traditional diets and practices may become difficult to sustain, leading to serious health and cultural repercussions.

What can Tribes do?

Climate change is especially threatening for aquatic species that are already vulnerable due to other impacts, human or otherwise. For this reason, some of the most immediate proactive measures that can be undertaken by tribes to protect fisheries involve the reduction and mitigation of impacts that aren't necessarily related to climate change. When it comes to streams, the strategies to improve adverse stream flow and water temperature changes caused by climate change include restoring floodplain connectivity, restoring stream flow regimes, re-planting deforested riparian zones, and re-aggrading incised channels (Beechie et al.). These measures can increase habitat diversity and population resilience.

Some tribal initiatives are going beyond habitat restoration, and are exploring innovative ways to compensate for the impacts of climate change on fisheries. In response to early snowmelt, the Tulalip Tribes are exploring the construction of artificial wetlands in the uplands that can help slow runoff, provide salmon refuges, and increase infiltration. They are also exploring innovative ways to address ocean acidification, such as the use of seaweed culture to take up excess nutrients and carbon dioxide, a strategy that the Tulalip Tribes and the Washington State Blue Ribbon Panel on Ocean Acidification consider may reduce acidity in localized areas (WSBRPOA).

Partnerships with other tribes and non-tribal organizations can strengthen tribal fisheries initiatives. The Tulalip Tribes have formed a partnership with local dairy farmers to pipe their cow's waste to a tribally owned anaerobic digester that converts the waste to electricity. This endeavor has proved profitable for the Tribes as well as the farmers, and has served to divert nutrients that would otherwise wash into the Snohomish Delta and negatively impact the Tribes' salmon fisheries (Scigliano).

Additionally, federally recognized tribes can improve fisheries management by engaging in meaningful government-to-government relationships with relevant federal agencies. The Nooksack Indian Tribe is collaborating with the EPA Office of Research and Development in the initiation of a pilot project addressing how to evaluate, design, and implement restoration tools in the South Fork Nooksack River. The project will address the projected increase in stream temperatures, loss of glacier melt contributions, decreased baseflows, and increased winter-time flows caused by continued climate change that adversely affect fish and fish habitat (Klein). In Alaska, various Native groups have entered into fisheries co-management agreements with the NOAA's National Marine Fisheries Service. An example is the Alaska Beluga Whale Committee, formed and run by Alaska Native beluga whale hunters, which brought together beluga hunting communities, local, state, and Federal governments, and researchers to discuss conservation issues, the biology of belugas, and future research needs (NOAA Fisheries).

Tribes seeking to kick-off fisheries climate change adaptation initiatives can begin by carrying out a climate change vulnerability assessment that helps identify potential impacts on important fisheries species and guides future management decisions via the development of an adaptation plan. The Grand Portage Band of Lake Superior Chippewa is an example of a tribe whose fisheries management is adapting to climate change impacts. Warming water temperatures are reaching critical lethal levels for brook trout and are causing complete collapse of the population. The Tribe's Natural Resources Department has decided to respond to this imminent collapse by shifting management of a 61-acre inland lake from a cold water (brook trout) fishery to a cool water fishery (yellow perch and walleye) through fish propagation and stocking (ITEP).

When developing a climate change adaptation plan, considerations for tribal fisheries managers might include:

- How can tribal fisheries managers:
 - Account for climate impacts on culturally important species when making management decisions?
 - Prepare for the potential arrival of new species as a result of climate change?
 - Strengthen fisheries initiatives through valuable management and information-sharing partnerships with other tribes or non-tribal entities?
 - Incorporate traditional ecological knowledge into the adaptation plan?

References

- Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney, and N. Mantua. 2012. Restoring salmon habitat for a changing climate. River Research and Applications: DOI: 10.1002/rra.2590.
- Glick, P., J. Clough, and B. Nunley. 2007. Sea-level Rise and Coastal Habitats in the Pacific Northwest: An Analysis for Puget Sound, Southwestern Washington, and Northwestern Oregon.

Seattle, WA: National Wildlife Federation. <http://www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2007/Sea-Level-Rise-in-the-Pacific-Northwest.aspx>

- Institute for Tribal Environmental Professionals (ITEP), Tribes & Climate Change - Grand Portage Band of Lake Superior Chippewa: Creative Solutions for a Changing Environment: http://www4.nau.edu/tribalclimatechange/tribes/greatlakes_lschippewa.asp
- Intergovernmental Panel on Climate Change (IPCC), Climate Change 2007- Working Group II - Impacts, Adaptation and Vulnerability - Agriculture, Forestry and Fisheries: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch14s14-4-4.html
- Klein, S. 2012. Draft Workshop Summary EPA Region 10 Climate Change TMDL Pilot & Temperature TMDL South Fork Nooksack River, WA, June 25, 2012.
- Lackey, Robert T. 2000. Restoring wild salmon to the Pacific Northwest: chasing an illusion? In: What We Don't Know about Pacific Northwest Fish Runs — An Inquiry into Decision-Making: <http://www.epa.gov/wed/pages/staff/lackey/pubs/illusion.htm> - Introduction
- Minnesota Department of Natural Resources (MN DNR), Forecast: Warmer Waters - How will Minnesota fish, anglers, and fisheries managers adapt to warmer lakes and streams?: http://www.dnr.state.mn.us/volunteer/mayjun08/warmer_waters.html
- National Wildlife Federation (NWF) - Salmon and Global Warming: <http://www.nwf.org/Wildlife/Threats-to-Wildlife/Global-Warming/Effects-on-Wildlife-and-Habitat/Salmon.aspx>
- NOAA Fisheries, National Marine Fisheries Service - Alaska Regional Office: Alaska Beluga Whale Committee Named Environmental Heroes: http://www.fakr.noaa.gov/newsreleases/2002/beluga_enviroheroes.htm
- Parker, Alan et al. 2006. Climate Change and Pacific Rim Nations. Evergreen State College, WA: Northwest Indian Applied Research Institute. <http://academic.evergreen.edu/g/grossmaz/IndigClimate2.pdf>
- Scigliano, Eric. 2012. Sweetening the Waters: The Feasibility and Efficacy of Measures to Protect Washington's Marine Resources from Ocean Acidification: http://www.ecy.wa.gov/water/marine/oa/2012report_app9.pdf
- Seattle Aquarium Suquamish (Suquamish) - How Ocean Acidification Affects Coastal Tribes: <http://suquamishechs.wikispaces.com>
- Swinomish Climate Change Initiative - Climate Adaptation Action Plan: http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- United States Global Change Research Program (USGCRP I), Impacts by Sector - Water Resources: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources>
- United States Global Change Research Program (USGCRP II), Regional Climate Impacts - Alaska: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/alaska>
- United States Global Change Research Program (USGCRP III) - Regional Climate Impacts: Midwest: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/midwest>
- Washington State Blue Ribbon Panel on Ocean Acidification (WSBRPOA), Ocean Acidification: From Knowledge to Action - Washington State's Strategic Response: <https://fortress.wa.gov/ecy/publications/SummaryPages/1201015.html>

Wildlife

Climate change has the potential to change wildlife species abundance and distribution by affecting the structure of ecosystems, wildlife habitat and wildlife health. Species' ranges may change as a result of changing temperature and precipitation patterns. Species may find themselves migrating to higher latitudes or altitudes to compensate for the changing climate. Wildlife may also be affected by the impacts of climate change on vegetation that provides them with food and shelter. If plants critical to an animal's survival become scarce or shift their range as a result of climate change, wildlife populations are likely to exhibit similar patterns.

As the composition and range of species change and some species transition out of a given region, new species may transition in. Invasive species may compete with existing species and threaten their survival. Tribes can carry out Climate Change Vulnerability Assessments to determine what species are likely to transition in and out of a given region. Tribes can then use this information to develop management plans that will protect ecosystem health and tribal resources. Milder winter temperatures in some parts of the country may lead to year-round survival of pests and diseases that compromise wildlife health. Additionally, hotter summer temperatures and less reliable precipitation regimes that are projected in many regions may lead to an increase in the frequency of wildfires, affecting wildlife populations and habitats.

Considerations for Fisheries and Wildlife

- How can tribal wildlife managers:
 - Account for climate impacts on culturally important species when making management decisions?
 - Adapt management plans to monitor and prepare for the potential increase in pests and diseases associated with higher winter temperatures
 - Prepare for the potential arrival of new species as a result of climate change?
- Are there partnerships that can be formed with other tribes or non-tribal entities to share information about species that are transitioning from one region to another?

Resources:

- Climate Change and Fisheries and Habitat Conservation - <http://www.fws.gov/fisheries/ccfhc.html>
- Tribes & Climate Change: Species - <http://www4.nau.edu/tribalclimatechange/basic/species.asp>
- United States Global Change Research Program Impacts by Sector: Ecosystems- <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/ecosystems>
- Washington State's Integrated Climate Response Strategy: Ecosystems, Species and Habitats - <http://www.ecy.wa.gov/pubs/1201004g.pdf>
- Washington State's Integrated Climate Response Strategy: Water Resources - <http://www.ecy.wa.gov/pubs/1201004i.pdf>

Water Resources

Tribes and Water Resources

For many indigenous peoples of the United States, water is not just a physical necessity; it is sacred, and essential to many cultural traditions. From freshwater to saltwater, from liquid to ice, water is indispensable to the various ecosystems that sustain tribal lifeways and economies. In the early 1800's, in an effort to protect their access to this vital resource, many tribes secured water rights in treaties with the United States government for water found on tribal lands (NCAI). Despite this, many tribes have had their water resources exploited by ranchers, farmers, industry and residential communities via the damming, re-routing, and free use of tribal water, creating water quantity shortages and leading many tribes to file legal claims in an effort to re-assert their rights. Many of these water rights disputes remain partially or completely unresolved. Additionally, poor land and water resource management practices have led to the degradation of many water resources that are vital to tribes. Climate change is likely to have a variety of impacts on water resources that could further threaten tribal economies, traditions, and subsistence activities.

Climate Projections and Implications for Water Resources

Climate change is likely to cause shifts in precipitation patterns that will become less predictable and more extreme (USGCRP). This may result in an increase in the number of floods and droughts, depending on the season and region. Impacts to tribes may include changes in the abundance and health of plant and animal species used for traditional foods and medicines. In Wisconsin, for example, extreme storm events, fluctuating lake water levels and warmer temperatures associated with climate change are wreaking havoc on already vulnerable wild rice populations that are sacred and culturally vital to the various bands of Ojibwe (Yeager).

Extreme and less predictable precipitation patterns may also lead to impacts on drinking water supplies, water scarcity for agricultural purposes, increased soil erosion, and an increase in community safety hazards (USGCRP, Parker). Some tribes may lack the water supply and stormwater management infrastructure necessary to cope with future impacts. Additionally, because many tribal water rights cases remain unresolved and their water quantities unspecified, tribes may find their rights sacrificed or overlooked as climate change leads to water shortages (Cozzetto).

Climate change is also resulting in warmer water temperatures in both freshwater and saltwater habitats, which affects the stability of ecosystems. Higher water temperatures pose a problem as it relates to water quality, given that warmer water holds less dissolved oxygen, which is essential for many aquatic life forms (USGCRP). Additionally, warmer water temperatures exacerbate the effects of fertilizers and other pollutants, leading, for example, to an increase in detrimental algal blooms that can affect aquatic habitats and pose health threats to people (USGCRP).

Sediment loads are also likely to increase as a result of a higher frequency of heavy storms (USGCRP). Sediment eroded by storms from the uplands is likely to end up in lakes and streams, and eventually reach the ocean. Increased sediment can decrease water quality and affect aquatic habitats. It can also affect the water-holding capacity of both natural and man-made reservoirs.

Sea-level rise is another concern in a climate change context. Rising sea levels as a result of warmer ocean waters pose various threats to coastal tribes, including coastal erosion, salinization of groundwater, changing coastal ecosystems and threats to tribes' ability to inhabit, recreate and perform subsistence and traditional activities in coastal areas (USGCRP, Parker). For some Alaska Native communities, sea-level rise coupled with delayed fall sea ice development has resulted in coastal erosion occurring at alarming rates of tens of feet per year, leading some communities to have to consider relocation (USGCRP I). Additionally, rising sea levels have led to the saltwater intrusion of well systems, compromising some Alaska Native communities' access to safe drinking water.

Ocean acidification may also have severe impacts of marine water resources. This is a process in which elevated levels of atmospheric carbon dioxide (CO²) affect oceans by chemically interacting with seawater and reducing its pH (WSBRPOA). Ocean acidification may have serious implications for many marine species, especially shell-building species.

What can Tribes do?

To prepare for climate change impacts on water resources, tribes can develop a water resources management plan to assess climate change impacts, quantify tribal water rights, evaluate water infrastructure deficiencies, and develop strategies for adaption and water allocation. An example of such a plan is the Clearwater River Subbasin Climate Change Adaptation Plan developed by the Nez Perce Tribe. Some of the Tribe's key goals in developing the plan are to create local partnership opportunities and catalyze the development of regional adaptation efforts (Nez Perce). The Swinomish Indian Tribal Community also addresses impacts to water resources in their Climate Adaptation Action Plan. Among the Tribe's greatest concerns are sea-level rise and storm surges. In light of this, their plan details both preventative and adaptive strategies to protect salt and fresh-water resources from these threats (Swinomish).

The 2011 Navajo Water Resource Development Strategy is another example of a tribal water resources plan. The Navajo Nation Department of Water Resources estimates that approximately 30% of households on the reservation are without direct access to public water systems (Navajo). In light of these statistics, the plan aims to promote water development on Navajo land and ameliorate water infrastructure deficiencies, which better positions the tribe to cope with future water scarcity.

When developing water resource plans, tribal managers can consider strategies to plan for changes in precipitation patterns, reduce the amount of sediment that gets washed into riparian systems, address increases in water temperature and associated impacts to freshwater and marine species and protect coastal resources that may be impacted by sea level rise. Furthermore, tribal staff can identify tribal cultural resources, lands and facilities that may be at risk to climate-related weather events such as floods or extreme drought. The tribe can also consider how to strengthen and use tribal water rights in a climate change context.

Tribes may find that collaborative processes can strengthen water resources planning and protection. Forming partnerships with other tribes or federal agencies can lead to comprehensive and effective management solutions. The Environmental Protection Agency is among the federal agencies that have been actively engaged with tribes regarding water resource planning and

protection in a climate change context. The agency's *2012 National Water Program Strategy*, examples of federal-tribal water management partnerships, potential funding opportunities, and various other relevant resources can be found on the EPA's *Climate Change and Water* webpage (EPA).

Another way in which tribes can protect water resources in a climate change context is by asserting water-related treaty rights. Tribes can engage with State and Federal governments to quantify and negotiate tribal water needs, revisit or further define treaty rights and set claim on water that rightfully belongs to the tribe. The Treaty Indian Tribes of Western Washington, for example, have developed a multi-media initiative known as *Treaty Rights at Risk* in which salmon-related treaty rights are kept in check and the government is held accountable¹². Their written report requests federal action to protect treaty rights by urging the government to stop the disparate treatment of Indian tribes when applying salmon conservation measures, better protect habitat, and establish federal oversight and coordination to align environmental and conservation programs to achieve salmon recovery (Treaty Indian Tribes).

References

- Cozzetto, Karen, et al. 2012. Impacts of Climate Changes on the Water Resources of American Indians and Alaska Natives in the U.S.
- Environmental Protection Agency (EPA) - Climate Change and Water. <http://water.epa.gov/scitech/climatechange/>
- National Congress of American Indians (NCAI), Native Resources - Water: <http://www.ncai.org/policy-issues/land-natural-resources/water>
- Navajo Nation Department of Water Resources (Navajo) - Water Resource Development Strategy for the Navajo Nation (Draft). http://www.tribesandclimatechange.org/docs/tribes_357.pdf
- Nez Perce Tribe Water Resources Division (Nez Perce) - Clearwater River Subbasin Climate Change Adaptation Plan. http://www.mfpp.org/wp-content/uploads/2012/03/ClearwaterRiver-Subbasin_ID_Forest-and-Water-Climate-Adaptation-Plan_2011.pdf
- Parker, Alan et al. 2006. Climate Change and Pacific Rim Nations. Evergreen State College, WA: Northwest Indian Applied Research Institute. <http://academic.evergreen.edu/g/grossmaz/IndigClimate2.pdf>
- Swinomish Climate Change Initiative (Swinomish) - Climate Adaptation Action Plan: http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- Treaty Indian Tribes of Western Washington (Treaty Indian Tribes) - Treaty Rights at Risk. [2013. http://treatyrightsatrisk.org](http://treatyrightsatrisk.org)
- United States Global Change Research Program (USGCRP) Impacts by Sector - Water Resources: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources>
- United States Global Change Research Program (USGCRP I), Regional Climate Impacts - Alaska: <http://downloads.globalchange.gov/usimpacts/pdfs/alaska.pdf>
- Washington State Blue Ribbon Panel on Ocean Acidification (WSBRPOA), Ocean Acidification: From Knowledge to Action - Washington State's Strategic Response: <https://fortress.wa.gov/ecy/publications/SummaryPages/1201015.html>
- Yeager, Codi. 2011. Where Food Grows on Water: Environmental and Human Threats to Wisconsin's Wild Rice. Circle of Blue. <http://www.circleofblue.org/waternews/2011/world/where-food-grows-on-water-environmental-and-human-made-threats-to-wisconsins-wild-rice/>

Agriculture & Rangelands

The projected increases in meteorological extremes, such as periods of drought and/or flooding, and weather unpredictability, have significant repercussions for agriculture and rangelands. Many U.S. regions are likely to see a rise in temperatures that will likely require more irrigation during the growing season. This may lead to higher production costs, as well as a strain on water resources. Periods of flooding and/or drought are also likely to significantly affect crop and livestock health, as well as deteriorate the health of rangelands, potentially forcing some in the industry to change the location or nature of their business or, in drastic cases, leave the industry altogether. Warmer winter temperatures in certain parts of the country may lead to increased difficulty managing pests that will now be more likely to survive the winter. Pests may affect crop and livestock health, impacting production and likely leading to higher production costs.

Heavy storms projected to increase in frequency and strength in many parts of the country may pose a threat to agriculture, livestock and rangelands. Tribal agricultural sectors can prepare for such events in part by reinforcing infrastructure, developing emergency plans for livestock and considering the acquisition of insurance. If agricultural production costs rise nationwide, prices are also likely to rise for the consumer. Tribes may consider finding ways to help tribal members have sustained access to local produce and livestock through the promotion of food co-operatives, community supported agriculture (CSA) programs, and/or tribal garden plots. Food co-operatives and CSA programs can result in mutually beneficial relationships between farmers and consumers. Educational programs can be developed using traditional knowledge and wisdom to inform tribal members about first foods that can be grown at home or in tribal garden plots. All of these alternatives can lead to improved food sovereignty in a climate change context. Climate change may have some positive implications for agricultural production in some parts of the country. Warmer temperatures may extend the growing season, and while some crops may become unfeasible, other crops that once couldn't grow in a given region may now become a viable alternative.

Considerations for Agriculture & Rangelands

- How can tribal agricultural and rangelands managers:
 - Adjust their practices, as well as the types of crops and livestock grown in order to be better prepared for the impacts of climate change?
 - Prepare for the potential increase in pests affecting crops and livestock?
- How can tribes prepare for the rise in food prices that may result due to climate change?
- Are there sustainable opportunities in a climate change context that tribal agriculture and rangeland sectors can capitalize upon?

Resources:

- Tribes & Climate Change: Agriculture - <http://www4.nau.edu/tribalclimatechange/basic/agricultural.asp>
- Tribes & Climate Change: Rangelands - <http://www4.nau.edu/tribalclimatechange/basic/rangeland.asp>
- United States Global Change Research Program Impacts by Sector: Agriculture- <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/agriculture>
- Washington State's Integrated Climate Response Strategy: Agriculture - <https://fortress.wa.gov/ecy/publications/publications/1201004k.pdf>

Cultural Resources

Tribal cultural resources face various threats in the face of climate change, given that environmental resources are cultural resources. Climate change has the potential to change the abundance and distribution of culturally critical species, affecting tribes' ability to practice traditional activities and sustain economies dependent on natural resources. Extreme weather resulting from climate change may also degrade ecosystems, impact sacred sites, and affect tribal access to culturally vital resources and places. Indigenous diets have historically been comprised of a variety of plant and animal species that are regionally available. These foods, often referred to as traditional, or first foods, promote health and vitality in indigenous communities and form an important part of cultural traditions. The ability to harvest traditional foods may be compromised in a climate change context if certain species decrease in abundance in tribal territory. This impact to food security and sovereignty may have health repercussions, especially if first foods are replaced with highly processed substitutes. Additionally, cultural traditions may be impacted if the foods that have a vital role in such traditions become scarce.

Tribal property may be under threat in a climate change context given the increased likelihood of floods, wildfire and higher sea levels. These may lead to loss of lands and damage to tribal infrastructure. The rapid changes that climate change is likely to bring to ecosystems across the U.S. also have implications for traditional ecological knowledge (TEK). TEK has historically evolved along with the landscapes in which indigenous peoples navigate and live. TEK has made indigenous peoples resilient through millennia particularly because it adapts to the changing landscapes. The rapid changes brought about by climate change may make certain elements of TEK less relevant or obsolete and may require modifications to beliefs and practices in order to align traditional knowledge systems to rapidly changing landscapes.

Considerations for Cultural Resources

- What measures can be taken by tribal cultural resources managers to protect tribal economies, lands, resources and infrastructure in the face of climate change?
- How can tribal cultural resources managers:
 - Identify/plan for changes in quantity and composition of plant and animal species.
 - Reduce the impacts that climate change may have on traditional foods?
 - Monitor and plan for impacts to sacred sites and resources?
 - Incorporate traditional ecological knowledge into climate change adaptation?

Resources:

- Exploring the Role of Traditional Ecological Knowledge in Climate Change Initiatives - <http://tribalclimate.uoregon.edu/publications/>
- First Foods and Climate Change - <http://tribalclimate.uoregon.edu/tribal-profiles/first-foods-and-climate-change/>
- Karuk Tribe: Integrating Traditional Ecological Knowledge within Natural Resource Management - <http://tribalclimate.uoregon.edu/tribal-profiles/karuk-profile/>
- Swinomish Climate Change Adaptation Plan: Cultural Traditions and Community Health (p.13-25) - http://www.swinomish-nsn.gov/climate_change/climate_main.html
- Tribes & Climate Change: Species - <http://www4.nau.edu/tribalclimatechange/basic/species.asp>
- United States Global Change Research Program Impacts by Sector: Ecosystems- <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/ecosystems>

- Washington State's Integrated Climate Response Strategy: Ecosystems, Species and Habitats - <http://www.ecy.wa.gov/pubs/1201004g.pdf>
- Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation - <http://unesdoc.unesco.org/images/0021/002166/216613e.pdf>

Tribal Planning and Development

Climate change impacts may pose risks to various critical resources and infrastructure found within the boundaries of tribal master plans, and planning initiatives can ensure that vulnerable resources and infrastructure are protected. Planning future development with climate change in mind can save tribes long-term financial and administrative challenges.

In some parts of the country, such as the Pacific Northwest, climate change is likely to increase the amount of stormwater during the winter and spring months, while decreasing stormwater in the summer months. Additionally, heavy storms are projected to increase in frequency in most parts of the country. This may lead to overtaxed stormwater management systems. When developing and updating master plans, drainage routes and water storage areas can be designed or preserved to avoid future flooding and maximize proper water routing and infiltration. Ensuring that water infiltrates into the ground as quickly and as often as possible helps keep water tables replenished, which can better prepare tribes during the drier months.

In parts of the country where drought is projected to worsen, such as in the Southern U.S., master plans can incorporate strategies to reduce water use and increase storage. Designing landscapes that require little to no irrigation and ensuring water infiltration into the water table are some strategies that can help reduce water consumption and reduce the impacts of drought. Tribal communities can also explore strategies to store large quantities of water in preparation for dry months.

In Arctic regions, climate change is already melting the permafrost that provides structural stability for many buildings and infrastructure. Alaska Natives can account for this threat in planning efforts by strategically situating new buildings, roads and other infrastructure, and by exploring construction strategies that reduce the impacts of permafrost melt. In extreme cases, Alaska Native villages might have to consider relocation.

The heavy storms projected to increase with climate change are also likely to increase the amount of weather-related hazards and emergencies. Master plans can protect tribal resources and the safety of tribal citizens, as well as provide effective routes for the emergency response team, by carrying out thoughtful emergency planning when updating/ revising existing master plans.

Master planning can also better prepare tribes by strategically locating and orienting tribal buildings and infrastructure. By applying sustainable architecture, landscape architecture and planning principles, tribal buildings can reduce energy consumption, appropriately manage stormwater, and protect surrounding resources. Traditional knowledge can inform these sustainable practices.

Perhaps the most important climate change implication for master planning is in the potential threats to fragile species and environments. Climate change may already tax vulnerable species and ecosystems that are important to tribes. Planning initiatives can help anticipate and prepare for impacts to these species and ecosystems by ensuring that they are not disturbed by poorly situated development.

Considerations for Tribal Planning and Development

- How can tribal planning efforts account for projected climate change impacts when updating/adding to existing plans?
- How can tribal planning initiatives:
 - Ensure that vulnerable environments and species are protected and not further impacted by development?
 - Account for sufficient stormwater storage in the event of heavy storm events?
 - Apply water-efficient strategies to prepare tribes for times of drought?
 - Incorporate emergency management and disaster mitigation strategies?
 - Promote energy-efficient tribal buildings and infrastructure?

Resources:

- Coquille Climate Change Action Plan (PNW Tribal Climate Change Plan) - <http://tribalclimate.uoregon.edu/tribal-profiles/coquille/>
- Relocation of Alaska Native Villages (PNW Tribal Climate Change Project) - <http://tribalclimate.uoregon.edu/tribal-profiles/relocation-of-alaska-native-villages/>
- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.64-67) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- United States Global Change Research Program Impacts by Sector: Energy Supply and Use - <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/energy-supply-and-use>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Development Guidelines and Building Standards

Existing tribal guidelines and standards may require updates in a climate change context. It is likely that climate change impacts will require new guidelines and standards, in order to prepare for and protect tribes from new stresses. "Best practices" frameworks can be established that guide tribal planning when preparing for and adapting to climate change impacts.

Heavy storms are projected to increase in many regions of the country. In the Arctic, warmer temperatures threaten to melt the permafrost that makes soils structurally sound. These changes may lead to a higher likelihood in damages to buildings and infrastructure, subsequently affecting citizen safety. Guidelines and standards can promote hardy structures and development that can withstand the effects of strong storms and melting permafrost, reduce climate-related damages and emergencies, and provide ample space and resources for emergency response.

Climate change is likely to bring warmer summer temperatures to most U.S. regions, increasing the demand for cooling in buildings. In such cases, energy consumption is likely to rise, reducing sustainability and leading to higher energy expenditures. There are planning, architecture and landscape architecture strategies that can be used to create heating and cooling-efficient buildings. Existing buildings can be retrofitted to improve efficiency. Guidelines can be established that promote these energy-efficient strategies in new and existing development.

In regions that typically receive snow, higher temperatures are likely to catalyze snowmelt and increase early spring streamflow and other forms of drainage, potentially overwhelming natural and manmade drainage systems. In some regions there is also the potential for increased precipitation, and as mentioned, heavy storms, which may also tax drainage systems. "Best Practices" frameworks can ensure that urban and rural drainage structures, such as storm drains and roadside swales, are retrofitted or built to compensate for these flash flood-type situations.

Some regions, such as the Southern U.S., are projected to experience more frequent periods of severe drought. Tribes residing in such regions can prepare by establishing tribal guidelines that promote water efficiency and storage. Encouraging water-efficient fixtures in residences and businesses, promoting water-efficient landscaping and the use of water storing mechanisms such as rain barrels and cisterns, and informing tribal members about water-efficient practices can help tribes reduce the impacts of drought.

Considerations for Development Guidelines and Building Standards

- How can tribes:
 - take potential climate change impacts into account when updating/writing tribal guidelines and standards?
 - incorporate traditional knowledge into the development of community guidelines and building standards?
 - ensure that tribal development follows new and revised guidelines and standards that account for climate change impacts?
 - inform tribal members about new guidelines and standards that assist in preparing for and adapting to climate change?

- How can tribal guidelines and building standards ensure that future development doesn't exacerbate climate change impacts?
- What tribal guidelines and building standards can be applied to promote energy-efficient, sustainable development in a climate change context?

Resources:

- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.64-67) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Energy

The energy sector is the largest producer of greenhouse gases. Adjusting the way energy is produced and used can mitigate the impacts of climate change by reducing emissions. Tribes can explore sustainable energy alternatives that can reduce tribal dependency on fossil fuels. In addition, tribes can explore ways in which energy consumption can be reduced by making businesses, industry, and residences more energy-efficient.

Climate change has the potential to affect energy outputs, either positively or negatively, depending on the region and the type of energy production. Hydroelectric power is a renewable energy source that could have increased or decreased productivity depending on the region and time of year. In some parts of the country, precipitation may increase in the winter, subsequently increasing streamflow and energy production. Alternatively, streamflows may decrease in the summer, thereby reducing energy production. Other forms of energy production dependent on specific meteorological events, such as wind or solar energy, may also experience productivity changes. Tribes can examine the viability of existing and future forms of energy production and ensure they will meet long-term tribal goals.

Climate change is likely to bring higher temperatures to most U.S. regions, potentially decreasing energy demand in the winter, but increasing the demand for cooling during the warmer months. This increase in the demand for energy to help cool homes and businesses may come at a time when climate change impacts challenge energy supply, especially if supply is associated with hydroelectric power. Tribes can reduce summer energy demands by encouraging the use of passive cooling strategies in residences, businesses and landscapes.

Energy production and delivery systems may be threatened by climate change impacts such as extreme weather and sea level rise. Flooding, extreme heat, and heavy winds may compromise energy infrastructure, threatening energy supply and possibly leading to more frequent blackouts. Ensuring that energy infrastructure is made of durable materials that can withstand extreme weather events will reduce the risk of energy supply disruption. Additionally, the strategic situation of new energy infrastructure can prevent future challenges.

If energy production becomes more costly as a result of climate change, energy expenditures are likely to increase for tribal members. Tribes can inform tribal members about ways to reduce energy consumption in both residences and businesses. Additionally, tribes can provide tribal cooling shelters in regions of extreme heat so that residents who can't afford to sufficiently cool their homes have a place to escape the heat during the hottest hours of the day.

Considerations for Energy

- How can tribal energy programs:
 - Reduce tribal greenhouse gas emissions?
 - Reduce tribal dependence on fossil fuels and transition to renewable forms of energy?
 - Ensure that existing tribal energy production will be viable long-term?
 - Encourage energy-efficient businesses, residences and industry?
 - Ensure that energy infrastructure is built with durable materials?

- Strategically situate new energy infrastructure to prevent weather-related damage?
- Protect tribal members from rising energy costs?

Resources:

- [Center for Energy and Climate Solutions: Science and Impacts](http://www.c2es.org/science-impacts) - <http://www.c2es.org/science-impacts>
- Department of Energy Tribal Energy Program - <http://apps1.eere.energy.gov/tribalenergy/>
- The Lummi Nation: Pursuing Clean Renewable Energy (PNW Tribal Climate Change Project) - <http://tribalclimate.uoregon.edu/the-lummi-nation-pursuing-clean-renewable-energy/>
- Siletz Tribal Energy Program (PNW Tribal Climate Change Project) - <http://tribalclimate.uoregon.edu/tribal-profiles/siletz-tribal-energy-program/>
- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.71-72) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- Tribal Energy and Environmental Information Clearinghouse - <http://teeic.anl.gov>
- United States Global Change Research Program Impacts by Sector: Energy Supply and Use - <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/energy-supply-and-use>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Housing

The increase in severe weather that is projected to occur in many parts of the country will call for residential buildings that can withstand heavy storms and temperature extremes. New housing can be planned and constructed with extreme weather in mind, situated in a safe location, and built durably with resilient materials. Existing housing can be retrofitted to withstand extreme weather, reducing storm damage and protecting residents.

In Arctic regions, melting permafrost threatens the structural stability of many homes. As permafrost melts and soil collapses due to the absence of ice, houses situated on these soils may shift or even collapse. Alaska Natives can assess the stability of existing homes and address some of these threats through architectural retrofits. Additionally, the condition of the permafrost layer can be taken into account when building new houses or situating new residential areas. In extreme cases, permafrost melt might call for the relocation of Alaska Native villages.

In regions where climate change is projected to threaten housing, it is important for American Indians and Alaska Natives to help indigenous homeowners and renters prepare by considering the acquisition of proper insurance that financially protect residents in the event of storm and flood-related damage to property. Tribes can inform tribal members about the types of insurance available and help promote access to affordable insurance options.

Climate change is likely to bring higher temperatures to most U.S. regions, increasing the demand for residential cooling during the warmer months. Tribes can reduce the impacts on energy systems by incorporating passive cooling, as well as passive heating and lighting into new and existing housing. Residential landscapes too can be modified to passively control winter and summer temperature extremes. This can help reduce homeowners' energy consumption, saving on costs and reducing the burden on the energy grid. Ensuring that tribal homeowners can afford to properly cool their homes can also reduce the threat of heat-related illness.

Because water shortages may become more common during the warmer months, especially in the South, it is important for tribes in such regions to facilitate the incorporation of water efficient fixtures and appliances in both existing and new homes. Whenever possible, residential landscapes can incorporate native plants that don't require much irrigation. Water storage mechanisms, such as cisterns or rain barrels, can also be encouraged in residential settings to supplement certain water uses.

Some of the most important climate change implications for the tribal housing relate to the selection of new housing development locations. An increase in heavy storms may lead to more frequent floods. Additionally, warmer, drier summers may lead to a higher frequency of wildfires. New developments can honor natural drainage patterns and give ample room for water to rise and fall in order to avoid flood damage in the future. New developments should also take into consideration the increased potential for wildfire. Additionally, heavy storms may increase erosion and the frequency of landslides.

When selecting the location for new housing developments it is also important to ensure the protection of natural resources that are already vulnerable, be it as a result of climate change or

some other factor. Development can be taxing to ecosystems and species, and it is important for the tribal housing programs to keep these impacts to a minimum.

Considerations for Housing

- How can tribal housing efforts:
 - Ensure the use of resilient building materials that can withstand future climate change impacts?
 - Provide assistance to help tribal members retrofit existing residences in preparation for climate change impacts?
 - Ensure that future residential developments are situated in climate change savvy locations?
 - Promote energy and water-efficiency in both existing and future residences?
 - Develop residential design guidelines that call for housing and landscapes that are designed with climate change in mind?
 - Ensure tribal access to home insurance, and to inform tribal residents about home insurance options?

Resources:

- Indigenous Housing Gateway - <http://indigenoushousing.org/EmergencyManagementUnitedStates>
- Relocation of Alaska Native Villages (PNW Tribal Climate Change Project) - <http://tribalclimate.uoregon.edu/tribal-profiles/relocation-of-alaska-native-villages/>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment_- <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Transportation

Climate change has the potential to affect transportation infrastructure in a number of ways. An increase in the likelihood of severe weather and wildfires may damage or destroy roads, make travel routes impassible, and cause weather-related accidents. This can pose problems not just for travelers, but also for emergency vehicles that are trying to respond to a given emergency.

Sea levels are predicted to rise with climate change, potentially threatening transportation infrastructure along coasts. Streams too are likely to be affected by climate change, fluctuating from high water levels in the winter, to low water levels in the summer, making them more challenging to navigate.

In Arctic regions, melting permafrost threatens the structural stability of ground transportation routes. As permafrost melts and soils shift or collapse due to the absence of ice, roads, landing strips and other ground transportation infrastructure are threatened. Alaska Natives can assess the stability of existing transportation infrastructure and determine which routes need repair, retrofits or, in extreme cases, complete re-routing. Transportation plans can take permafrost melt into account when siting and building new infrastructure in an effort to prevent future damage.

An increase in heavy storms may overwhelm current stormwater management infrastructure along streets and roads. Additionally, heavy storms may lead to an increase in erosion and landslides, compromising the stability of transportation routes on or near unstable ground. The severe weather that is predicted to increase with climate change is likely to impact the reliability of most forms of transportation.

As climate change takes its toll and scarce petroleum reserves lead to higher gas prices, tribes may consider investigating alternative fuels and forms of transportation. Tribes can reduce greenhouse gas emissions by exploring alternative energy sources and alternative methods and less carbon-intensive forms of transportation.

Considerations for Transportation

- How can tribal transportation:
 - Monitor and prepare for the impacts that climate change may have on transportation routes and infrastructure?
 - Plan for emergency vehicle access in weather-related emergencies?
 - Explore alternatives to fossil fuels?
 - Facilitate alternative transportation and reduce greenhouse gas emissions?

Resources:

- AASHTO Transportation and Climate Change Resource Center - <http://climatechange.transportation.org>
- DOT Transportation and Climate Change Clearinghouse - <http://www.climate.dot.gov/>
- EPA Transportation and Climate Change - <http://www.epa.gov/otaq/climate/index.htm>
- Federal Highway Administration and Climate Change - http://www.fhwa.dot.gov/environment/climate_change/index.cfm
- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.64-67) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf

- United States Global Change Research Program Impacts by Sector: Transportation - <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/transportation>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Telecommunications

Telecommunications infrastructure faces risks in the face of climate change as a result of heavier, more frequent storms, flooding, and wildfires. Severe weather, wildfires and flooding can damage infrastructure and cause service outages, potentially threatening telecommunications networks. Additionally, heavy rainstorms and extreme temperatures can affect the quality and range of wireless signals.

It is important for tribal telecommunications to prepare for the possibility of severe weather by ensuring the use of resilient materials in telecommunications infrastructure, and by situating such infrastructure in strategic locations that are less likely to flood or be at risk of wildfire. This will reduce the risk of infrastructure damage and thereby reduce the likelihood of telecommunications costs rising for tribal customers.

It is also important for tribal telecommunications to assess how to best cope with potential service disruption in the event of an outage. Tribes may want to consider establishing alternative communication strategies that can be used in the case of an outage.

Power outages resulting from severe weather can lead to lost digital data, resulting in setbacks to businesses, governments and individuals. It is important for tribal telecommunications to explore mechanisms to ensure the protection of vital data that is stored within telecommunications networks.

Considerations for Telecommunications

- How can tribal telecommunications:
 - Ensure that telecommunications infrastructure is made from resilient materials that can withstand the impacts of climate change?
 - Ensure that the quality and range of wireless signals are as little affected as possible by the impacts of climate change?
 - Reduce the risk of digital data loss in the event of a power outage?
- What measures can tribal telecommunications take to cope with service disruption in the event of an outage?
- Can alternative communication strategies be developed that can be used in the case of an outage, especially during emergencies?

Resources:

- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.71-72) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Economic Development

Climate change poses threats to the infrastructure and natural resources that are vital to tribal economies, and therefore there are climate change implications for tribal economic development.

Climate change has the potential to change the quantity and distribution of economically important plant and animal species, affecting business endeavors that rely on these resources for revenue. Tribal businesses and investors must foresee these potential economic impacts and seek viable alternatives.

Rising temperatures and changes in precipitation patterns may affect business enterprises rooted in plant production and agriculture. The higher summer temperatures projected in many parts of the country, coupled with a higher likelihood of summer drought, may affect production and require higher rates of irrigation. Tribal enterprises can prepare by foreseeing these likely challenges and developing strategies to maintain a sustainable business over the long-term. In extreme cases, some enterprises may no longer be feasible in geographic locations where they once thrived.

A higher likelihood of extreme weather means that tribal buildings and infrastructure are at a higher risk of weather-related damage, affecting the stability of tribal investments and leading to a higher likelihood of tribal expense accrual related to the repair and/or relocation of affected structures. It is important to assess which buildings and infrastructure are most vulnerable, and consider which planning and adaptation measures will be most cost-effective and sustainable.

Similarly, when planning new businesses and investments, it is important to do so with climate change impacts in mind. Site selection, design and construction can take projected climate change impacts into consideration to avoid costly damages and high operation costs in the future.

Tribes whose economy is highly reliant on one or two major industries are highly susceptible in a climate change context. If climate change affects one of these industries, much of the tribe's economy is devastated. Tribes with diversified economies are likely to be more resilient in the face of climate change, given that the local revenue is distributed across a variety of enterprises. If one fails due to climate change, there are still several others in place to hold up the economy.

In the face of climate change, tribes may find that there are not only negative economic impacts, but also economic opportunities. Communities can invest in industries that mitigate climate change, such as renewable energy and sustainable transportation alternatives. These are likely to be economically fruitful long-term while at the same time improving communities' ability to reduce greenhouse gas outputs.

Considerations for Economic Development

- How can tribal economic development:
 - Gauge local businesses, tribal infrastructure and other investments are most susceptible to climate change impacts?
 - Provide incentives to incorporate climate change mitigation and adaptation strategies in the design of commercial buildings and projects and within local businesses?

- What measures can tribal economic development take to expand, diversify and secure the tribal economy in a climate change context?

Resources:

- Center for Climate and Energy Solutions: Economics - <http://www.c2es.org/economics>
- Organization for Economic Co-operation and Development: Economic Aspects of Climate Change - <http://www.oecd.org/env/climatechange/oecdworkonadaptationtoclimatechange.htm>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Health

One of the climate change impacts that is likely to pose a threat to human health is the projected increase of high temperatures during the summer. This may lead to a higher likelihood of heat-related illnesses, such as heatstroke. The likely increase in high intensity storms and wildfires means that human health is also likely to suffer as a result of storm and fire-related injuries, or even death. Frequent fires are also likely to negatively impact air quality in some parts of the country, and thus have the potential to cause or worsen respiratory conditions such as asthma. The elderly, children, and chronically ill individuals are especially vulnerable when it comes to health, and will require special attention as tribes prepare for the health impacts of climate change.

It is projected that precipitation will be less reliable and more extreme in many U.S. regions, with heavy precipitation during the cold months, and more frequent droughts during the warmer months. Declining springtime snowpack in regions that tend to get snow could lead to reduced streamflow during the warm months. As a result, water supply could be affected, threatening human health. Additionally, climate change has the potential to deteriorate water quality by increasing water temperatures and promoting the presence of algal blooms, some of which can be dangerous to human health when consumed or bathed in.

Warmer winter temperatures and a higher likelihood of extreme weather events and flooding may lead to a higher prevalence of infectious diseases, including insect-borne diseases, and diseases transmitted through contaminated water and/or food. An increase in extreme weather may also lead to an increase in the frequency of power outages, which may affect patients who rely on electricity-dependent machines, such as those used for dialysis.

Climate change may cause shifts in the quantity and distribution of plant and animal species, which could affect tribal first foods and make them more difficult to find and harvest. This could have serious health implications for tribal members who depend on first foods to maintain a healthy diet. Heart disease and diabetes could become more prevalent as a result of the decrease in the consumption of traditional foods, especially if they are replaced by highly processed substitutes.

The stresses associated with the impacts of climate change may lead to emotional trauma and effects to mental health. The increased likelihood of extreme weather events and storm damage to communities, the possible impacts on the economy, the increased likelihood of other health issues, and the possibility of witnessing substantial environmental deterioration may all contribute to a decline in mental health and emotional well-being. Problems such as depression, post-traumatic stress disorder and alcohol and drug abuse may become more prevalent as a result of climate change impacts.

Considerations for Health Services

- How can tribal health services:
 - Reduce the health impacts posed by climate change?
 - Protect vulnerable tribal members, such as children and the elderly, from climate change-related health impacts?

- Keep tribal communities informed about new (or exacerbated) health threats posed by climate change?
- Prepare tribal communities for the potential decrease in the availability of first foods?
- Ensure that tribal members have access to clean water and safe foods?
- Prepare for power outages affecting elderly and chronically ill patients requiring life support systems dependent on electricity?
- How can tribal health practitioners and facilities best prepare themselves for the likely increase in certain health problems associated with the impacts of climate change?

Resources:

- Alaska Native Tribal Health Consortium: Center for Climate and Health - <http://www.anthc.org/chs/ces/climate/>
- Center for Disease Control and Prevention Climate and Health Program - <http://www.cdc.gov/climateandhealth/effects/default.htm>
- EPA Human Health Impacts and Adaptation - <http://www.epa.gov/climatechange/impacts-adaptation/health.html>
- First Foods and Climate Change (PNW Tribal Climate Change Project) - <http://tribalclimate.uoregon.edu/tribal-profiles/first-foods-and-climate-change/>
- Swinomish Climate Change Adaptation Plan: Physical Health (p.59-63) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- United States Global Change Research Program Impacts by Sector: Human Health- <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/human-health>
- Washington State's Integrated Climate Response Strategy: Human Health - <http://www.ecy.wa.gov/pubs/1201004f.pdf>

Emergency Management and Public Safety

Climate change may lead to higher weather unpredictability, heavier storms, wildfire, floods, and droughts, significantly increasing the likelihood of weather-related emergencies. It is important for tribes to prepare for emergencies in an effort to ensure the safety of tribal residents and the protection of tribal property.

Among the potential impacts that may threaten tribal lands and citizens is the higher likelihood of wildfires as a result of warmer and drier summers in many parts of the country, combined with an increase in pests affecting tree health. Wildfires can destroy property and endanger lives. Additionally, wildfires may block transportation routes and challenge visibility, affecting travel and emergency response access.

Sea levels are predicted to rise with climate change, potentially threatening transportation infrastructure along coasts. Streams too are likely to be affected by climate change, becoming more challenging to navigate due to fluctuations from high water levels in the winter, to low water levels in the summer. These impacts have the potential to place citizens in danger and once again make emergency access challenging.

In addition, extreme weather is likely to be more frequent. Heavy storms may contain strong winds and lead to floods, potentially causing damage to private property and tribal infrastructure. Power outages may also be more likely as a result of extreme weather events, potentially affecting telecommunications, and threatening heating and cooling systems.

Human health-related emergencies are also likely to increase as a result of climate change. Wildfires and extreme weather can lead to citizen injury. Warmer summer temperatures may lead to an increase in heat-related health problems, such as heat stroke and dehydration, especially if power outages affect the use of air conditioning. Additionally, power outages resulting from heavy storms may lead to interruptions to life-supporting medical technologies on which the elderly and the chronically ill depend on to survive.

Strategies for disaster management can focus on emergency response plans in the event of a number of likely emergency scenarios, including wildfire, flooding, drought, extreme heat, and extreme storms. These plans would include the provision of emergency tribal shelters and supplies (such as water), alternate transportation routes, emergency vehicle response access, and alternate communication strategies. In addition, these plans should consider the possibility of power outages that can jeopardize life-support systems for the sick and the elderly.

Climate change is projected to increase the frequency and strength of heavy storms, increasing the likelihood of storm damage caused by heavy winds and flooding. Roads can get flooded, or blocked by downed trees and infrastructure, fire or smoke, affecting transportation routes and potentially disrupting emergency response and evacuation efforts. It is important for disaster management/ emergency response to work closely with tribal transportation planning to plan alternate transportation routes in the event that primary transportation routes are blocked or flooded during a weather-related emergency. It is also important for the two departments to adequately plan for emergency vehicle access in emergency scenarios.

Disaster management/ emergency response strategies can be coordinated with tribal telecommunications to develop alternative forms of communication in the event that severe weather affects the functionality of primary telecommunications.

Disaster management/ emergency response can also be closely connected with tribal police and public safety services to ensure that tribes are sufficiently staffed and equipped to respond to community-wide emergencies. Educational campaigns can inform tribal members about emergency response plans to ensure that they are prepared and know how to respond when an emergency occurs. Practice drills can be arranged to further prepare the tribe.

Considerations for Disaster Management and Emergency Response

- How can tribes prepare for the community-wide emergencies that are more likely to occur as a result of climate change?
- What tribal departments have responsibilities related to disaster management and emergency response, and can coordinate to ensure that efforts are as effective as possible?
- How can tribes plan for alternative transportation and communication strategies in the event that primary transportation routes and telecommunications are compromised by an emergency?
- What measures can tribes take to ensure they are sufficiently staffed and equipped to respond to community-wide emergencies?
 - Ensure emergency vehicle access in weather-related emergencies?
 - Plan for service outages in weather-related emergencies?
- How can tribes inform tribal residents about emergency response plans to ensure residents know how to respond when an emergency actually occurs?

Resources:

- FEMA Indian Country Resources - <http://www.ready.gov/indiancountry>
- Swinomish Climate Change Adaptation Plan: Community Infrastructure and Services (p.64-67) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- Swinomish Climate Change Adaptation Plan: Physical Health (p.59-63) - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf
- United States Global Change Research Program Impacts by Sector: Human Health - <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/human-health>
- Washington State's Integrated Climate Response Strategy: Human Health - <http://www.ecy.wa.gov/pubs/1201004f.pdf>
- Washington State's Integrated Climate Response Strategy: Infrastructure and the Built Environment - <http://www.ecy.wa.gov/pubs/1201004m.pdf>

Climate Change Law and Policy Issues

Climate change may affect tribal resources and treaty rights in various ways, and it is becoming increasingly important to examine tribal rights in a climate change context to protect tribal culture and resources. The Federal government has an obligation to engage in a Government-to-Government relationship with federally-recognized tribes, as specified by President Clinton's 1994 Memorandum on *Government to Government Relations with Native American Tribal Governments*. Key principles defining the Government-to-Government in this memorandum include the following:

- *Each executive department and agency shall assess the impact of Federal government plans, projects, programs, and activities on Tribal trust resources and assure that Tribal government rights and concerns are considered during the development of such plans, projects, programs and activities.*
- *Each executive department and agency shall consult, to the greatest extent practicable and to the extent permitted by law, with Tribal governments prior to taking actions that affect Federally recognized Tribal governments. All such consultations are to be open and candid so that all interested parties may evaluate for themselves the potential impact of relevant proposals.*

The Federal Indian trust responsibility includes a fiduciary obligation on the part of the Federal government to protect tribal treaty rights, lands, assets, and resources. Climate change impacts and proposed solutions may have implications on tribal lands, assets and resources.

Climate change is also likely to increase interaction and collaboration between traditional knowledge holders and Western scientists. Such interactions and collaborations can lead to mutual understanding between practitioners, communities and governments, and can lead to climate change assessment and adaptation plans that meet the needs of both tribal and non-tribal communities. However, it is important that traditional knowledge be protected during collaborative processes to avoid the misappropriation and exploitation of this knowledge. Tribes can take measures to protect traditional knowledge anytime the tribe plans on sharing this knowledge with non-tribal parties, such as having non-tribal parties sign legally binding agreements that ensure the information shared will not be misappropriated.

Considerations for Climate Change Law and Policy

- How can tribes prepare for the legal and policy issues associated with climate change?
- How will treaty rights be affected by the impacts from climate change?
- What measures can tribes take to protect traditional knowledge?

Resources:

- The Government-to-Government Relationship in a Changing Climate: A review of federal consultation policies - http://tribalclimate.uoregon.edu/files/2010/11/consultation_report_2-22-20122.pdf
- Government-to-government relations with Native American tribal governments - <http://www.gpo.gov/fdsys/pkg/WCPD-1994-05-02/pdf/WCPD-1994-05-02-Pg936.pdf>

Climate Change Vulnerability Assessments

The climate change implications listed for each tribal sector above are based on broad climate change projections. Comprehensive climate change vulnerability assessments are necessary to understand specific climate change impacts and more direct effects on tribal sectors, cultural resources and traditional ways of life.

Climate Change Vulnerability Assessments first determine the projected climate change impacts for a given region. Once the projected impacts have been determined, the climate change vulnerability of natural and cultural resources can be assessed. The vulnerability of a given resource is often determined based on projected exposure to impacts, sensitivity to impacts and the capacity to adapt to impacts. Resources can be categorized from most to least vulnerable, helping tribal resource managers establish climate change priorities. Tribes can opt to follow up Vulnerability Assessments with formal Climate Change Adaptation Plans.

Resources:

- Ecosystem-based Management Tools Network: Climate Change Vulnerability Assessment and Adaptation Tools - <http://www.ebmtoolsdatabase.org/resource/climate-change-vulnerability-assessment-and-adaptation-tools>
- Indigenous Peoples' Biocultural Climate Change Assessment Initiative - <http://ipcca.info/>
- Preparing for Climate Change: A Guidebook for Local, Regional and State Governments - <http://www.cses.washington.edu/db/pdf/snoveretalgb574.pdf>
- Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment - <http://www.nwf.org/~media/PDFs/Global-Warming/Climate-Smart-Conservation/NWFScanningtheConservationHorizonFINAL92311.ashx>
- Swinomish Climate Change Adaptation Plan - http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf

Climate Change Adaptation Planning Resources

- **AASHTO Transportation and Climate Change Resource Center -**
<http://climatechange.transportation.org>
AASHTO's Sustainable Transportation: Energy, Infrastructure, and Climate Solutions Technical Assistance Program is designed to assist state DOTs understand the potential effects of climate change and the range of strategies and options for climate change mitigation and adaptation.
- **Adapting to Climate Change in Coastal Alaska (Alaska Sea Grant Marine Advisory Program) -**
<https://seagrant.uaf.edu/map/climate/>
- The Alaska Sea Grant Marine Advisory Program (MAP) project brings a marine-dependent community perspective to climate change adaptation issues. The project is supported by the Alaska Center for Climate Assessment and Policy (ACCAP). This webpage includes links to fact sheets describing current and projected climate change impacts, as well as links to adaptation planning tools.
- **Alaska Native Tribal Health Consortium: Center for Climate and Health -**
<http://www.anthc.org/chs/ces/climate/>
Global warming is rapidly changing the environment and the lives of Arctic people. Climate change is increasing the risk for injury and disease and damaging health infrastructure such as water systems. The Alaska Native Tribal Health Consortium's Center for Climate and Health helps people to understand climate change impacts.
- **Center for Climate and Energy Solutions -** <http://www.c2es.org>
The Center for Climate and Energy Solutions is an independent, nonpartisan, nonprofit organization working to advance strong policy and action to address the twin challenges of energy and climate change.
 - Economics - <http://www.c2es.org/economics>
 - Science and Impacts - <http://www.c2es.org/science-impacts>
- **Center for Disease Control and Prevention Climate and Health Program -**
<http://www.cdc.gov/climateandhealth/effects/default.htm>
The CDC climate and public health framework was established in 2006, due to a recognition by several scientists that there was a need to prepare for the inevitability of climate change, and the impact it would likely have on the health of US residents and the world population in general. In FY2009, CDC formally established its Climate and Health Program. The website provides a brief overview of the likely health effects of increased temperatures and extreme weather events.
- **Clearwater River Subbasin Climate Change Adaptation Plan (Nez Perce Tribe Water Resources Division) -** http://www.mfpp.org/wp-content/uploads/2012/03/ClearwaterRiver-Subbasin_ID_Forest-and-Water-Climate-Adaptation-Plan_2011.pdf
This project came about because the Nez Perce Tribe Water Resources Division recognized the need for increased awareness of climate change issues in the Clearwater River Subbasin. The main emphasis of this climate change adaptation plan is on forest and water resources, as well as the potential economic impacts of climate change on those resources. The goal of the plan is to act as a catalyst for the regional community to begin developing and implementing detailed adaptation strategies in order to better withstand the impacts of a changing climate upon the natural resources, economy and social structure.

- **Climate Change Adaptation Planning Trainings for Tribes -** <http://www4.nau.edu/itep/climatechange/>
 ITEP offers training to tribal environmental professionals to build their capacity to address climate change issues. The courses are taught by instructional teams that include staff from ITEP, federal agencies, universities, and/or organizations, and most importantly, the tribes themselves, who share their expertise and experience. Course offerings include Climate Change on Tribal Lands and Climate Change Adaptation Planning.
- **Climate Change and Fisheries and Habitat Conservation (U.S. Fish & Wildlife Service) -** <http://www.fws.gov/fisheries/cefhc.html>
 Site lists some of the initiatives that being taken by the Division of Fisheries and Habitat Conservation to address climate change, specifically in terms of aquatic resources and habitat.
- **Climate Change Planning Tools for First Nations Guidebooks (Centre for Indigenous Environmental Resources) -** www.cier.ca/information-and-resources/publications-and-products.aspx?id=412
 Includes six Guidebooks, each of which develops an important part of the planning process and is a precursor to the next guidebook. They contain: suggestions of how a First Nation might plan for climate change, how to involve the community, and activities that a First Nation can use to involve members of the community to set priorities and achieve them.
- **Coquille Climate Change Action Plan (PNW Tribal Climate Change Plan) -** <http://tribalclimate.uoregon.edu/tribal-profiles/coquille/>
 In 2008, the Coquille Indian Tribe established a Climate Change Committee to engage tribal government, tribal members, and natural and cultural resource managers in the development of a Climate Change Action Plan. This profile highlights key concerns and potential climate change impacts to the Coquille Tribe, and initial tribal strategies to address climate change.
- **DOT Transportation and Climate Change Clearinghouse -** <http://www.climate.dot.gov/>
 The Transportation and Climate Change Clearinghouse is designed as a one-stop source of information on transportation and climate change issues. It includes information on greenhouse gas (GHG) inventories, analytic methods and tools, GHG reduction strategies, potential impacts of climate change on transportation infrastructure, and approaches for integrating climate change considerations into transportation decision making.
- **DOE Tribal Energy Program -** <http://apps1.eere.energy.gov/tribalenergy/>
 The U.S. Department of Energy's Tribal Energy Program provides financial and technical assistance that enables tribes to evaluate and develop their renewable energy resources and reduce their energy consumption through efficiency and weatherization. The program also offers education and training opportunities designed to foster clean energy technology adoption, promote green jobs and growth, and strengthen native communities.
- **Drought-Ready Communities: A Guide to Community Drought Preparedness (National Drought Mitigation Center) -** <http://www.drought.unl.edu/Planning/PlanningProcesses/DroughtReadyCommunities.aspx>
 The process outlined in this Guide is broad-based, recognizing that drought creates problems that go beyond the scope of what water suppliers alone can address. Worksheets and other exercises can help communities see how drought has affected water supplies and overall community well-being in the past. The Guide can also help communities identify their drought monitoring resources, so they can spot emerging drought. A planning section helps communities determine steps they can take to reduce their drought risk ahead of time. It also recommends planning responses to drought before the next

one happens. The Guide includes case studies and an extensive resource collection on how other municipalities have planned for drought, including both processes and solutions.

- **Ecosystem-based Management Tools Network: Climate Change Vulnerability Assessment and Adaptation Tools** - <http://www.ebmtoolsdatabase.org/resource/climate-change-vulnerability-assessment-and-adaptation-tools>

The Ecosystem-based Management Tools Network is an online hub for tools and projects for innovative interdisciplinary coastal-marine spatial planning and ecosystem-based management. The Climate Change Vulnerability Assessment and Adaptation Tools section lists and describes the types of tools that may assist communities is getting started on climate change planning efforts.

- **EPA Climate Change Impacts and Adapting to Change** -

<http://www.epa.gov/climatechange/impacts-adaptation/>

On this website, the EPA provides an overview of climate change impacts and adaptation strategies that can be searched either by region or by sector.

- Human Health Impacts and Adaptation - <http://www.epa.gov/climatechange/impacts-adaptation/health.html>
- Transportation and Climate Change - <http://www.epa.gov/otaq/climate/index.htm>

- **Exploring the Role of Traditional Ecological Knowledge in Climate Change Initiatives (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/publications/>

This synthesis explores the role of TEK in climate change assessments, planning and management. The report includes various examples of indigenous groups, agencies and organizations incorporating TEK into various types of research, education and resource planning efforts. These examples can serve as ideas for tribes and public and private partners with an interest in exploring the role of TEK in addressing climate change.

- **Federal Highway Administration and Climate Change** -

http://www.fhwa.dot.gov/environment/climate_change/index.cfm

FHWA focuses its resources on supporting transportation and climate change research and disseminating the results, providing technical assistance to stakeholders, and coordinating its activities within U.S. DOT and with other Federal agencies in the areas of mitigation, adaptation and sustainability.

- **FEMA Indian Country Resources** - <http://www.ready.gov/indiancountry>

A set of resources assembled by FEMA to assist Alaska Native and tribal governments recovering from a natural disaster or emergency, and/or preparing for future emergencies.

- **First Foods and Climate Change (PNW Tribal Climate Change Project)** -

<http://tribalclimate.uoregon.edu/tribal-profiles/first-foods-and-climate-change/>

This profile explores the challenges that indigenous peoples face in maintaining their historically important relationships with first foods in the context of climate change. The profile also outlines the impacts that climate change may have on many first foods, describes challenges facing indigenous peoples in continuing their relationship with first foods, and explore ways in which they have adapted or responded to these challenges.

- **The Government-to-Government Relationship in a Changing Climate: A review of federal consultation policies (PNW Tribal Climate Change Project)** -

http://tribalclimate.uoregon.edu/files/2010/11/consultation_report_2-22-20122.pdf

The goal of this research is to examine government-to-government relationships in the context of climate change. This report is intended to provide information and tools to increase the effectiveness

of federal-tribal consultation in addressing climate change impacts, and in the management of culturally important resources. The report examines the scope of federal consultation policies in the context of climate change and highlights specific policies that have the potential to strengthen federal-tribal efforts to address climate change.

- **Government-to-government Relations with Native American Tribal Governments -** <http://www.gpo.gov/fdsys/pkg/WCPD-1994-05-02/pdf/WCPD-1994-05-02-Pg936.pdf>
In this Presidential Memorandum, President Clinton outlines principles that executive departments and agencies, including every component bureau and office, are to follow in their interactions with Native American tribal governments.
- **A Guide For Tribal Leaders on U.S. Climate Change Programs (PNW Tribal Climate Change Project) -** <http://tribalclimate.uoregon.edu/publications/>
In June 2011, the Tribal Climate Change Project released the first iteration of a Guide For Tribal Leaders on U.S. Climate Change Programs. This guide was subsequently updated in December 2011. This guide summarizes key U.S. government programs addressing climate change, opportunities for tribal engagement and contacts for each agency. In addition to its immediate value to tribes and their partners, this information will provide important groundwork for research on understanding and improving the tribal consultation processes in the context of climate change. This guide also begins to include tribal, academic and non-governmental agencies and programs to assist tribes in addressing climate change.
- **Impacts of Climate Change on Fisheries Resources (U.S. Fish & Wildlife Service) -** <http://www.fws.gov/fisheries/fcc.html>
The U.S. Fish & Wildlife Service describes the general impacts of climate change on fisheries and describe the role of the Fisheries Program in the face of these impacts.
- **Indigenous Housing Gateway -** <http://indigenoushousing.org/EmergencyManagementUnitedStates>
The Indigenous Housing Gateway is a compendium of resources, tools, papers, and websites that can help decision-makers and housing workers make better and more informed decisions regarding indigenous housing. The Emergency Management tab provides resources that can help communities prepare for the impacts of climate change.
- **Indigenous Peoples' Bicultural Climate Change Assessment Initiative (IPCCA) -** <http://ipcca.info/>
The IPCCA has emerged as an innovative response, bringing together indigenous knowledge and science in a process that links biocultural realities with complex global processes. Under IPCCA, nine indigenous-led biocultural assessments are empowering indigenous peoples to develop and use indigenous frameworks to assess the impacts of climate change on their communities and ecosystems. The assessments are taking place in a variety of fragile ecosystems such as the Arctic and tropical rain forests, using emancipatory methodologies that combine science and traditional knowledge through inter-cultural dialogue.
- **Institute for Tribal Environmental Professionals (ITEP) -** <http://www4.nau.edu/itep/>
ITEP was created in 1992 to act as a catalyst among tribal governments, research and technical resources at Northern Arizona University (NAU), in support of environmental protection of Native American natural resources.

- **Karuk Tribe: Integrating Traditional Ecological Knowledge within Natural Resource Management (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/tribal-profiles/karuk-profile/>

This profile explores the role of traditional ecological knowledge in the Karuk Tribe's Eco-Cultural Resource Management Plan, the ways in which this unique approach may contribute to tribal efforts to address climate change, and the importance of the federal-tribal relationship in addressing climate change.

- **The Lummi Nation: Pursuing Clean Renewable Energy (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/the-lummi-nation-pursuing-clean-renewable-energy/>

This profile provides detailed information on the wind energy development feasibility assessment project and also examines the opportunities and motivation that inspired the Lummi Nation to explore the options for renewable energy on their tribal lands.

National Tribal Air Association (NTAA): Impacts of Climate Change on Tribes in the United States - <http://www.ntaatribalair.org/air-topics/climate-change.html>

The NTAA's mission is to advance air quality management and policies and programs, consistent with the needs, interests, and unique legal status of American Indian tribes and Alaskan Natives. Climate change is one of the air topics addressed by NTAA. Documents such as Impacts of Climate Change on Tribes in the United States summarize the expected impacts by region.

- **Native Communities and Climate Change** - <http://www.tribesandclimatechange.org/>

This project seeks to provide resources for climate change adaptation and natural resource planning by American Indian tribes as well as to provide useful information to organizations and agencies working with Indian tribes on these issues.

- **Nez Perce Carbon Sequestration Project** - http://www4.nau.edu/tribalclimatechange/tribes/northwest_nezperce.asp

This profile describes the Nez Perce's initial trial afforestation project, and their strategies for reinvesting revenue from the sale of carbon to invest in additional afforestation projects, wildlife rehabilitation and forest development.

- **The Oregon Climate Change Adaptation Framework** - http://www.oregon.gov/LCD/docs/ClimateChange/Framework_Final.pdf?ga=t

This report constitutes a framework for the continued development of strategies and plans to address future climate conditions in the State of Oregon. This Climate Change Adaptation Framework provides context, identifies risks, lays out short-term priorities, and provides momentum and direction for Oregon to prepare for future climate change.

- **Organization for Economic Co-operation and Development: Economic Aspects of Climate Change** - <http://www.oecd.org/env/climatechange/oecdworkonadaptationtoclimatechange.htm>

The Organization for Economic Co-operation and Development (OECD) supports governments by providing the analytical foundation required to develop efficient and effective policies that promote adaptation to climate change. As a coordinating forum for bilateral donors, the OECD also has an important role in facilitating the integration of adaptation into development cooperation activities. OECD's work on adaptation has contributed to key international assessments of climate change including the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and the Stern Review on the Economics of Climate Change.

- **Preparing for Climate Change: A Guidebook for Local, Regional and State Governments (University of Washington)** - <http://cses.washington.edu/cig/fpt/guidebook.shtml>
 This Guidebook is designed to help local, regional, and state governments prepare for climate change by recommending a detailed, easy-to-understand process for climate change preparedness based on familiar resources and tools.
- **Promoting Generations of Self-Reliance: Stories and Examples of Tribal Adaptation to Change (U.S. EPA)** - www.epa.gov/region10/pdf/tribal/stories_and_examples_of_tribal_adaptation_to_change.pdf
 This collection of adaptation practices and strategies presents practical examples for tribal environmental managers and leadership to consider applying to their own unique circumstances.
- **Relocation of Alaska Native Villages (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/tribal-profiles/relocation-of-alaska-native-villages/>
 This profile examines the challenges of relocation and offers examples from three Alaska Native villages working to protect their people, culture and natural resources.
- **Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment** - <http://www.nwf.org/vulnerabilityguide>
 This publication has been designed to assist fish and wildlife managers and other conservation and resource professionals to better plan, execute, and interpret climate change vulnerability assessments.
- **Siletz Tribal Energy Program (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/tribal-profiles/siletz-tribal-energy-program/>
 The Confederated Tribes of Siletz Indians, located on the Oregon coast, have created the Siletz Tribal Energy Program (STEP), which works within the tribal community to encourage efficient energy use and reduced energy consumption and greenhouse gas emissions. This profile examines the many facets of this initiative, which include weatherization and energy efficiency, conservation, renewable power and solar.
- **Swinomish Climate Change Initiative** - http://www.swinomish-nsn.gov/climate_change/climate_main.html
 In October of 2007 the Swinomish Indian Senate issued a Proclamation directing action to respond to climate change challenges. The Proclamation acknowledged the potential for issues and impacts in the vicinity of the Swinomish Indian Reservation and directs tribal departments and staff to undertake efforts and studies for promoting long-term proactive action. This website describes this initiative, and includes links to the Swinomish Impact Assessment Technical Report and Climate Adaptation Action Plan.
- **Tribal Climate Change Adaptation Options: A Review of the Scientific Literature** - http://www.tribesandclimatechange.org/documents/nccc/nccc20110105_0008.pdf
 The purpose of this report is to summarize information in published scientific literature that identify physical changes in the climate due to climate change, to identify the vulnerability of tribal resources, and to identify adaptation options that tribes in Region 10 could implement to minimize the possible adverse effects to their lifestyle and well-being. This report is intended to be a 'living' document and will be updated and revised, as needed, in response to the needs of the tribes, and to incorporate the most recent information on climate change adaptation in the scientific literature.

- Tribal Climate Change Adaptation Plan Template** - Available from ITEP by request. Please contact ITEP's Climate Change Program Manager, Sue Wotkyns (Susan.Wotkyns@nau.edu), to request the template.

This template, developed by the Institute for Tribal Environmental Professionals (ITEP), provides guidelines and suggestions for writing a climate change adaptation plan and includes key terms and additional resources. The template is intended to be used for organizing and presenting information but is not meant to create a "one-size fits-all" plan, as each tribe will have unique needs and approaches to planning for climate change.
- Tribal Climate Change Funding Guide (PNW Tribal Climate Change Project)** - <http://tribalclimate.uoregon.edu/publications/>

This funding guide is intended to provide up-to-date information on grants that may assist tribes in addressing climate change through a broad range of sectors. You can search this guide with keywords based on general descriptions, agencies or geography, or use the drop down menu to search by category. The Pacific Northwest Tribal Climate Change Project at the University of Oregon and the Environmental Protection Agency, Region 10 Tribal Program Office developed this guide collaboratively.
- Tribal Energy and Environmental Information Clearinghouse** - <http://teeic.anl.gov>

This website includes information about energy resource development and associated environmental impacts and mitigation measures; guidance for conducting site-specific environmental assessments and developing monitoring programs; information about applicable federal laws and regulations; and federal and tribal points of contact.
- Tribes & Climate Change** - <http://www4.nau.edu/tribalclimatechange/index.asp>

This website provides information and resources tailored to helping Native people gain a better understanding of climate change and its impacts on their communities. Here you'll find basic climate-change information; profiles of tribes in diverse regions of the U.S., including Alaska, who are coping with climate change impacts; audio files of elders discussing the issue from traditional perspectives; and resources and contacts you can use to develop climate change mitigation and adaptation strategies.
- United States Global Change Research Program** - <http://www.globalchange.gov/>

The U.S. Global Change Research Program (USGCRP) coordinates and integrates federal research on changes in the global environment and their implications for society. Publications include descriptions of projected U.S. climate change impacts by sector and by region.

 - Impacts by Sector: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector>
 - Regional Climate Change Impacts - <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts>
- Washington State's Integrated Climate Response Strategy:** <https://fortress.wa.gov/ecy/publications/summarypages/1201004.html>

This document offers recommendations on how existing state policies and programs can better prepare Washington State to respond to the impacts of climate change. It urges state agencies to make adaptation a standard part of agency planning and to make scientific information about climate change impacts accessible to public and private sector decision makers. It also recommends that state agencies strengthen existing efforts to help local and tribal governments, private and public organizations, and individuals reduce their vulnerability to climate change. The response strategy

underscores the need to build strong partnerships to support state, local, and tribal adaptation; coordinate activities across sectors; and engage stakeholders and the public.

- **Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation** - <http://unesdoc.unesco.org/images/0021/002166/216613e.pdf>

This report provides an overview of the published scientific literature (primarily peer-reviewed, but also grey) relating to the contribution of traditional/indigenous knowledge to our understanding of global climate change: observations, impacts and opportunities for adaptation. It focuses in particular on post-AR4 literature and also includes inputs from the international expert meeting 'Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge', held from 19–21 July 2011 in Mexico City, Mexico.