# Chapter 17

# Unique Challenges Facing Southwestern Tribes


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## Executive Summary

When considering climate change, risks to Native American lands, people, and cultures are noteworthy. Impacts on Native lands and communities are anticipated to be both early and severe due to their location in marginal environments. Because Native American societies are socially, culturally, and politically unique, conventional climate change adaptation planning and related policies could result in unintended consequences or conflicts with Native American governments, or could prove to be inadequate if tribal consultation is not considered. Therefore, it is important to understand the distinct historical, legal, and economic contexts of the vulnerability and adaptive capacity of Southwestern Native American communities. The key messages presented in this chapter are:

- Vulnerability of Southwestern tribes is higher than that for most groups because it is closely linked to endangered cultural practices, history, water rights, and


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socio-economic and political marginalization, characteristics that most Indigenous people share. (high confidence)

- Very little data are available that quantify the changes that are occurring or that establish baseline conditions for many tribal communities. Additional data are crucial for understanding impacts on tribal lands for resource monitoring and scientific studies. (high confidence)
- The scant data available indicate that at least some tribes may already be experiencing climate change impacts. (medium confidence)
- Tribes are taking action to address climate change by instituting climate-change mitigation initiatives, including utility-scale, alternative-energy projects, and energy-conservation projects. Tribes are also evaluating their existing capacity to engage in effective adaptation planning, even though financial and social capital is limited.

## 17.1 Introduction

The Southwestern United States is home to 182 federally recognized tribes (Federal Register 2010, Figure 17.1). California has the largest number of tribes (109), and the largest Native American population in the country (Table 17.1). Arizona, New Mexico, Colorado, and Utah are also home to seven of the most populous tribes, with populations ranging from 10,000 to over 300,000 (U.S. Census 2010). Nine tribes in the Southwest are considered "large land-holding tribes," five of which are among the ten largest reservations in the United States, ranging in size from 600,000 to 15 million acres (Federal Register 2010). More than one-third of the land in Arizona is tribal land.

Southwestern tribes are situated within all of the region's ecosystems and climatic zones, and the challenges these Native nations face from climate change may be just as varied. For example, tribes with large land holdings, those near the coast or in areas of scarce water, and those with large populations could face challenges different from the challenges faced by smaller tribes or those in or near urban areas. However, special issues confronting most if not all tribes include cultural and religious impacts, impacts to sustainable livelihoods, population emigration, and threats to the feasibility of living conditions. Tribal resources, already stretched to the limit, will have to be improved for tribes to cope adequately with a changing climate. Tribes' unique histories and legal status often results in political marginalization that must be addressed in order for tribes to face these challenges on equal footing with other governments.

Native nations predate the formation of the U.S. government; they entered into treaties with Great Britain and other European countries within their own territories. The United States continued the treaty relationship until 1871, but the nature of the political relationship changed over time. In a famous trilogy of nineteenth-century U.S. Supreme Court cases, Chief Justice John Marshall designated tribal governments as domestic, dependent nations that govern themselves under the protection of federal law. The federal government holds reservation lands in trust for the benefit of Indian nations; U.S. state governments generally may not exercise jurisdiction over reservation lands except when authorized to do so by the federal government (Cohen 2005).

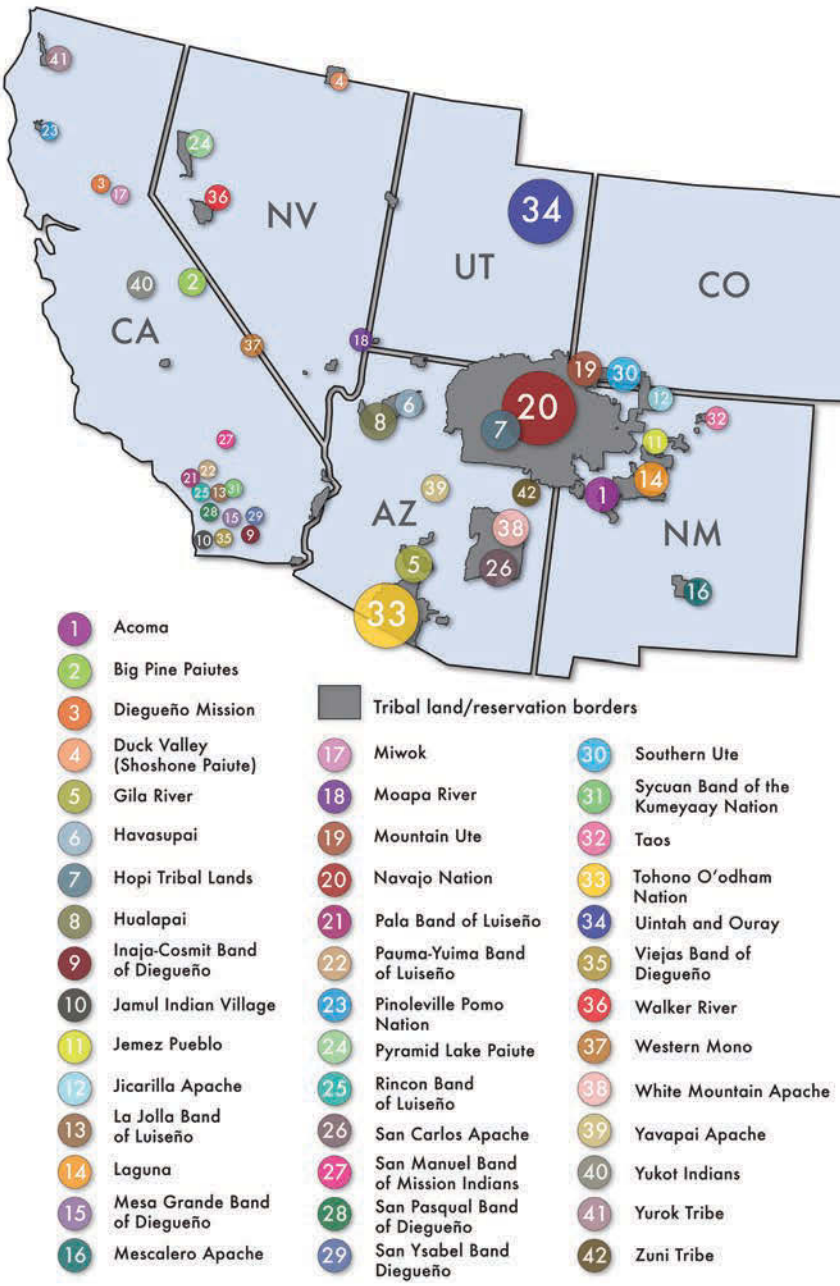


**Figure 17.1 Map of southwestern United States showing tribal lands and the location of tribes discussed in text.**

The federal government's duty to protect Indian nations, as articulated by Chief Justice John Marshall, is now understood as the federal trust responsibility. The Bureau of Indian Affairs is the agency that directly administers the trust responsibility. However, other agencies that control federal land and other natural resources must protect any applicable tribal rights, including rights to water, fish and wildlife, and cultural resources, such as traditional cultural properties. (Pevar 2012).

**Table 17.1** Tribal lands and populations in the Southwestern United States

| State | No. of Tribes | Total State Population | Tribal Population | % Tribal Population | Total State (acres) | Approx. Tribal land (acres) | % Tribal Land |
|---|---|---|---|---|---|---|---|
| AZ | 21 | 6,392,017 | 294,033 | 4.6 % | 72,982,074 | 26,273,547 | 36 % |
| NM | 23 | 2,059,179 | 193,562 | 9.4 % | 77,841,869 | 4,467,287 | 5.7 % |
| UT | 8 | 2,763,885 | 33,166 | 1.2 % | 54,352,753 | 5,150,817 | 9.5 % |
| CO | 2 | 5,029,196 | 55,321 | 1.1 % | 66,641,485 | 921,214 | 1.4 % |
| NV | 19 | 2,700,551 | 12,600 | 1.2 % | 70,782,330 | 1,253,812 | 1.8 % |
| CA | 109 | 37,253,956 | 372,529 | 1.0 % | 104,798,976 | 407,932 | 0.4 % |
| **Total** | **182** | **56,198,784** | **961,211** | **1.7 %** | **447,399,488** | **48,474,609** | **10.8 %** |

Source: Federal Register (2010), U.S. Census (2010).

The federal government's "plenary power" over Indian affairs has resulted in a complex web of statutes that promote a policy of self-determination for tribal governments. Tribes have legal authority to make and enforce their own laws, and to regulate their lands, resources, and members. As U.S. senior district Judge Bruce S. Jenkins has noted (after Duthu 2008, p 4):

> *Modern tribal governments routinely exercise civil governmental authority over a range of day to day activities, much like comparable state and local government entities.… [T]ribal departments and agencies administer and deliver an expanding array of community services—from police, fire, and other emergency services, to education, health, housing, justice, employment assistance, environmental protection, cultural preservation, land use planning, natural resource conservation and management, road maintenance, water and public utilities. Indian tribes fit squarely within the ranks of American civic bodies, sharing the common duty and responsibility to provide essential services to the people of the communities they serve.*

As separate sovereign governments, tribes have the authority to address climate change as an important issue that affects their lands, resources, and traditional practices. Because climate change operates across jurisdictional boundaries, an awareness of tribal rights to water and cultural resources, located both on and off the reservation, are important to understand and evaluate when examining how climate change will affect tribes. This is particularly true for California, where tribes have smaller land holdings and must rely heavily on public lands for resources used in their cultural and religious practices (Anderson 2005).

## 17.2 The Effects of Marginal Living Conditions and Extreme Climatic Environments

In some cases, Native people and their cultural resources have already been affected by climate change. Reservations were often established in regions that typically have extreme environments and where sustainability of acceptable living conditions is already a challenge. In more arid parts of the Southwest, tribes sometimes have land that is drier—and has more limited access to water—than do their non-Indian neighbors. Large land-holding tribes, particularly in Arizona and Utah, are situated in regions with limited rainfall and water sources of poor quality that non-Native pioneers settling in the West found to be undesirable. For example, Navajo reservation boundaries were established within the driest third of the Navajo traditional homeland (Redsteer, Kelley et al. 2010), and fierce competition among Anglo and Hispanic populations for the best rangelands precluded retention of the more verdant traditional lands for Navajo use (Bailey and Bailey 1986). Helen H. Jackson (1883, 459) in describing changes of land occupation wrote:

> *From tract after tract of [ancestral] lands they have been driven out year by year by the white settlers of the country until they can retreat no further, some of their villages being literally on the last tillable spot on the deserts edge or in mountains far recesses… In southern California today are many fertile valleys which were thirty years ago the garden spots of these same Indians.*

Despite these historical land tenure changes and all the challenges facing Native people today, they continue to practice a lifestyle deeply connected to their natural surroundings. Cultural ties to the land include gathering herbal medicines and native plant foods, subsistence hunting and fishing, and traditional agricultural practices, such as farming and raising sheep. These practices continue to play a role in tribal life, and may also provide significant portions of many tribal economies.

## 17.3 Current Impacts on Native Lands

Native American cultures are closely linked to local resources in specific ecological niches that are likely to be altered in a changing climate (Kuhnlein and Receveur 1996; Smith et al. 2008; Green and Raygorodesky 2010). Many publications have generally described how tribes could be affected by climate change (see Hanna 2007; National Wildlife Federation 2011). However, few scientific studies address and quantify current climate-change impacts on Native lands and peoples of the United States, except in Alaska (e.g. Cruikshank 2001; Krupnik and Jolly 2002; Parkinson and Berner 2008; Davis 2010; Kofinas et al. 2010; Alexander et al. 2011). The high vulnerability of tribes to climate change and the information available (although limited) suggest that some tribes could be experiencing impacts, even though they lack specific documentation.

Many factors can lead to ecological and environmental change, and clear links of cause and effect need to be established in order to assess the effects that climate has had and might have for Native peoples in the region. In one documented example on the Navajo Nation, long-term trends of increasing temperatures, decreasing snowfall,

declining streamflow, and water availability have magnified the impacts of drought that began in 1996 and continues today (Redsteer, Kelley et al. 2010). Streamflow data and historic information on surface-water features (such as springs, lakes and streams) show significant changes over the past century (Redsteer, Kelley et al. 2010). These changes have not coincided spatially or temporally with water development. Many surface-water features are now dry year-round or ephemeral, and began to disappear in the early to mid-1900s. Moreover, significant reductions in the number and length of stream reaches with perennial flow have occurred since 1920, and for some historic ephemeral streams, no flow during spring run-off and summer rains occurs today (Figure 17.2).

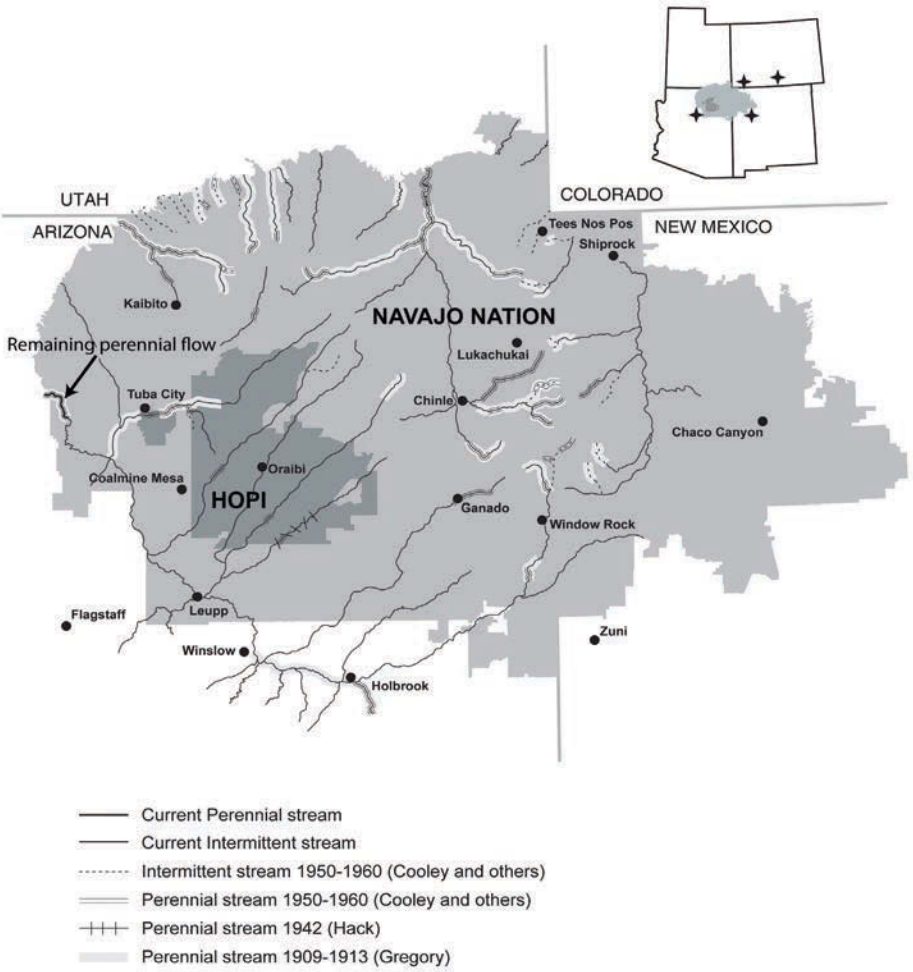


**Figure 17.2 Map of the Navajo Nation (and lands of the Hopi Tribe) showing historic changes in perennial flow.** The bold black line (shown with arrow) indicates where perennial stream flow exists today. Inset map shows location of Navajo lands, black diamonds specify locations of sacred mountains on the perimeter of Navajo traditional homelands. Data from reports by Herbert Gregory (1917), Hack (1942), Cooley et al. (1969) and USGS stream gauge data (after Redsteer, Kelley et al. 2010).

Interviews with 73 traditional Navajo elders about their observations of weather patterns and their impacts on traditional practices provided detailed accounts describing declines in snowfall, surface water features, and water availability (Redsteer, Kelley and Francis 2011). Other noticeable changes reported in these accounts include the disappearance of springs and the plants and animals found near water sources or in high elevations, such as certain medicinal plants, cottonwood trees, beavers, and eagles. The elders observed changes in the frequency of wind, sand, and dust storms. Navajo traditionalists also mentioned the lack of available water and changing socio-economic conditions as leading causes for the decline in the ability to grow corn and other crops (Redsteer, Kelley et al. 2010). Corn has been central to many Native cultural practices and traditions, including all Puebloan people in the Southwest. The use of corn pollen is also central to every Navajo ceremony.

Although the studies of climate-change impacts to Native people are limited, significant recent climate-related impacts to ecosystems on Native lands have occurred. In 2002, the Southwest experienced one of its most active fire seasons as a result of drought conditions and high winds (Feltz et al. 2002). The Rodeo-Chediski fire in Arizona burned 467,000 acres, setting a record for its immense size. Approximately 25% of the area burned was timber and grazing land belonging to the White Mountain Apache Tribe (Strom 2005; Kuenzi 2006). The fire resulted in areas that were severely burned, with 50% of the area showing no signs of ponderosa pine regeneration, and 16% with no surviving ponderosa pine. These areas are projected to undergo a shift to oak-manzanita shrubland (Strom 2005). The White Mountain Apache land, however, fared better than adjacent Forest Service lands because of the tribe's forest management policy of prescribed burns (Kuenzi 2006).

A continuation of dry, windy conditions in following years also led to record-breaking wildfire conditions that affected tribes in California (FEMA 2004). In October 2003, three simultaneous wildfires, the largest and most deadly in the history of California, destroyed 2,400 homes, killed sixteen people, and charred 376,000 acres in San Diego County. Again in October 2007, nine simultaneous fires of varying sizes burned throughout the county (including the Poomacha fire). These fires required the evacuation of 300,000 people and resulted in the loss of more than 1,800 homes and many other structures, 369,600 acres of land, and nine fire-related deaths. Local firefighting costs in 2007 topped $80 million (City of San Diego 2007).

In the 2007 Poomacha fire, the La Jolla Band of Luiseño Indians and the Rincon Band of Luiseño Indians, who had escaped major damage from the fires in 2003, suffered severe damage to homes and businesses (BIA 2007). Closing the reservations because of the fire caused food shortages, but the damage to tribal communities is more severe than these statistics would suggest. As one tribal member told a reporter, nearby municipalities "are newer places and people can leave and go elsewhere. …This has been our home for generations. We have ties to the land. We won't go rebuild somewhere else" (Kelly 2007). The Poomacha fire burned 94% of the La Jolla reservation, destroying thick forests of live oak that once shaded homes and provided acorns for generations of Native Americans. "We were already at the bottom of the barrel and now this takes us down even further," said tribal Chairman Tracy Lee Nelson, whose house was destroyed in the fire (Kelly 2007).

Other tribal communities impacted by California wildfires include the Barona Band of Mission Indians (Cedar fire of 2003; Witch fire of 2007), the Inaja-Cosmit Band Indians (Witch fire of 2007), the Mesa Grande Band of Mission Indians (Witch fire of 2007), the Pala Band of Mission Indians (Poomacha fire of 2007), the Pauma Band of Luiseño Indians (Poomacha fire of 2007), the San Pasqual Band of Diegueno Mission Indians (Poomacha fire of 2007), the Iipay Nation of Santa Ysabel (Witch fire of 2007) and the Viejas Band of Kumeyaay Indians (Witch fire of 2007). The Jamul Indian Village and the Sycuan Band of the Kumeyaay Nation were also threatened by the Harris fire of 2007 (BIA 2007).

It is highly likely that increasing fire severity and other climate-related ecosystem impacts are affecting traditional Native foods and resources. Another climate-related impact, "sudden oak death," is a growing concern in California coastal areas and is spread by a pathogen that is sensitive to changes in humidity and temperature (Guo, Kelly, and Graham 2005; Liu et al. 2007). It may have been rare until changes in the environment (related to climate change) and increasing fire frequency led to its increasing prevalence (Rizzo and Garbelotto 2003; Pautasso et al. 2012). Tribes that have used oaks and acorns are numerous, and include Miwok, Western Mono, Yukots, Yurok, Paiute, and various Apache tribes, among many others (Anderson 2005). Acorns are a recognized staple food source of Native Americans in coastal California and the surrounding region, including Paiutes that traversed the Sierra Nevada in historic times to obtain them (Muir 1911). In addition to being a source of traditional foods, oaks are a valued source for traditional medicine and dyes for basketry (Ortiz 2008).

## 17.4 Potential Rangeland Impacts

Many tribes are dependent on livestock as a significant part of their economy, including the Hopi Tribe, Hualapai Tribe, Jicarilla Apache Nation, Navajo Nation, Pyramid Lake Paiute Tribe, San Carlos Apache Tribe, Southern Ute Indian Tribe, Tohono O'odham Nation, and White Mountain Apache Tribe. Tribal communities dependent on livestock tend to have limited alternative livelihoods, and additional climate-related stresses to the rangeland will further reduce economic resources. Livestock, especially cattle, are a significant source of economic and food security for large numbers of families on the Navajo Nation (Redsteer, Kelley et al. 2010). Stock-raising by large numbers of Navajo families is also important to preserve aspects of traditional culture.

### *Sand and dust storms*

Climate-driven impacts to rangeland include increased mobility of sand dunes and potentially an increase in regional dust storms (Painter et al. 2010; Redsteer, Bogle and Vogel 2011). Sand dunes cover approximately one-third of the Navajo Nation as well as significant areas of Hopi tribal land (Redsteer 2002; Redsteer and Block 2003). Dune fields are susceptible to changes in precipitation, temperature, and wind speed and circulation patterns. In areas of Navajo and Hopi land that have wetter and cooler conditions, vegetation grows on sand dunes and stabilizes them. However, with drought conditions, these dune fields and sheet sands now exist under meteorological conditions where dunes may not have enough moisture to support the plant life necessary to make

dunes resistant to wind erosion (Redsteer 2002). Increasing aridity in arid and semi-arid regions is often concurrent with the deterioration of surface vegetation and increasing dune mobility, jeopardizing rangeland productivity (Redsteer and Block 2004). An additional complication is that during floods, new sediment delivered in ephemeral rivers and washes (i.e., drainages that flow only temporarily after precipitation or snowmelt) provides a sand supply for new dune fields (Redsteer, Bogle et al. 2010). The risk of wide-scale movement of sand dunes is high, because the dry spells already make sand dunes more active. With projected warmer and drier conditions, deposits of sand dunes that have been stabilized by vegetation are highly likely to become mobile (Figure 17.3). Once sand dunes are mobile, it is difficult to reverse the process so that stabilization can occur, because vegetation must establish itself on a moving landform (Yizhaq, Ashkenazy, and Tsoar 2009). Very few plants are adapted to surviving abrasion by sand and sand burial (Downes et al. 1977). Currently, dunes are inundating housing, causing transportation problems, and contributing to a loss of rare and endangered native plants and grazing land (Redsteer, Bogle and Vogel 2011).

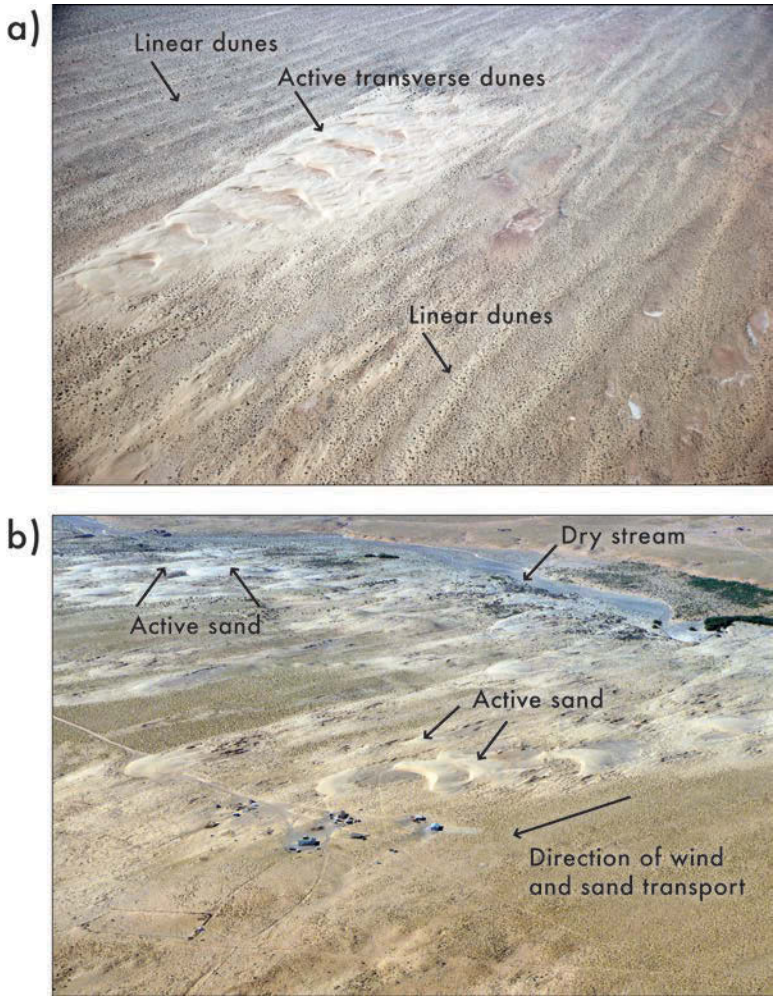


**Figure 17.3 Photos of sand dune deposits on Navajo and Hopi land.** a) Stabilized linear dunes, with local reactivation forming mobile transverse dunes; and b) Active sand dunes forming downwind of a dry streambed sediment source. Photo courtesy of Margaret Hiza Redsteer.

## 17.5 Adaptation Strategies and Adaptation Planning

In the past, Native peoples in the Southwest adapted to natural hazards through unique strategies guided by their cultural beliefs and practices (Tsosie 2007). Although many such Native traditions continue today, modern circumstances now make tribes especially vulnerable to climate extremes (National Wildlife Federation 2011). In some cases, modern land-use policies circumvent the ability of Native people to practice traditional adaptation strategies (James, Hall, and Redsteer 2008; Redsteer, Kelley et al. 2010). Tribal environmental and natural-resources management programs are working to address local impacts and tribes have lobbied for adaptation funding from the federal government. According to California Indian Water Commission President Atta Stevenson (a member of the Cahto tribe), "There are numerous climate change conditions we have witnessed and try to adapt to, but climate change is a global crisis without funding resources or commitment by government leadership to address Tribal suffrage and ecological demise of our traditional cultures. We cannot combat this … alone."[i] In 2011, the Bureau of Indian Affairs (BIA) began to offer grants under a Tribal Climate Change Program, with a total allocation of $319,000.[ii] However, of the fifteen grants awarded, only three were for vulnerability assessments, and none were for climate adaptation planning.[iii] In 2009, the Department of the Interior (DOI) began a Climate Change Adaptation Initiative, setting aside funding for lands under federal jurisdiction, but it has not provided adequate funding for the BIA to assist tribes. Lack of adequate funding is not merely an impediment to adaptation planning, but it also further increases vulnerability to climate change impacts. Jerry Pardilla (2011), the National Tribal Environmental Council Executive Director, describes the situation in these terms:

> *Tribal lands comprise 95 million acres of the 587 million acres or 16 percent of federal land in the Initiative. The BIA has 11 million acres more than the National Park Service, yet the Administration has proposed nearly 50 times more funding for the NPS in FY 2012.*

Despite having few resources, adaptation planning workshops for tribes in the Southwest for both climate change and drought have occurred frequently in the past few years. There has also been a concerted effort by many tribes to forge ahead with adaptation plans (Wotkyns 2011). One example from the Yurok Tribe in the coastal Klamath Basin, California, demonstrates what tribes can implement if the resources are available. Adaptation planning by the Yurok Tribe Environmental Program entails monitoring water, air, and fisheries to understand local effects of climate change. Kathleen Sloan, the Tribe's Environmental Program Director, noted in 2009 that in many areas, the Yurok Tribe is the only entity collecting the data critical for creating climate models for the Lower Klamath. The tribe is training staff to monitor impacts, developing educational materials to encourage participation in adaptation planning, gathering oral histories from tribal elders, and creating a comprehensive prioritization plan to guide future tribal assessments. The Yurok Tribe's plan includes developing regional models to provide information for the Klamath Basin.

### *Floods and disaster planning*

Severe weather events are occurring on tribal lands frequently, resulting in emergency

declarations. Severe flooding in Havasu Canyon in 2008 struck a blow to the Havasupai tribal economy from lost tourism revenue. Since then, the Havasupai have experienced repeated flood events, the latest in October 2010, making recovery difficult. Funding from the San Manuel Band of Mission Indians ($1 million), federal and state agencies, and non-profit organizations has helped in recovery efforts. Currently, Havasu Canyon is closed until rehabilitation work and flood mitigation measures are completed (Wotkyns 2011).

The Federal Emergency Management Agency (FEMA) is a major source of flood and disaster assistance that requires ongoing commitments by communities for eligibility. The National Flood Insurance Program is a cornerstone of floodplain management, but only four Southwestern tribes participate in it (FEMA 2011). Many tribes lack zoning laws or floodplain delineation despite retaining jurisdiction over federal lands. Lack of funding, difficult jurisdictional challenges posed by the presence of non-Indian lands, and in some cases the need for approval by the Department of the Interior comprise some of the causes for the lack of regulation. Today, limited resources and abundant low-income housing challenge administration of floodplain ordinances and mandatory insurance for federally financed homes located in floodplains (Bemis 2003). FEMA-approved hazard mitigation plans address other disasters and are a prerequisite to receive certain federal funding. Forty-eight Southwestern tribes participate in these management plans, either through their own plans or by adopting plans developed by other local jurisdictions (FEMA 2009). The requirement for renewal every five years presents a continual challenge to resource-limited tribes, and some plans have expired.

### *Droughts and drought mitigation planning*

Many tribal governments are unprepared to cope with climate extremes because of the poor economic conditions in tribal communities. Tribal water resources on arid reservations are typically marginal and highly susceptible to frequent water shortages. While every Southwestern state has a drought plan, only four Southwestern tribes have completed plans through the Bureau of Reclamation States Emergency Drought Program (National Drought Mitigation Center 2010; Reclamation 2010). Tribes have limited resources to develop and implement these plans. Despite being the first tribe to submit its plan to Congress, the Hualapai Tribe lacks the personnel and funding to perform monitoring and actions triggered pursuant to its plan (Knudson, Hayes, and Svoboda 2007). The Hopi Tribe and Navajo Nation have submitted plans to Congress but also have struggled with monitoring (Ferguson and Crimmins 2009). The large region encompassed by these two tribes (about 30,000 square miles in total) presents challenges for adequate monitoring. With a smaller land area (about 700 square miles), the Zuni Tribe has been able to issue monthly monitoring reports for its plan, but some federal stations it uses are at risk from insufficient federal cost-sharing and the inability to replace cooperators (Bemis 2010).

Recent reports from workshops offered through the National Integrated Drought Information Systems (NIDIS) documented the challenges facing tribes and identified opportunities for assistance (Collins et al. 2010; Ferguson et al. 2011). Chronic underfunding and short-term funding cycles for programs within tribal government leave tribes without the financial and human resources needed to make climate assessments

or plan for natural hazards (Ferguson et al. 2011). Planning must also address tribal cultural needs and sovereignty. Modern monitoring, forecasting, and adaptation techniques can sometimes ignore or be inconsistent with traditional Native values, knowledge, and practices. The sovereign status of tribes can create complications or obstacles for collecting data and managing resources. The NIDIS Four Corners Tribal Lands Regional Drought Early Warning System is a pilot project attempting to address some of these issues and provide better information and resources for drought planning (Alvord 2011). By fully involving tribes throughout its course, this pilot project can provide a model for other tribal regions.

## 17.6 Challenges for Adaptation Planning

In planning to face the effects of climate change, tribal rights to water, cultural resources, and sacred sites located both on and off reservations are likely to be issues connected to adaptation planning. If sacred sites are not recognized, there is a substantial chance of increased conflict, which would constrain or even derail efforts to maintain resilient cultural and natural resources. The challenges of climate change and adaptation planning for federal land managers and for tribes may be difficult because of potential conflicts between the trust responsibility to Indian nations and the mandate of federal agencies to engage in a multiple-use policy. There have been effective partnerships initiated by tribes to address climate-related issues that affect resources and traditional practices, but there are also examples of ineffective communication leading to conflict.

Within the Department of the Interior (DOI), Landscape Conservation Cooperatives (LCCs) were established to develop science capacity to support resolution of resource management issues. The Native American Land Conservancy (NALC) is land conservancy with representatives from the Chemehuevi, Cahuilla, Wyandotte, Seneca, and other tribes. The NALC is providing a strategy for the Desert LCC, with members on the LCC steering committee and science working group, incorporating observations of eastern Mojave Desert traditional ecological knowledge. To this end, the NALC has drafted a white paper that includes historical information, cultural resource concerns, and ways to evaluate and lessen impacts of climate change based on indigenous understanding of the region's sacred sites, areas and landscapes.

## 17.7 Vulnerability from Economic, Political, and Legal Stresses

Limited resources and poor economic conditions reduce the resilience of tribes to climate change. More than one-quarter of the American Indian and Alaska Native population lives in poverty—a rate more than double the general U.S. population (Sarche and Spicer 2008). Moreover, approximately 13.3% of Native Americans lack accessibility to safe drinking water (Indian Health Service 2007). Income levels and human development indicators such as health and education are significantly lower than those of the rest of the population (U.S. Commission on Civil Rights 2004).

### *Vulnerability and adaptive capacity*

Nevada's largest tribe, the Pyramid Lake Paiute Tribe (PLPT), is deeply connected—culturally, physically, and spiritually—to Pyramid Lake and its ecosystem. Pyramid Lake,

at the terminal end of the Truckee-Carson River, is considered "the most beautiful of North America's desert lakes" (Wagner and Lebo 1996, 108). It is home to an endangered fish called cui-ui (*Chasmistes cujus*)—a primary cultural resource—and the threatened Lahontan cutthroat trout. The Paiute tribe's original name is *Kuyuidokado,* or cui-ui eaters. Traditionally, they traveled to the lake for annual cui-ui spawning to gather and dry fish (Wagner and Lebo 1996). The Paiute origin story is based upon the lake and a tufa-rock formation called the Stone Mother, resembling a woman whose tears created the lake (Wheeler 1987). Fishing and recreational activities are central to the PLPT economy. Wetlands also provide reeds for basketry, a symbol of Native identity. Although some cultural practices have been lost due to impacts from non-tribal settlement and exploitation, the PLPT continues to hold steadfast to their cultural connection to the lake. The tribe protects the lake via water rights negotiations for endangered species protection, by creating and enforcing policies on water quality, maintaining minimum in-stream flows for spawning, and by funding fisheries management activities.

The case of the Pyramid Lake Paiute Tribe exemplifies the vulnerabilities that tribes face from climate change (Tsosie 2007; Shonkoff et al. 2011). The tribe's vulnerability is related to cultural dependence on the lake, but external socio-economic factors also influence its adaptive capacity, amplifying potential impacts (Gautam and Chief forthcoming). Risk factors include upstream water use by municipal, industrial, and agricultural entities. Spawning and sustenance of endangered cui-ui fish are dependent on both water quantity and quality (Sigler, Vigg, and Bres 1985; USFWS 1992). Water supplies in nearby Carson Basin largely determine how much water reaches Pyramid Lake, particularly in the dry years, as irrigation requirements have senior water rights. Devastating impacts have already occurred from water diversion for agricultural use. Blocked access to upriver spawning grounds during a drought left dying fish for two miles downstream of the Derby Dam. Cattle encroachment upon wetlands occurs during droughts that reduce available forage. Limited economic opportunities and dwindling federal support constrain the tribe's adaptation capacity. In a survey, 73% of PLPT respondents said they believe climate change is occurring and that humans play a role, whereas 63% of rural Nevadans believe climate change is occurring, with only 29% attributing a human role (personal communication from Z. Liu, 2012). Factors such as a remarkable public awareness of climate change, sustainability-based values, the technical capacity for natural resource management, proactive initiatives for invasive-species control, and external scientific networks contribute to PLPT's adaptive capacity.

### *Water rights*

Water rights are closely linked to the vulnerability and adaptive capacity of tribes. The legal basis for tribal water rights is the federal "reserved rights" doctrine, which holds that Indian nations have reserved rights to land and resources in treaties they signed with the United States. In the famous 1908 case of *Winters v. United States*, the Supreme Court held that when the U.S. government establishes a reservation, it also implicitly reserves water rights sufficient to meet the current and future needs of the tribe and the purpose for which the reservation was set aside (including fisheries, where applicable). Thus, the priority date for tribal water rights under the *Winters* doctrine is the date the reservation was established, making many tribal governments in the Southwest senior water resource users with significant adjudication rights (Cohen 2005).

In the 1963 case of *Arizona v. California*, the Supreme Court determined that the only feasible way to quantify tribal rights was by "practicably irrigable acreage" (PIA) on reservations. Difficulties with the PIA quantification of water rights include the differences in the amount of tillable land available from one reservation to another, as well as the water-rights standard being based on the amount of land a tribe has, rather than tribal population. Western water law doctrine may have worked well in early nineteenth and twentieth centuries, but fails to take into account valuable in-stream uses of water such as fish and wildlife habitat (Royster and Blumm 2008). The Arizona Supreme Court extended the PIA standard in 2001, finding that agriculture is not the only means to determine tribal water allocations and that water is also needed by tribes for other purposes.[4] The Arizona Supreme Court found that the purpose of a federal Indian reservation is to serve as a "permanent home and abiding place" to the Native American people living there, and that water allocations must satisfy both present and future needs of reservations as "livable homelands."

Litigation for a determination of water rights on paper is an expensive and lengthy process. Some tribal governments have negotiated settlement agreements, foregoing a significant percentage of their legal claims to water in exchange for a secure allocation and for funding for the infrastructure necessary to gain the actual value of water resources (Clinton et al. 2010). Congressional action is needed to approve settlements and allocate the funding necessary to build water-delivery infrastructure. Between 1986 and 2006 Congress enacted twenty settlements into law (Royster and Blumm 2008). In spite of the cost, some tribes have preferred litigation, because with settlements, tribes invariably give up some measure of their legal rights to water, leaving them in a weaker bargaining position. Many examples of current tribal vulnerabilities are linked to water allocations. In a warmer and drier Southwest, conflicts over water appear imminent.

In the arid Owens Valley of California, spring and summer snowmelt are crucial to water supplies. The Big Pine Paiute Tribe of Owens Valley channeled this runoff to irrigate important food plants, and have observed changes to runoff in the watershed. Repeat photography of upstream Palisade Glacier shows notable shrinkage in recent decades. The tribe shares water with the Los Angeles Department of Water and Power (DWP), which owns nearly all the water rights in the valley. DWP allocates the tribe 1,116.32 acre-feet per year based on a 1939 land exchange between the federal government and the city (Gorin and Pisor 2007). Water shortages are likely to increase DWP's export of water from the Valley, leaving the Big Pine Paiute with an uncertain water supply.

## 17.8 Climate Change Mitigation Strategies

Despite needing additional resources, tribes are forging ahead to address climate change. Many see climate change mitigation and energy conservation as great financial opportunities that may help address current economic woes and the challenges of a limited resource base. The Pueblo of Jemez has begun constructing a utility-scale solar project in New Mexico. Tribes with mitigation plans include the Gila River Indian Community, Hopi Tribe, Navajo Nation, and Yavapai-Apache Nation. Examples outlined below depict some of the current activities.

The Pinoleville Pomo Nation, in partnership with the University of California, Berkeley, launched a sustainable housing program. Drought conditions within and around the Pinoleville Pomo Nation were taxing residents and the local government resources. Heating and cooling inefficient standard houses funded by the U.S. Department of Housing and Urban Development (HUD) also placed an increased burden on residents (Shelby et al. 2010). A self-sufficient, sustainably focused community model for housing, energy, and water conservation now addresses these issues through the use of solar photovoltaic systems, wind turbine systems, passive and active solar water heaters, grey water systems, and passive building design strategies such as passive solar gain and sun shading.

The Rincon Band of Luiseño Indians, in San Diego County, owns Harrah's Rincon Casino and Resort. When the economy declined in 2008 and 2009, Rincon still invested $13.5 million in energy-efficient retrofits and a one-megawatt solar plant to power the casino (Wolfe 2010). The tribe commissioned the solar plant in conjunction with a casino-wide retrofit of rooftop air-conditioning. A modified chiller plant captures waste heat for hot water in the casino's 662 hotel rooms. According to EPA, this saves 3.3 million kWh/year. The 3,986-panel solar plant provides 90% of the required power for heating, ventilation, and air conditioning, generating enough energy to power 2,200 homes. Through offsets, the solar array also saves 3.5 million KW hours per year, providing enough electricity for 583 individuals (based on average individual use of 6,000 KW hours/year).

Among the tribe's many additional mitigation and environmental sustainability practices are the use of solar induction to heat Harrah's pool and the composting of green waste for the property's organic gardens (diverting 6,000 pounds of waste per month).

LOOKING FORWARD. With continuing climate change effects, Native American lands, communities, cultures, and traditions are at risk. Vulnerability is closely linked to external land use policies, political marginalization, water rights, and poor socio-economic conditions. Tribes will be important parties to any future proceedings that deal with water shortage allocations or coordinated reservoir operations because of their reserved water rights. These issues are likely to intensify in an era of climate change. However, there have been few climate change studies on tribal lands and little documentation of the impacts. Studies that are available show that impacts to tribal resources are already underway in at least in some areas of the Southwest. Additional transformation of ecosystems by fire, pests, and disease, exacerbated by altered climatic conditions, are certain to affect traditional foods and medicines.

Many reservations, particularly those with large land holdings, have insufficient capacity to adequately monitor climatic conditions (Ferguson et al. 2011). Without monitoring, tribal decision makers lack necessary data to quantify and evaluate the changes taking place and to plan and manage resources accordingly. In addition, lack of information from tribal lands that typically have more extreme environments leaves climate scientists without crucial information from areas that are likely to see early impacts from climate change. Most reservations lack the data necessary to contribute to more accurate downscaled climate models, because meteorological monitoring is sparse over areas of significant size. The latest U.S. Census (2010) shows that some reservations are losing the younger segment of their population to emigration; this trend is cause for concern among those in tribal governments who interpret the changing demographics as a sign

of untenable living conditions due to dwindling water resources and increasingly desertified rangeland.[v]

Despite all of the challenges, Native communities also have much to offer the climate science community. Native communities have persisted and adapted during periods of wide-ranging natural climate variability. The role of indigenous environmental knowledge has received increasing attention, and studies of local environmental knowledge show that it contributes greatly to our understanding of ecosystem change (e.g. Newton, Paci and Ogden 2005; Green and Raygorodetsky 2010; Pearce et al. 2010; Sanchez-Cortes and Chavero 2010; Alexander et al. 2011; Harris and Harper 2011; Singh, Bhowmik and Pandey 2011). In spite of fewer economic resources, or perhaps because of them, many Southwestern tribal communities are exemplary in their efforts to mitigate climate change, and are actively seeking resources to assist with adaptation.

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## Endnotes

i Stevenson, Atta, (November, 2011)."California Indian Water Commission: Statement on Climate Change." Written communication. The California Indian Water Rights Commission consists of Tribal People dedicated to the protection of sacred sites, tribal water, and other inherent rights. According to Stevenson, "We offer our opinions to give voice to our relatives that cannot speak for themselves, the fish, the trees, winged-ones, etc., and especially the water."

ii U.S. Department of the Interior, Bureau of Indian Affairs (August 2011) Letter to tribal leaders and request for proposals 5p.

iii Jill Sherman-Wayne, (January 2012). Written communication.

iv In re General Adjudication of All Rights to Use Water in the Gila River System and Source, 35 P.3d 68 Ariz. 2001.

v John Leeper (October 2011). Director of Navajo Nation Water Resource Management, written communication.