

CHAPTER 12

POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE FOR NATIVE PEOPLES AND HOMELANDS

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Contents of this Chapter

Chapter Summary

Introduction

Historical Context

Geographical and Socioeconomic Context

Climate and Ecological Context

Scenarios for Future Climate

Key Issues

Tourism and Community Development

Human Health and Extreme Events

Rights to Water and Other Natural Resources

Subsistence Economies and Cultural Resources

Cultural Sites, Wildlife and Natural Resources

Coping and Adaptation Strategies

Enhance Education and Access to Information and Technology

Promote Local Land-use and Natural Resource Planning

Participate in Regional and National Discussions and Decision-making

Crucial Unknowns and Research Needs

Literature Cited

Acknowledgments

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CHAPTER SUMMARY

Context

Native peoples, including American Indians and the indigenous peoples of Alaska, Hawaii, and the Pacific and Caribbean Islands, currently comprise almost 1% of the US population. Formal tribal enrollments total approximately two million individuals, more than half of whom live on or adjacent to hundreds of reservations throughout the country, while the rest live in cities, suburbs, and small rural communities outside the boundaries of reservations. The federal government recognizes the unique status of more than 565 tribal and Alaska Native governments as “domestic dependent nations.” The relationships between tribes and the federal government are determined by treaties, executive orders, tribal legislation, acts of Congress, and decisions of the federal courts. These actions cover a range of issues that will be important in adapting to climate change, from responsibilities and governance to use and maintenance of land and water resources.

Tribal land holdings in the 48 contiguous states currently total about 56 million acres, or about 3% of the land. This area is approximately the size of the state of Minnesota. Additionally, Alaska Native corporations hold approximately 44 million acres of land. Despite the relatively extensive total land holdings, most individual reservations are small, supporting communities with populations of less than 2,000. Larger reservation populations, while unusual, do reach as high as 200,000 on the Navajo Reservation.

The federal government has recognized that tribes and tribal governments also have legal rights in territories that lie beyond the boundaries of their respective reservations. Treaties in the Pacific Northwest and the north-central states of Minnesota, Wisconsin, and Michigan recognize rights of tribes to fish, hunt, and gather off-reservation. Further, federal legislation has recognized tribal interests in historical and cultural interest areas beyond reservation boundaries. These interest areas cover a significant fraction of the 48 contiguous states, generally matching the “Native Homelands” that Native peoples inhabited prior to or since European settlement.

With the beginning of clearly observable climate change, and because of the relationships of plants, water, and migrating wildlife with ecosystems outside reservation boundaries, the potential consequences of climate change create significant interest

among Native peoples. These interests arise because the consequences will affect both their reservation lands and the much larger land areas encompassed in the concept of Native homelands. While each tribe will face its own challenges, this chapter focuses on a few general issues facing large numbers of Native peoples, particularly American Indians. More region-specific issues are covered in the various regional sections of the report, notably in those dealing with the Pacific Northwest and Alaska.

Climate of Past Century

- During the 20th century, much of the western US, where most reservation lands are located, has warmed several degrees Fahrenheit, contributing to apparent changes in the length of the seasons.
- After relatively dry periods in the central and western US during the first half of the 20th century, the second half has been wetter, with more runoff in key river basins.

Climate of the Coming Century

- During the 21st century, the Hadley and Canadian model scenarios both project that temperatures in the western US are likely to rise significantly (typically 5 to 10°F) with even larger increases possible in the Great Plains and Alaska.
- Greater precipitation is projected for the southwestern US, although projections are uncertain as to how far inland the increase is likely to extend.
- Although rainfall is likely to increase in many regions, the higher temperatures will increase evaporation, likely causing a soil moisture deficit in some regions that will tend to dry out forests and grasslands.

Key Findings

Sustaining economic vitality will require thoughtful planning because many reservation economies and tribal government program budgets depend heavily on agriculture, forest products, and tradition- and recreation-based tourism, which are all likely to be affected as the climate shifts and warm extremes become more frequent. For example, hotter and drier summer conditions are likely to affect recreational use of forest campgrounds and lakes. Economic diversification has the potential to reduce the existing vulnerability.

Preparing for the health and welfare implications of unusual climate episodes is likely to become more important as climatic patterns shift and landscapes change. This is likely to be particularly important because Native housing is typically more sensitive to the prevailing climatic conditions than national average for housing. As a result, increasing use of air-conditioning is not as ready a means of addressing an increasing frequency of very hot and dry conditions. In addition, increased dust and wildfire smoke may well exacerbate respiratory conditions.

Ensuring stable water supplies for tribal lands and surrounding users will require consideration of climate variability and change in management of water resources and in negotiations concerning Indian water rights. Financial resources are also likely to be needed to address infrastructure issues. It is possible that increased precipitation in the Southwest could help to diminish water concerns in that area while other areas are likely to face decreased water availability.

Although only a few tribal economies in Alaska and other regions are primarily based on subsistence,

many tribal communities depend on their environment for many types of resources. A changing environment puts such resources at risk, which will affect both sustenance and cultural dependence on environmental resources.

Sacred and historically significant sites (and the experiences associated with them) and cultural traditions are likely to be significantly affected. Because some sites are located in vulnerable locations, changes in climate and ecosystems are likely to alter the site environment. Changes in the timing of animal migrations and changes in the seasonal appearance and abundance of both plants and animals are also likely.

Coping Options

Increasing education about basic science issues and health and wellness as well as increasing scientific and technical expertise could help to build economic resilience. Increased monitoring of ongoing changes and improved projections of future changes are needed to improve the quality of planning and preparing for climate change. Enhancing access to information and technology has the potential to alleviate some of the stresses from climate variability and change.

Promoting and enabling local land use and natural resource planning are likely to help create the conditions for prudent preparations for and responses to climate change. Increasing participation of Native peoples in regional and national decision-making is needed in recognition of the connectedness of tribal reservations, surrounding lands, and larger regional and even national landscapes.

POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE FOR NATIVE PEOPLES AND HOMELANDS

The Earth and Nature are inseparable from Indians themselves. Land sustains the lifestyle of countless tribes, even when little acreage is in production or has little productivity. Land sustains far more than subsistence, and indeed many Indians recognized decades ago the folly in attempting to sustain their daily needs on acreage that is marginal, both in resources and in per capita size. But land has emotional meaning, a psychological significance for the Indian that is far more intense than our nostalgic longing for the family farm and a rural way of life.

James Rattling Leaf,
Sicangu Lakota

INTRODUCTION

With projections of significant changes in the climate and in the character of the land and its resources over the next century, American Indians and the indigenous peoples of Alaska, Hawaii, and the Pacific and Caribbean islands that are part of the US will face special challenges. Although counting methods vary, Native peoples currently comprise almost 1% of the US population (see end note 1). Tribal enrollments total approximately two million individuals, of which about 1.2 million live on or adjacent to hundreds of reservations throughout the country. The other 40% of Native peoples live in cities, suburbs, and small rural communities outside the boundaries of reservations (BIA, 2000a). The federal government recognizes the unique status of more than 565 tribal and Alaska Native governments as “domestic dependent nations.” The relationships between tribes and the federal government are determined by treaties, executive orders, tribal legislation, acts of Congress, and decisions of the federal courts. These agreements cover a range of issues that will be important in adapting to climate change, from responsibilities and governance, to use and maintenance of land and water resources. It is important to note that many of the phenomena of a changing climate addressed in this chapter are precisely those which affect rural areas throughout the United States. At least half of the Native peoples of the US live in reservations in rural areas. Why, then, if climatological phenomena are so similar, should there be a separate chapter addressing the issues of Native peoples? The answer is at least twofold.

First, the institutional, legal, economic, and political structures in Indian country differ significantly from those of other rural communities. These structures determine and constrain, to a great degree, the resources that Native peoples can deploy in addressing issues that arise from changes in climate.

Secondly, different cultures provide their members with different kinds of tools for addressing life’s situations: language, preferences of technology, responses to innovation, tastes in food, attitudes towards strangers, relationships to the physical environment. Native peoples, with traditional cultures as different from each other as they might be from those of Swedish-Americans, bring a wide variety of cultural tools and experience to issues of climate change and adaptation. This chapter examines a number of those tools and their implications for adaptation to significant environmental changes.

The chapter is based on the Native Peoples/Native Homelands portion of the Assessment (NPNH, 2000), which is examining the potential for climate-related impacts that are likely to affect Native peoples and the interactions of these impacts with contemporary Native cultures, communities, and future generations. Although the diversity of land areas and tribal perspectives and situations makes generalization difficult, Native peoples recognize that becoming more resilient to variations in the climate and preparing for and adapting to climate change will require special attention. The preceding regional sections of this report, for example the chapters on Alaska, the West, and the Pacific Northwest, highlight a number of region-specific issues. This section reports on aspects that reach beyond what citizens of particular regions will experience.

HISTORICAL CONTEXT

Over the last 500 years, essential environmental balances that sustained Native peoples in North America for many millennia began to shift rapidly. Forests were cut for homesteads and farming. Alien plants replaced native grasslands. Dry lands flooded, rivers changed their courses, and ponds and swamps drained away as watercourses were dammed and channeled. Important providers of nourishment and protection – buffalo, salmon, and shad – were harvested to near extinction. New and strange creatures – horse, cow, pig, sheep, and pheasant – shoved aside nature’s important spiritual guardians and came to dominate local economies. Exotic new diseases eradicated whole villages. Tribal governments and relationships fell. Spiritual leaders lost their followers. Communities – even entire tribal nations – were forced to relocate.

Five hundred years ago, the population of Native peoples in North America is thought to have ranged between about 10 and 18 million. Between 1500 and 1890, the population of Native peoples on the continent was declining at an average rate of between 500,000 and 850,000 individuals each 20-year generation, and by 1890 had dropped to only 228,000 (Snipp, 1991). Some opinion leaders predicted that Native people would soon disappear. However, those who predicted the “vanishing of the Red Man” substantially underestimated the endurance and adaptability of Native peoples, and the strength of Native perspectives and values. Over the last 100 years, the population of Native peoples has grown almost ten-fold as Native communities have been rebuilt; artists, craftworkers, and writers have created a renaissance of beauty and meaning; and economic development has accelerated (Cornell, 1998).

In that the global temperatures have varied relatively little over the past millennium, the environmental changes that drastically altered the lives and circumstances of Native peoples as a whole since 1492 seem to have been more influenced by changes

in climate at the continental and regional levels. In addition, as Native peoples were displaced and national development occurred (Brown, 1991), Native peoples experienced continental-scale changes in their surroundings that are not unlike the types of changes that all Americans may face in coming decades. The changes were substantial in magnitude, surprising in their occurrence, unmanageable by available technologies and existing forms of government, and generally irreversible. In those respects, the changes may provide insights of the kinds of transformations – cultural, economic, and social – that global changes in climate may bring, both for Native peoples and for America as a whole.

GEOGRAPHICAL AND SOCIOECONOMIC CONTEXT

The lands held by Native peoples are extensive. In addition to the 40 million acres of land held by Alaska Natives, tribal lands in the rest of the US currently total about 56 million acres (Department of the Interior, 1996). The lands outside Alaska amount to about 3% of the land area of the 48 contiguous states, or approximately the size of the state of Minnesota (see Figure 1). The largest portion of Indian lands are held on reservations, so named because they consist of lands that were reserved for



Figure 1: Map of Indian lands in the conterminous United States (BIA, 2000b). The largest areas are located in the central to western US. See Color Plate Appendix

the sole use and occupancy of Indian peoples from the vast expanses of land which were ceded to the United States government (Brown, 1991). Property ownership by Native peoples of the Pacific and Caribbean islands varies greatly because of a variety of circumstances, including traditional rights and leadership and historical legal rights. As indicated in the Islands chapter, however, some island lands are overseen by clans with responsibility for stewardship on behalf of their members, whereas on other islands there are no longer reserved land rights.

By far the majority of reservations are small, both geographically and demographically, with populations less than 2,000 (Tiller, 1996). These lands, although they are owned by tribes or individual Indian people, are held in trust for the owners by the federal government, in much the same way that banks or other trustees hold property for heirs until they come of age and can assume personal management of the property. One result of this system of trusteeship is that tribes and individual Indian people have had very limited control over the use, environmental management, or profits of their own lands. For much of the 20th century, in fact, many of the decisions over these matters rested with the federal government, not with the tribes themselves. Only in the last several decades have tribal governments taken over more control of and responsibility for their lands.

From the most basic perspectives of the American legal system, reservations may be viewed as jurisdictional islands, largely exempt from the laws of the states that surround them. Tribal governments hold the authority to levy taxes, regulate commerce, pass and enforce civil and criminal codes and, in principle, regulate the use of tribal lands and water. While federal laws prevail, state authorities generally have no rights of enforcement within these jurisdictional islands.

However, from the perspective of tribal environmental and land management policies and practices, the paradigm of reservations as islands is inadequate. First, the paradigm is inadequate environmentally because these "islands" are surrounded not by oceans, but by land, and so these lands are intimately tied to the forests, grasslands, watersheds, and other ecosystems surrounding them; thus, the changes on Native and surrounding lands are closely coupled. Second, because many reservations have considerable populations of non-Indians residing within the exterior borders of reservations (see end note 2), the paradigm is inadequate administratively. Third, throughout the country, non-Indians also

work on Indian lands because of the leasing of tribal lands to non-Indian farmers and ranchers – or, for example, in the case of Agua Caliente, near Palm Springs, California, for commercial development. The leasing of reservation lands is a long-standing practice and a vital source of income to the landowners (Lawson, 1982). Complicating matters further, a major portion of the lands that were allotted to Indian heads of household are now managed either by the Bureau of Indian Affairs (BIA) or by the appropriate tribal government. This land is also frequently leased to non-Indian farmers or ranchers with the proceeds from the leases then being divided among the descendants of the original allottee. Maps of land ownership and tribal jurisdiction on many individual reservations thus resemble checkerboards, greatly complicating planning efforts. At the same time, judicial decisions have sharply limited the jurisdiction of tribal governments and tribal courts over non-Indians.

As a result, many tribes face severe legal difficulties in creating or enforcing comprehensive plans for land use or natural resource management, a situation that will complicate planning for climate change. For example, if a tribal government creates an environmental code, enforcement over an entire watershed or forest may be impossible without the voluntary consent of non-Indian owners of property within and outside of reservation boundaries. If a tribe leases cropland, grazing rights, or timber to non-Indians, environmental regulations can conceivably be written into the terms of the leases, although long-term traditions are likely to be difficult to change and the practical job of enforcing new regulations is likely to stretch the resources of small and understaffed tribal governments (Getches et al., 1998; Pevar, 1992).

Tribal governments also have some legal rights in lands beyond the boundaries of reservations – rights that may establish precedents for collaboration on issues involving climate and environmental changes. For example, the federal government has recognized historical and cultural interests of tribes and tribal governments concerning broader regions, often called "Native Homelands," which include lands occupied by Native peoples at present or in the past. Within the pre-determined boundaries of historical and cultural interest areas (generally homeland areas inhabited by a particular Native people prior to contact with Europeans), tribes are entitled, for example, to establish claims to human remains, if evidence of kinship or ancestry can be established.¹ These historical and cultural interest areas cover a

¹ For further information, see <http://www.doi.gov/oait/docs/eo13007.htm>.

significant fraction of the 48 contiguous states, widening greatly the areas of interests of Native peoples.

CLIMATE AND ECOLOGICAL CONTEXT

Reservations are present in all of the major ecosystems across the US, including the unique environments represented by Alaska and the islands of the Pacific and Caribbean regions. Native peoples have been experiencing the vagaries of climate on this continent for many thousands of years. The resource-rich environment created by the woodlands of the northeastern, southeastern, and Great Lakes regions, especially the presence of deer, rabbit, beaver, fish, berries, and many other resources, allowed tribes to occupy particular regions for long periods. The Great Plains provided a source of grains and buffalo, along with fish and other resources, but the wide range of climate extremes caused these tribes to be relatively mobile in order to survive. The western US provided a wide array of environments, from coastlines to mountains and river valleys to deserts, and is now home to the greatest number of Indian reservations. The Native peoples of Alaska have developed a lifestyle that depends, in large part, on very cold winters. Those living on islands depend on the reliability of the rains, and are adversely affected by either too much or too little precipitation.

Their adaptability, and the histories of the experiences and the lessons that have been learned about coping with climate fluctuations, have sustained Native cultures through many generations. Native oral histories are now being linked with past climate data derived from tree rings and other sources in ways that are enriching understanding of past climatic conditions. Oral histories often correlate with events identified in the geological record, such as periods with high or low rainfall, periods of warm or cold winters, and periods of flooding or drought (e.g., Deloria, 1997). What makes these histories especially valuable is that they often record not only the consequences of these climate fluctuations for people and for the environment around them, but also the responses that helped the communities to adjust and survive. Thus, the retelling of these events by tribal elders has created a populace that is relatively well informed about how to adapt to external stresses.

There are, however, two key changes that will limit the application of some of the lessons to the issue of climate change, and are likely to create greater vulnerability than in the past. First, the changes in climate are likely to be larger and more long lasting than the fluctuations experienced in the past. Second, earlier coping strategies of Native peoples, on which many of their histories and traditions are based, relied on shifting and moving, sometimes from one food source to another, sometimes from one place to another, or sometimes to find alternative sources of food and water, or to intersect with the annual migrations of wildlife. In the Southwest, archeological evidence and Native oral histories indicate that the great regional drought of the 13th century caused the ancestral Pueblo people to abandon their permanent homes in the mesas and valleys of marginal areas (see box, "Lessons from the Relocation of the Ancestral Pueblo People in the 13th Century"). When the ability to cope in one place was exceeded, Native peoples moved, later returning if and when climate permitted.

Over recent decades, Native peoples have been observing that changes in the environment have been occurring, some due to regional or global-scale changes in the climate and some due to changing practices of land management and use. These changes are noteworthy, both because Native peoples are changing their practices and because of the nature of the observations themselves. In northwestern Alaska, for example, elders lament that winter temperatures have become so warm (now typically only -20° F instead of -70° F) that the traditional ecosystem on which they have depended for generations is deteriorating and is no longer able to provide the needed resources. In the Southwest, recollections by elders (corroborated by Army records from the early 1800s) are of valleys full of tall sacaton grasslands, whereas the region now is scarred by deep arroyos and supports only sparse vegetation, likely as a result of overgrazing and subsequent drought. All across North America, tribal histories indicate that change is occurring.

Native peoples today feel vulnerable to significant environmental changes because they are no longer able to cope easily with changes by relocating. Few contemporary tribes can afford the purchase of large tracts of new land, and federal laws hinder the transfer or expansion of tribal jurisdiction. Tribes therefore see their traditional cultures directly endangered by the magnitude of the projected climate change. Had the ancient Anasazi been compelled to remain in place, the culture and way of life of an indigenous people that can be traced back

Lessons from the Relocation of the Ancestral Pueblo People in the 13th Century

About 2000 years ago, ancestors of today's Pueblo people inhabited expansive areas of the Southwest, including much of what is now known as New Mexico, Arizona, Utah, Nevada, and Colorado. They developed advanced architecture, moved water via extensive and complex irrigation systems to grow crops, made baskets and pottery, and created sophisticated social and religious structures. Today, those ancestral homelands are dotted with the ruins of large villages that show deserted centers of trade and commerce, abandoned road systems and multi-story houses, forsaken art, and elaborate ceremonial chambers.

What happened to these communities is believed to have been a result, quite possibly in large part, of changes in the climate of this region. In the late 1200s, evidence from the growth rings of trees documents significant changes in the weather and climate. In particular, proxy evidence indicates that droughts became more frequent in southwestern North America. These conditions in turn would have led to disruption of the agricultural lifestyle of the communities dependent on the runoff from the southern Rocky Mountains. Although these regional climate changes were not particularly evident in the global climate record (see the Climate chapter's description of the 1000-year climate record), the regional changes were apparently so large that they contributed to the abandonment of these ancient cities. Cross-sections of soil combined with pollen records tell a similar story of changing conditions, with increasing erosion, ruined farmlands, and possibly a prehistoric "dust bowl." As communities became unable to adapt their abilities to grow food to the deteriorating environment, these changes apparently triggered a mass migration of what had been a typically stationary, agriculture-based people.

Pueblo people living today pass on migration stories that recall the early journeys that brought them to the villages they still occupy, mostly along the Rio Grande in New Mexico. Some clans migrated as far to the west as today's Hopi tribe in Arizona. Others settled in the Pueblos of Zuni, Acoma, and Laguna. Since these moves, much has changed that limits the ability of Native peoples to move again to escape the consequences of climate fluctuations and change. For the Pueblo people, Spaniards claimed their ancestral homelands in the early 1500s. Subsequently, tribal land holdings were generally confined to the very limited boundaries that persist to this day. Thus, if another disruptive climate fluctuation or change were to occur, the Pueblo people could no longer easily move as a group to places with better conditions in order to preserve their societies and cultures.

thousands of years would likely have been lost forever. This history provides a context for thinking about the potential consequences of future changes in the climate.

SCENARIOS OF FUTURE CLIMATE

Most of the large Indian reservations in the US are located in the central and western United States. Coincidentally, most climate models project that changes in temperature and precipitation will be greater over the western than over the eastern US. The Canadian and Hadley model scenarios project warming of as much as 5 to 10°F (3-6°C) over the 21st century over much of the western US, with more warming during winters than during summers in many areas (see Chapter 1 for more details).

The warming is already being experienced by some Native peoples. Regions in Alaska are already experiencing significant warming, with some melting of permafrost and sea ice. Across northern North America, warming is already lengthening the period of plant growth. Such changes are expected to intensify. These trends will affect agriculture, wildlife migrations, flowering seasons, and other important ecological events or occurrences that are closely tied to seasonal change.

Some models project that, particularly in the Southwest, warmer winters will also bring increasing wintertime precipitation, a rising snowline, and earlier springtime runoff, thereby affecting the timing and volume of river flows. Increased precipitation would be expected to increase river runoff, which, if it occurs in seasons when the water can be used or stored, may help to augment water supplies. Increased precipitation, however, can cause erosion on sparsely vegetated surfaces, distribute

contaminants more widely, and create greater potential for flash flooding. Moreover, warmer conditions will also lead to increased evaporation, especially in summer, that will dry summer soils and vegetation in ways that may more than offset the increase in runoff in some regions. For example, these changes will likely lead to lower river and lake levels in the northern Great Plains and Great Lakes.

KEY ISSUES

The national workshop on Native Peoples/Native Homelands identified a wide variety of issues facing Native peoples. Assessment studies of issues of specific interest to Native peoples in particular regions are just beginning; information on the first such study, reporting on issues in the southwestern US, can be found at <http://native-peoples.unm.edu/>. In this report, issues that are primarily regional are addressed in more detail in the chapters dealing with particular regions (e.g., Alaska) whereas issues that have broader national implications for Native peoples are addressed in this chapter. These issues include:

Tourism and Community Development. In a number of regions, Native economies are strongly dependent on tourism, agriculture, and other environmentally sensitive activities, so that shifts in temperature and precipitation and the ecosystems that are based on the prevailing climate are likely to require adjustments away from traditional activities. For example, hotter and drier summer conditions are likely to limit recreational use of forest campgrounds and lakes at lower elevations while potentially allowing more use at higher elevations.

Human Health and Extreme Events. As a result of insufficient economic development, Native housing is typically more sensitive to the prevailing climatic conditions than the national average. As a result, increasing use of air-conditioning is not as ready a means of addressing an increasing frequency of very hot and dry conditions. In addition, increased dust and wildfire smoke may exacerbate respiratory conditions.

Rights to Water and Other Natural Resources. Native water rights are established in a variety of treaties, agreements, and court decisions. Provided financing is available, significant amounts of potentially irrigable land exist on reservations, and the potential exercising of these rights along with precipitation changes is likely to complicate water resource allocations, negotiations, planning, and management.

Subsistence Economies and Cultural Resources. Although only a few tribal economies in Alaska and other regions are primarily based on subsistence, many tribal communities depend on their environment for many types of resources. A changing environment puts such resources at risk, which will affect both sustenance and cultural dependence on environmental resources.

Cultural Sites, Wildlife, and Natural Resources. The environment, both climate and the landscape, provides an important sense of place for Native peoples, both for historical and cultural reasons. As the climate changes and vegetation patterns and the presence of wildlife and migrating species shift, the cultural context of Native peoples, who view themselves as tightly coupled with and integral to the natural environment, will be disrupted, with little recourse as the shifts occur.

1. Tourism and Community Development

The most urgent priorities for tribal governments and communities over the past thirty years have been economic development and job creation. Many tribes have based their development initiatives around land-based enterprises, including dryland and irrigation-based agriculture in the central and western US; forestry and forest products in the central, western, and sub-Arctic regions; and recreation and tradition-based tourism in areas ranging from Hawaii and Alaska to the central, western, and southwestern US. All of these activities are dependent on favorable weather and climatic conditions. Although few of these enterprises have generated enough income to develop a strong economic base for entire tribes, they are all vital to economic development for tribal communities. Adverse conditions, from severe winter storms to unusually wet or dry conditions, can have very severe economic effects, especially because tribal communities are already economically stressed. The 1990 census indicated that 31.6% of all Indian people were below the poverty line, compared to 13.1% of the total population (US Bureau of the Census, 1990). From 1969 through 1989, of the 23 reservations which have data for the period, per capita income declined on 18 reservations during the second decade (Trosper, 1996). The sustained growth of the American economy over the past decade has, for the most part, bypassed Native American households and reservations.

Although none of the primary barriers to development on reservations is currently a result of long-

term climate change, recent variations and changes in weather patterns are requiring tribes to adapt and adjust their actions and plans. Tribes have already identified many local needs in response to an increasing frequency of disruptions from severe storms, including improving or re-routing roads (many of which are unpaved), flood control and bank stabilization, providing new or more reliable water and drainage services for industrial sites, strengthening communications links and power supplies, and altering schedules and calendars at schools and medical clinics to adapt to changing weather conditions. Tribal communities now experiencing sharp changes in precipitation patterns are already modifying reservation infrastructures to deal with such situations². Projections of increased occurrence of extreme rains are likely to intensify the need to improve infrastructure on reservations. Significant warming and the rise in the heat index are likely to necessitate alterations in community buildings and water supply systems. For the future, particularly for tribes in the Southwest, longer-term changes in water resources on which many tribes depend are likely to have significant consequences for resource-based sectors such as agriculture and industry that depend on stable water supplies.

Many tribes also are basing an increasing share of their economic development on recreation and tourism (Tiller, 1996). Tourism and recreation-based activities take advantage of the attractions of rivers, lakes, mountains, forests, and the other elements of the natural aesthetic beauty of reservations without, in most cases, causing long-term change. Cultural and historical sites and ceremonies of Native peoples can also be used to attract tourists. These activities provide income while also encouraging the re-establishment of customs and traditions that had been suppressed for many decades by federal policies.

The economic viability of many aspects of recreation and tourism, however, is based on natural attractions that depend on the prevailing climate – rivers and lakes provide water-based recreation opportunities, forests provide campsites and trails, and the wildlife, including migrating fish and birds, and flowering of plants, attract many visitors. As the climate changes, these environments will change: reduced winter runoff from reduced snow cover is

² Repeatedly during the assessment process, participants raised issues about the development of rural transportation systems. Reliable transportation is a major concern in many tribal communities, where many individuals cannot afford newer, more reliable, and fuel-efficient vehicles. Providing effective public transportation in rural communities – most particularly communities with limited incomes – improves access to employment, education, and medical services, and has the additional benefit of improving the efficiency of the use of fossil fuels, thus reducing the production of greenhouse gases.

likely to reduce the flow in many streams; drier summer conditions are likely to increase the fire risk and require closure of campgrounds; and the combined effects of climate and ecosystem change are likely to disrupt wildlife and plant communities.

Cultural traditions that draw visitors (and their money) are often tied to the cycles of the seasonal rhythms in plant and animal life, with some traditions honoring annual weather-related events that are likely to be significantly affected by climatic change. The willingness to visit reservations for such events is dependent on the existence (and even the perception) of a safe and healthy environment. Such conditions can be disrupted by unusual climatic occurrences. In 1993, for example, a hantavirus outbreak associated with unusually heavy rains induced by El Niño conditions created a perception of an unhealthy environment (Schmaljohn and Hjelle, 1997). The rains were conducive to high production of piñon nuts and other food sources, leading to an explosion in the hanta-bearing mouse population. This high mouse population then encroached on human populations, resulting in a number of virus-caused deaths (Engelthaler et al., 1999). This one event led to a significant reduction in tourist visits to the Southwest, especially to Pueblo country, indicating how vulnerable sensitive tourist-based economies can be in the event of the outbreak of rare, but frightening diseases, even when these outbreaks are not occurring primarily on Indian reservations. It is possible that a change toward more intense El Niño/La Niña variations could increase the likelihood of such conditions in that such variations would likely upset the predator-prey relationships that develop during less variable conditions.

While some economic diversification of reservation economies is underway, and casino gambling is becoming a basis for attracting tourists in a number of regions, tribal economies tend to be more closely tied to their environments than is typical for the economies in regions where the reservations are located. Because of this, tribal economies tend to be more vulnerable to adverse changes and, on the other hand, more likely to benefit from climatic changes that provide opportunities by enhancing water availability.

Adaptation Options

With many tribal lands already under climatic stress, and with the economies of Indian Nations strongly dependent on climatically sensitive activities such as agriculture and tourism, the lands and economies of many Native peoples are vulnerable to climate change. As a result of the less-diversified Native

economies, a larger share of financial resources will likely need to be devoted to ongoing adaptation than is the case for society as a whole, thereby possibly making tribal economies less competitive. To address this issue, enhancement and diversification of reservation resources and the strategic integration of tribal economies with local non-Indian economies could help to make the tribal economies more resilient and sustainable.

At the same time, climate change and resulting policy actions are likely to create some economic opportunities. For example, an increased demand for renewable energy from wind and solar energy could create new opportunities because undeveloped tribal lands could be an important resource for such energy in areas that are already developed. For tribes in the Great Plains, this region could utilize its tremendous wind resource and development could help to reduce greenhouse gas emissions as well as alleviate management problems created by demands for Missouri River hydropower, thereby helping to maintain water levels for power generation, navigation, and recreation. In addition, there may be opportunities for carbon sequestration.

2. Human Health and Extreme Events

The rural living conditions of many Native peoples increase the likelihood of impacts due to variations in the weather. Due to the poor economic conditions, housing on many reservations is old and offers limited protection from the environment. Although many traditional structures are designed to take advantage of the natural warmth or coolness of the landscape (e.g., by being located below ground, having thick walls, and being exposed to or sheltered from the sun), acclimation, both physiological and through use of appropriate clothing, is critical because homes in many areas lack effective heating and cooling systems. A recent study of energy consumption on Indian lands (EIA, 2000) found that reservation households are ten times more likely to be without electricity (14.2%) than the national average (1.4%). While warming in colder regions will alleviate some home heating needs, some acclimation has already occurred so this will not significantly reduce stresses. In presently hot regions, however, there is likely to be a significant increase in natural heating that will require new acclimation and responses as new extremes are reached. While an increase in the presence of air-conditioned facilities would help, it would also require changes in behavior toward a more indoor lifestyle along with improved housing and access to electricity.

Climate change is also likely to exacerbate the delivery of and need for health services. The delivery of health care to rural communities throughout the United States has already been affected significantly by widespread changes in demographic and economic patterns. Rates of depopulation in the least densely populated portions of the country are accelerating. As communities lose population and economic conditions stagnate, the numbers of doctors, pharmacists, and other health care professionals attracted to rural communities have been declining. Full-service health care is increasingly concentrated in regional centers, and consultation with a specialist increasingly involves, for rural residents, an extensive trip.

Reservation populations, on the other hand, are continuing to increase, as birth rates remain high, longevity increases, and tribal members move back to their home communities from urban areas. The institutional structure of health care delivery to Native peoples, however, differs sharply from the market-driven system that provides medical care for rural non-Indians. The federal government, as part of its trust responsibility for Indian people, provides the health care systems for reservation residents. The Indian Health Service (IHS), part of the United States Department of Health and Human Services, is the primary provider of medical services to Native peoples. IHS operates clinics, pharmacies, and hospitals in many tribal communities; in others, tribes have contracted with the federal government to operate health care facilities themselves.

Access to these health care facilities, however, is not always easy for reservation residents, particularly under extreme weather conditions. A single hospital, for example, serves the entire Rosebud Sioux reservation in South Dakota, where many roads are unpaved. The external boundaries of the reservation are approximately 120 miles east-to-west, and 60 miles north-to-south. The hospital is located in the southwestern part of the reservation and access can be disrupted or cut-off by extreme precipitation conditions (whether rain or snow). Because of the distances that many Native people must travel to health care facilities and the conditions of the roads, their access to health care is more subject to sharp variations in the weather than those living and working in cities, and extreme weather events are likely to cause significant interruptions in access.

Changes in climate would also create new challenges for community health. Drier summer conditions and the projected increase in forest fire incidence would likely lead to increased lofting of dust

and dust-borne organisms and an increase in forest fire incidence. The poorer air quality resulting from increases in smoke and dust would likely increase respiratory illnesses such as asthma. Hypertension and adult-onset diabetes are pandemic in tribal communities. As life spans increase, larger portions of the populations are becoming increasingly vulnerable to extreme temperatures, and increasingly dependent on uninterrupted access to such therapeutic interventions as kidney dialysis. Further, direct and side effects of many standard medications are affected by climatic conditions.

Adaptation Options

Health care delivery systems that serve Native communities will need to educate health professionals, paraprofessionals, and patients on the potentials for dehydration, overexposure to sunlight, and the need to restrict activity during hot weather. This need for education and appropriate care is intensified because many Indian people live in substandard housing that exposes them to heat and cold. Much of the most effective health education in Native communities is carried out by Community Health Representatives (CHRs), paraprofessionals employed and trained by the Indian Health Service or individual tribal health programs. Specific training, focusing on climate-related health and wellness issues, and targeted towards CHRs could enhance use of a system that has already demonstrated its abilities to reduce infant mortality rates and improve care for the elderly among many Native peoples.

In addition, consideration should be given to the design and construction of appropriate housing for Native peoples. Most housing construction on many reservations is financed through the federal Department of Housing and Urban Development. Tribal housing authorities, however, have taken over much of the responsibility for design, construction, and management of both rental and mutual self-help (purchasable by the occupant) housing units. Given the likelihood of significant changes in average temperatures, precipitation levels, and severe weather events, training and regular updates for decision-makers and technical specialists within tribal housing authorities are needed to assist in improving the design, construction, or remodeling of homes to increase resilience to extreme weather conditions.

3. Rights to Water and Other Natural Resources

For Native peoples, water is recognized as a cultural as well as a physical necessity. Water is vital for life and livelihood, especially for those relying on the

resources provided by natural ecosystems. Water is necessary for community use and the production of food as well as for fish, riparian plants, and wildlife. Water is particularly valued where it is most scarce, such as in the southwestern US. Prior to European settlement, water was not owned, but was viewed as a gift to be shared by all. Settlement – both by tribes on reservations and by other Americans – brought increasing demands for water and concepts of ownership that were not traditional to Native peoples. As a result, rights to water, including access to sufficient quantity and quality, are now established and guaranteed by treaties, statutes, and decisional law. Changes in the amount, timing, and variability of flows will affect the exercise of these rights.

Despite the many agreements and treaties, quantitative determination of existing Native rights to water remains a contentious legal issue over much of the western US. Access to water was a key issue in many of the treaties negotiated between tribes and the US government, especially when relocation of tribes to reservations restricted or eliminated their access to traditional homelands. These provisions became the subject of litigation as expectations were not met. The concept of federal reserved water rights for Indians originated in the landmark case *Winters v. United States* [207 US 564 (1908)] involving withdrawal of water from the Milk River along the Fort Belknap Reservation. The Winters Doctrine provided that in the treaties the federal government entered into with various tribes, the government had implicitly reserved a quantity of water necessary to supply the needs of the reservation³. Under this provision, the federal government's commitment of water rights would be paramount because it had created the Indian reservations and therefore had a fiduciary duty to protect water implicitly reserved by and for the tribes. The doctrine was based on a set of principles underpinning reservation establishment that retained for Indian tribes all rights not explicitly waived.

Indian reserved water rights have become a subject of considerable importance to tribes, states, the federal government, and private water users due to: (i) the scarcity of water, particularly in the Southwest and Great Plains; (ii) the reality of drought conditions; and (iii) uncertainties arising because of fully (or even over) appropriated watersheds and international water commitments (some of which do not account for tribal water rights at all). The courts

³The Winters Doctrine later also formed the basis for federal reserved water rights asserted by the government to obtain water for national forest, wetland, wildlife refuge, military, and other reservations.

have often had to resolve conflicting interests in the allocation of water rights, usually using a standard known as “practicable irrigable acreage” for determining the allotment to Indian reservations. This standard quantifies *Winters* rights by providing that allotments include sufficient water to provide for agriculture, livestock, domestic, recreational, cultural, and other uses. In addition, for some tribes, specific legal language also reserves water to maintain in-stream flows necessary to sustain fish or riparian areas. Figure 2 compares the acreage of Indian lands that are currently being irrigated in eleven western states with the areas that could potentially be irrigated under the *Winters* doctrine. Quite clearly, substantially increasing the areas of irrigated lands would significantly increase the amount of water being withdrawn from current resources, increasing the competition for water among the various users.

In some cases, tribes have not had the financial wherewithal to develop their water rights. In other cases, despite having high priority (i.e., senior) rights to sufficient water, tribes have often had to compete for access to water with non-tribal water users, including federal, state, and local governments. This has required negotiations, which have often proven to be time-consuming, costly, and complex. The potential for changes in the amounts and timing of water flows caused by climate change are likely to add to the complexity of the allocations, negotiations, agreements, and management of water resources.

As an indication of the complexity of the issues involved, consider the Southwest, where climate models project that there is likely to be additional precipitation (most probably as rain) in winter, but with earlier snowmelt and generally warmer and drier conditions during the summer. If this occurs, overall winter runoff is likely to increase while summer runoff is likely to decrease significantly. While an increase in annual precipitation could ease overall management of water resources (at least to the extent that increases in the amount of vegetation do not counterbalance the likely increase in runoff), if the extra runoff in winter is not retained in reservoirs, then the increased needs for water in summer would likely increase water demands. Further, water storage that benefits some could be detrimental to others, an example of which is described in the box on “Shifting Ecosystem Boundaries” later in this chapter. With Native peoples exercising their historical water rights more fully, and with federal policies requiring additional amounts of water to protect the environment, the amount of water available for irrigation, communities, and other uses is likely to

decline, particularly during years in which climate fluctuations lead to reduced overall water flows. Water quality is a major issue that is coupled to the issues of water rights and water quantity; as water quantity changes, water quality is likely to change as well. Water quality affects everything from the environment for fish to the purity of drinking water to the quality of aquifers. In addition, because of the cultural connection of Native peoples, water pollution and poor water quality can have unusual ramifications. In the Northeast, for example, streams have been polluted by persistent organic pollutants and heavy metals, so fishing and fish consumption are not permitted. These prohibitions affect not only the diets of Native peoples who observe such restrictions (many do not for cultural reasons), but the restrictions have also reduced the opportunity for intergenerational connection while fishing. In the Southwest, water purity has become an issue based on water’s use in religious ceremonies (see box “Ensuring Water Quality for Religious Ceremonies”). The prospect of diminished summertime water flows, along with more intermittent flows of some streams as a result of an increase in frequency and intensity of extreme rains, introduces the potential for water quality to become an issue in some regions.

Adaptation Options

Where water is scarce, it merits careful stewardship. Improving the efficiency of water capture and use

Currently Irrigated vs. Potentially Irrigable Indian Land

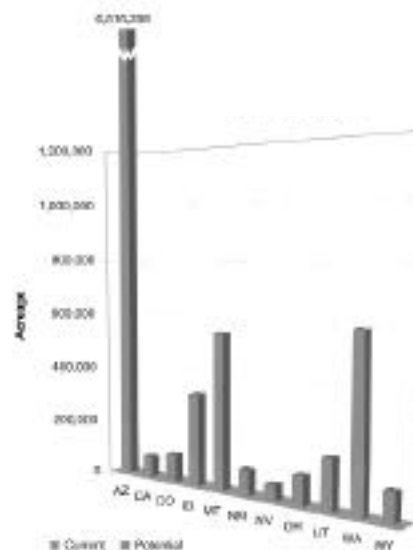


Figure 2: Comparison of existing acreage being irrigated on Indian lands in eleven western states with the maximum acreage that could potentially be integrated based on the *Winters* doctrine that is applied for determining Indian water rights (Riebsame et al., 1997) See Color Plate Appendix

through more efficient irrigation practices and choosing and growing crops that need less water are steps that can be taken now, provided resources are available. As an additional possibility, increased use of cisterns and other water harvesting techniques of the type used several centuries ago by tribes living in the Southwest could also provide a very localized means of conserving water. Increasing in-ground storage of water through artificial recharge is another possibility. Other historical practices of Pueblo cultures may also be applicable; mapping of ancient land use practices show extensive use of water management techniques, including gridding of gardens to slow runoff, pebble mulch fields to reduce evaporation, stone-lined drainage channels to reduce leakage, and terraces on hillsides to retain water and prevent erosion. Quite clearly, however, the climate changes, ensuring the reliability and availability of water resources for tribal lands and surrounding users will require special consideration.

4. Subsistence Economies and Cultural Resources

Native lands have provided a wide variety of

resources for Native peoples for thousands of years. Forests, grasslands, streams, coastal zones, and more have provided, and for many groups still provide, substantial amounts of food, fiber, fish, medicines, and culturally important materials. Native traditions are also very closely tied to natural events and resources, including migrating birds and fowl, land animals, fish, and medicinal plants, creating an important cultural link to the land. Indeed, subsistence economies were the predominant form of community organization in North America prior to the colonization of the continent by Europeans. It is clear from oral traditions of Native peoples themselves throughout the continent, and from the accounts of the first Europeans who contacted them, that subsistence economies were able to sustain communities in lives of comfort, relative stability, and abundance, with sophisticated artistic and intellectual traditions.

With the spread of the market economy across the US, especially during the 20th century, subsistence economies began to disappear as the resources necessary to support them were absorbed by commercial markets. By the end of the 20th century, subsistence economies among Native peoples were signif-

Ensuring Water Quality and Quantity for Legally Protected Religious Ceremonies and Cultural Practices

In 1986, the US Environmental Protection Agency (EPA) was authorized to treat tribes as states for purposes of grant and contract assistance, regulatory program development, and permitting and enforcement. This has allowed some tribes to propose water quality standards. As for other states, these standards must then be approved by EPA. One example where this has occurred is the Pueblo of Isleta, which is located immediately south of Albuquerque, New Mexico. This was the first Native government in the US to obtain approval and Treatment-as-State (TAS) status from the EPA, pursuant to Section 518 of the Clean Water Act.

When the Pueblo of Isleta acted to protect its water quality, the City of Albuquerque sued the EPA for approving Isleta's standards (which are more stringent than off-reservation standards) in Federal District Court. In October 1997, the US Supreme Court upheld the tribe's standards as approved by the lower court. The case was decided in the favor of the Isleta Pueblo, with reasoning that has implications for Native governments throughout the country. Isleta Pueblo's standards were based on three significant use designations: use for irrigation, use for recreation, and use for religious ceremonies. The last reason is important to emphasize because no Native government had ever before asserted its right to religious freedom for the protection of its waters. The Pueblo's contention was based on the fact that tribal religious ceremonies (including bathing in the river) were adversely impacted by the contamination of the river water by toxic discharges from Albuquerque's run-off and from the municipal waste treatment facility located four miles north of the Pueblo. Although the city claimed that the tribe's standards were arbitrary and capricious and would create an undue burden on the city to comply, the court upheld the Pueblo's water quality standards.

With projections indicating that climate change is likely to lead to changes in the amounts and timing of water flows, it is possible that changes in water quality and quantity, especially during the summer, could become an issue in other regions. Lower lake levels in the upper Great Lakes region and reduced flows in western rivers may be examples of where this issue could arise.

Premises Supporting Sustainable Subsistence Economies

The most important differences between market economies and the subsistence economies of Native peoples involve concepts of surplus, accumulation, ownership, private property, individuality, and community. Participation in a sustainable subsistence economy demands knowledge, attitudes, behaviors, and expectations that differ significantly from those which work in market economies. The basic premises that have emerged and still generally prevail include recognition that:

Sustainable subsistence activities require traditional ecological knowledge acquired over generations (LaDuke, 1994).

Subsistence communities are fairly, though not completely, closed economic systems. For day-to-day necessities, people rely primarily on goods and services produced within their own community. Other goods might be acquired from external sources through trading (or, in earlier times, raiding), but sustenance depends on work done within the community.

Most subsistence communities use a variety of food sources and methods of food production, including hunting, fishing, gathering, and agriculture.

Success in food production varies from individual to individual within each community, and varies for each individual over time.

Food preservation technologies are often limited primarily to drying and smoking, technologies that do not support the storage of large amounts of foodstuffs over several years.

Food is sought in the amounts needed to sustain the community, with perhaps a small surplus for trading. Hoarding of food makes very little sense because it generally cannot be preserved, and so is actively discouraged.

Subsistence communities are small enough so that everyone within an individual community knows and acknowledges their relationships with everyone else. Kinship ties, in particular, are widely recognized (Akerlof, 1984; Schelling, 1978, 1984).

Family relationships carry with them obligations of mutual support and sharing of resources.

Use of resources by the current generation must take into account the needs of future generations. An individual might gather, harvest, or hunt enough for household and family use, but must leave enough to ensure regeneration of renewable resources.

icant as a basis for family life only in the far north of Canada and Alaska, where some communities still support themselves by a combination of subsistence, welfare and market economies; mixed market-subsistence-welfare economies also exist in some tribal communities in the conterminous US.

The values that have supported subsistence economies have persisted, however, and this is a major feature that distinguishes Native peoples from other contemporary rural residents. The ethics embodied in these subsistence systems continue to form the core set of values in many modern Native communities, even as they are also integrated, in varying degrees, into mainstream market economies. These values are incorporated into, and reinforced by spiritual teachings, moral principles, and community and family relationships. To the extent that these values continue to shape contemporary attitudes and relationships of Native peoples, they form a crucial part of the treasury of values on which the Nation may draw in addressing global climate change (see box, "Premises Supporting Sustainable Subsistence Economies").

Relying on a closed system involving primarily local resources rather than on a global network that provides food and goods introduces much greater elements of risk. Membership in a community provides one means of limiting risk, because each household has more or less equal opportunities to share in the community's resources.⁴ Under such circumstances, special provisions are often made for individuals such as the elderly and the sick who might be unable to contribute regularly to the community's present food supply (Axelrod, 1984, 1997; Brams, 1996). Prosperity, in this economic system, is measured not exclusively in terms of accumulated possessions – food, fields, and horses – but in terms of personal relationships. Having a large and healthy family, respectful and aware of their obligations, provides assurance of mutual support by

⁴The Lakota (western Sioux) begin each traditional religious ceremony with the phrase "Mitakuye Owasin" which can be translated as "All my relatives" or more freely "We are all related." In the world-view of many Native Peoples, this concept includes not only all of humanity, but all life, and physical objects including rocks, the earth, stars and water. Many traditional Native spiritual leaders support the concept that all life shares a foundation in DNA, and all of life and physical matter shares common structures at the atomic and molecular level.

spreading widely the responsibilities for care and sustenance (Olson,1965;Hardin,1982;Houser and White Hat,1993).

Generosity, in this economy, is a highly prized virtue. When generosity is linked with the obligation for reciprocity, the development of positive human relationships through sharing becomes the most effective way to limit risk for any particular family or individual. Among many Native peoples, there were historically – and continue to be – regular, institutionalized opportunities to show generosity, by giving food and material gifts to members of the community. During dances and special celebrations, Pueblo families open their homes to invited guests and community members for home-cooked feasts, and give away baskets of food and cloth to honor family members whom are participating in ceremonies. Northern Plains' tribes hold giveaways in honor of particular individuals – the honoree is celebrated, not by receiving presents, but by having gifts given to others by the family in his or her name. Families may save for a year or more in order to provide appropriate honor to a family member.

Traditional subsistence economies use a second method of managing risk – the avoidance of over-

specialization or over-dependence on single sources of food. In the past, woodlands tribes, for example, raised corn, beans, and squash, while also gathering wild rice, berries, acorns and nuts, wild turnips and onions, and other edible and medicinal roots and plants (Vennum, 1988; Ritzenthaler and Ritzenthaler, 1991). These tribes also fished, and hunted large and small animals and waterfowl. Pueblo communities developed extensive systems of agriculture, but were likewise active hunters. Inuit communities still rely on caribou, whaling, fishing, and gathering of plants and berries for balance in their diets. For each of these economic systems, the likelihood of all sources of food failing simultaneously in a relatively quiescent climatic period is considerably less than the likelihood of one source declining for a particular period (Trospen, 1999).

During the Native Peoples/Native Homelands workshop, Native peoples from the Arctic and sub-Arctic presented substantial evidence that their communities are immediately jeopardized by changes in global climate. In Alaska (see box "A Circle of Life: A Lesson from Alaska"), rapid warming, and the environmental consequences it brings, started about 30 years ago, and the lives of Native peoples there are already being seriously affected (Gibson and

A Circle of Life: A Lesson from Alaska

Caleb Pungoyiwi is a Yupik Eskimo who moves back and forth between Alaska and Siberia in pursuit of walrus and other sea mammals. Gathering food directly from the land and the sea makes the Yupiks very careful observers of their surroundings. In recent years, they have noticed that the walrus are thinner, their blubber less nutritious, and the oil from walrus fat does not burn as brightly in their lamps as in times of old. At the same time, they have noticed that there are fewer and weaker seals. The Yupik hunters have had to go farther and farther from shore to reach the ice pack to find the newborn seals that are being fed fish from nearby waters by their parents. Concurrently, scientists have observed that the sea ice over much of the Arctic is thinner and melting back, with the changes encompassing a broader area than that observed by the Yupiks earlier (Rothrock et al., 1999).

Both the Yupiks and the scientists have come to understand the intertwined chain of events that is occurring (Tynan and DeMaster, 1997). The retreat of the sea ice due to large-scale warming has reduced the platform that seals and walrus have used to rest between searches for fish and mussels; weakened and less productive, they provide less sustenance for both the Yupiks and the whales. The Yupiks have also observed some killer whales eating sea otters, an unusual shift in the whales' diet apparently brought on by the reduced number of seals. The loss of sea otters is important because sea otters control the number of sea urchins. With fewer sea otters, there are more urchins and therefore less kelp (which the urchins eat). And with less kelp, there is reduced habitat for fish; it is fish that would normally be the major food source for the whales as well as the Yupiks, the Inupiat, and other Northern peoples. As another part of this ecological continuum, the sea ice quiets ocean waters during winter storms, helping protect young fish; it also accumulates nutrients that, when the ice melts, create a springtime algal bloom on which the fish feed at a critical stage in their development. What has occurred may seem like only a little warming in a very cold place, but as the Native traditions make clear, everything is woven together – disruption in one place affects everything else (NPNH, 2000; Moreno, 1999; Huntington, 2000).

Schullinger, 1998). Changes in climate, coupled with other human influences, are now becoming more and more rapid in other regions, with projections of much more rapid change in the future. These changes are likely to bring much larger changes in land cover and wildlife than have occurred in the past. As the world warms, as precipitation patterns shift, as sea level changes, as mountain glaciers and sea ice melt (IPCC, 1996a), just as in Alaska, ecosystems elsewhere are likely to change in complex and often unexpected ways, affecting the resources that can be drawn from them (IPCC, 1996b).

In the Plains, warmer winter conditions are already favoring certain types of grasses, thereby changing the mix of vegetation types. The distributions, timing of migrations, and abundances of waterfowl and other birds are also changing (Sorenson et al., 1998; Price, 2001; T. Root, Univ. of Michigan, unpublished data). These changes have been and will be affected not only by temperature and precipitation changes, but also by changes in the timing of the ripening of plants and crops, and other ecosystem factors on which Native peoples depend. How much longer these types of changes can go on without a serious disruption of the services and diversity provided by the various ecosystems that support subsistence economies is not known, although there are signs that some systems are already being seriously stressed.

Adaptation Options

While local environments have changed significantly over past centuries, changes have often been slow enough to allow adjustment or for local environments to be managed. Historically, Native peoples actively worked to manage their environments in ways that led to desired and productive results. Native peoples were not passive inhabitants of their homelands, simply fitting into niches conveniently provided by a supportive environment. Tribes used a variety of consciously developed technologies and culturally based choices to improve opportunities for obtaining resources. The Paiutes, Hopi, Apaches, and Tohono O'odham, all lived in desert environments, but employed significantly different methods of land use. The Paiutes based their subsistence on a wide variety of plants, fish, and animals, and took advantage of whichever food supplies were most abundant, even if this meant making short migrations to take advantage of each season's particular opportunities. Boundaries between the various Paiute bands were relatively flexible, and permitted hunting and gathering over relatively extensive areas of the Great Basin. The Hopi, in contrast, settled in villages on Black Mesa and created permanent fields

that sustained repeated harvests of corn, squash, and beans. The Apaches, on the other hand, used fire as a technique for hunting, driving animals in a single direction for harvest. Regular burning of hunting areas (a technique also used by the Paiutes) had the additional effect of promoting plant growth and improving forage for game animals (White and Cronon, 1988). The ancestors of the modern Tohono O'odham developed a sophisticated system of irrigation to support extensive agriculture. Many of these techniques are no longer available or are not likely to be adequate, however, to sustain subsistence economies in the event of the large changes in climate that are projected.

When changes were rapid and Native peoples were faced with inadequate resources, several approaches were used to adapt. Historically, many tribal communities could rely on migration to adapt to changing resource bases in any particular local area. However, the establishment of reservations has limited the option of entire tribes moving to more hospitable locations to seek water, cropland, forests, or cooler temperatures. While individuals can pursue that option, it is not an option that is available to most tribes because they are tied to where they are by land ownership and governance issues.

When Native peoples were challenged by radical changes in their physical environments, a second approach was to incorporate new technologies. As the Lakota (western Sioux) moved from forests around the Great Lakes to the Great Plains, they found the most suitable agricultural lands – the bottom lands along the Missouri River – already occupied by residents of large and stable villages. Within two generations, however, they adopted the complex technologies of horsemanship and the gun. This rapid adaptation provided the Lakota with both military and economic advantages, and provided the material foundation for a prosperous and vital culture (Houser, 1995). This willingness to absorb new technologies, new materials, and new ways of doing things forms a common theme in the histories of many Native peoples. Cloth (and the complexities of sewing woven textiles) replaced hides. Glass beads from Bohemia replaced porcupine quills. Aniline dyes replaced vegetable colorings. Steel knives replaced stone or bone implements. Cotton thread replaced sinew. For the future, adopting new technologies is likely to be the only means for dealing with the disruptions to the traditional subsistence economies.

5. Cultural Sites, Wildlife, and Natural Resources

Ceremonial and historic sites, graves and archeological locations, special mountain and riverine environments, and seasonal cycles and migrations are central parts of the cultural traditions and traditional indigenous knowledge to Native peoples. Taken together, atmospheric conditions and the character of local landscapes – both the vegetation cover and the wildlife – help to shape people’s sense of place and how they relate to what surrounds them. While Native peoples have no monopoly among Americans on love of land, water, wildlife, and the sea, their interests start from different premises and have developed over thousands of years of living on this continent. As a result, the connections of Native peoples to their homelands differ, at fundamental levels, from the kinds of relationships developed in densely populated suburban and urban environments. These differences are frequently explained in spiritual terms, although the differences also include traditional ecological and intellectual knowledge and historical familiarities. These understandings and relationships have been, and continue to be, transmitted orally and through ceremonial forms that carry the interconnections of nature and histories forward to future generations (Brody, 1982; Goodman, 1990; Hiss, 1991; Gallagher, 1993; Basso, 1996; Bordewich, 1996).

Changes in climate and in ecosystems in the decades ahead are likely to have consequences and influences that are both practical and that affect

deeper life experiences. A variety of indigenous plants and animals, including migrating fish and waterfowl, provide many tribes with sustenance, as indicated in the previous section, and essential components of many cultural traditions. As climate shifts, the optimal habitats for various plants (including medicinal plants) and fish runs are likely to shift. These changes are, in turn, likely to lead to a declining presence of some plants while other plants become more abundant, altering the resource base and cultural experience for many tribal communities. At deeper levels, humans’ whole experience of their environment is likely to diverge from what has been sustained through many generations via historical and religious traditions. For Native peoples, externally driven climate change is likely to disrupt the long history of intimate association with the environment.

Central to the worldviews of Native peoples is an acknowledgement of kinship with all of creation. Through honoring and paying close attention to their relatives, no matter how those relationships are defined, Native peoples have acquired and continue to draw strength from unique insights about the interactions of climate and the environmental health of their homelands. These insights can have very practical significance. For example, in the 1970s and 80s, elders on the Rosebud Sioux Reservation in South Dakota raised many questions about the potential implications of proposed efforts to exterminate prairie dogs in the sparsely settled western portions of their reservation. Although the elders expressed their objections in the language of

SONG OF THE SKY LOOM

Oh our Mother the Earth, oh our Father the Sky
Your children are we, and with tired backs
We bring you the gifts that you love.
Then weave for us a garment of brightness;
May the warp be the white light of morning,
May the weft be the red light of evening,
May the fringes be the falling rain,
May the border be the standing rainbow.
Thus weave for us a garment of brightness
That we may walk fittingly where birds sing,
That we may walk fittingly where grass is green,
Oh our Mother the Earth, oh our Father the Sky!

*Found in “Songs of the Tewa”
as translated by Herbert Joseph Spinden, copyright 1933.*

Lakota spirituality, which values balance in nature and emphasizes the importance of each part of creation, wildlife biologists have since come to recognize that prairie dogs are a “keystone species” that plays a pivotal role in the maintenance of ecosystems on the Great Plains.⁵ Additional examples of the value of this close local knowledge are abundant: the exceptionally successful forestry manage-

ment of the Menominee Nation; the care of Cree bands in harvesting animals to ensure that all generations of game and fish survive in sufficient quantities to ensure the continuity of all species.

Climate change will bring changes to the landscapes and wildlife that are important to Native peoples, changing the surroundings in ways that will change

Shifting Ecosystem Boundaries and the Sense of Place

Anyone who has ever walked up a mountain has experienced the fact that the climate at a particular altitude determines the vegetation. Because of this, mountaintops have their own particular ecosystems that are isolated like islands from surrounding areas. Although not unique to this region, the very large reservations of southwestern New Mexico and southeastern Arizona are home to many “sky islands” that rise high above the desert floor, some of them reaching to heights exceeding 10,000 feet. These unique regions, which are natural parks in a sea of desert scrub, add greatly to the quality of life, and their biodiversity and genetic richness is among the greatest to be found anywhere on the continent (Arias Rojo et al., 1999). These environments are particularly meaningful, even sacred, to many of the tribes, being environments with particular types of plants and wildlife that are important culturally and medicinally. At the same time, they are particularly vulnerable to climate change because of their unique settings in a largely arid region. As climate warms, ecological communities from the bottom to top will be disrupted as plant species gradually move up-slope, each at their own rate. The existing mountain ecosystems will be forced into ever-diminishing areas of land and those species already at the mountaintops will become extinct because they cannot migrate easily to distant, higher mountains.

Ecosystem shifts will occur not only in the vertical, but also in the horizontal dimension. For centuries, the Anishinaabeg (Ojibway or Chippewa) who live around Lake Superior and along the upper Mississippi River have depended upon the natural resources of the forests, lakes, and rivers of the region (Vennum, 1988). Many of the reservation locations were selected to ensure access to culturally significant resources, such as maple sugar bushes and wild rice beds, whose locations were thought to be fixed. As drier summer conditions cause the western prairies to shift eastward toward the western Great Lakes, the extents of maple, birch, and wild rice habitats in the US are likely to be significantly reduced. Because Ojibway communities cannot, as a whole, move as the ecosystems that are their homes shift, climate change is likely to reduce the resources needed to sustain their traditional culture and impact their economic productivity and the value of established treaty rights unless adjustments are made (e.g., see Keller, 1989).

The wild rice that grows abundantly in shallow lake and marshy habitats of northern Wisconsin and Minnesota is likely to be adversely affected. Wild rice plays a critical role in the economic and ceremonial life of many tribes. The hand-harvested and processed seed is highly prized as a gourmet food and adds significant commercial value to the rural reservation economy. Federal treaties guarantee the right of the Anishinaabeg to gather wild rice in their aboriginal territories, which cover much of the states of Wisconsin and Minnesota. As the climate changes, deep or flooding waters in early spring could delay germination of the seed on lake or river bottoms, leading to crop failure. Lower water levels later in the summer could cause the wild rice stalks to break under the weight of the fruithead or make the rice beds inaccessible to harvesters. Extended drought conditions could encourage greater natural competition from more shallow water species. Climate change will disrupt the current balances, and, as was illustrated during the dry summer of 1988, conflicts over water can pit federal river management policies against tribal treaty rights and state demands for water.

Evidence of significant patterns of change over the past 10,000 years confirms that substantial ecosystem changes can occur as a result of changes in climate. Presuming future changes occur to the same extent as past changes, tribes that trace their ancestry to the wooded regions will slowly become overtaken by grasslands, such that the entire nature of place for many Native peoples is likely to change.

⁵ Personal communications from Lionel Bordeaux and Ronald Trosper.

human experiences. Mountain environments, edges of ecosystems, and bird populations will be especially vulnerable. For example, the “Sky Islands” in the mountainous west and the prairie-forest interface between the Great Plains and Great Lakes will be places where significant changes seem likely (see box, “Shifting Ecosystem Boundaries and the Sense of Place”). Wildlife, which is central to the cultural life of many tribes, is likely to be significantly affected over coming decades. For example, under the equilibrium climate conditions of the Canadian climate scenario, models of bird distributions (Price, 2000) project a gross loss of up to 27% of the neotropical migratory birds, 32% of the short-distance migratory birds, and 40% of the resident bird species in Arizona (J. Price, draft report prepared for the Environmental Protection Agency). Because some extirpations (local extinctions) are likely to be offset by immigrations, this study suggests that the net changes (6% loss of neotropical migrants, 15% loss of short-distance migrants and 30% gain in resident species) are not likely to be as severe as the gross. Whether colonizing species can “replace” extirpated species in an ecological sense is unknown at this time, as are the overall rates of change. From the point-of-view of Native peoples, what may be as important is the degree to which any of these changes will impact their cultures or religions (see box, “Wildlife and Ceremonies”).

Adaptation Options

In some cases, improved or altered land management practices (e.g., fire management) may be able

to sustain the presence of particular types of useful plants or animals for at least a while longer. Where ecosystems shift from Native land holdings to nearby non-Native lands, new areas may need to be developed or acquired to allow access to traditional food sources. Increased involvement of Native experts in resource management, particularly of public lands, may improve the quality of the new environments as well as help to sustain traditional plants. Where climatic and ecosystem shifts are significant, new approaches will be needed. In all of these situations, adapting to changing wildlife and land cover on tribal lands will be challenging because options for continued access by Native peoples to traditional ecosystem resources on neighboring lands may be limited.

In planning and working to meet the changing conditions, experience indicates that both traditional knowledge and contemporary scientific knowledge can help to understand and improve the environment. The relationships between Native peoples and their environments provide significant insights and context for the scientific findings about climate change and its implications for human life. Building the bridge will be essential, for many tribal communities use such traditional understandings, developed over many generations, to guide their uses of lands within their immediate political jurisdictions. Because land use decisions on reservations will have influences on, and be influenced by, the health and services provided by wider regional ecosystems, it will be essential for Indian and non-Indian people to

Wildlife and Ceremonies

Many Native peoples use wildlife as integral parts of their cultural and religious ceremonies. Among the various Pueblo peoples (e.g., Hopi, Zuni, Keres, Tewas, Tiwas, and Towas), religious ceremonies are the center of their cultural lives (Tyler 1991). Birds are seen as spiritual messengers and are completely integrated into the traditions of these Native American communities. More than 200 species of birds have unique Native names, and more than 100 are essential to parts of the Pueblo culture. Birds mark the passing of the seasons and are considered to have valuable spiritual properties needed by members of these Pueblos. Among the Zuni, prayer sticks are used as offerings to the spirit realm. Each prayer stick, depending on its purpose, requires a particular combination of feathers drawn from among 72 different species of birds (Tyler 1991). Prayer sticks serve many of the same spiritual purposes in the Zuni religion that rosary beads serve to the Catholic religion.

Zuni also have separate names for the Western and Mountain Bluebirds. These species are only found on the Pueblo in winter and are used as symbols of transitions for fall and spring. Among both the Hopi and the Zuni, bluebirds are associated with puberty rituals surrounding the passage from girlhood into womanhood (Tyler 1991).

Because of such linkages, shifts in climate and consequent shifts in the timing or the distributions of wildlife species are likely to have profound impacts on the cultural and religious lives of these peoples.

work together towards understanding each others' perspectives and choices about climate change, its implications, and how best to adapt.

COPING AND ADAPTATION STRATEGIES

During the assessment process, speakers from tribal communities consistently attributed the endurance of Native peoples, through extreme conditions and brutal transitions, to spiritual and cultural values. Although public and ceremonial expressions of these values differ considerably from tribe to tribe, Native people identify many commonalities across wide geographical, linguistic, and environmental distances. These values form a connector between the past and future, bringing important lessons learned through tens of thousands of years on the continent into the frameworks for choices that will need to be made about the futures of Native peoples and homelands. From the analyses to date, it is clear that responding to substantial changes in climate, while populations remain in fixed and permanent locations, is very likely to require new technologies, skilled personnel, and financial resources. These three necessities, however, are desperately scarce in many tribal communities. Most tribal communities are limited in ways of creating wealth and they continue to rely heavily on transfer payments from the federal government. Adjusting plans for economic and social development to account for climate change may require fresh thinking in federal and tribal policies and budgets. For example, because lands are usually held in trust for Native peoples, it can be very difficult to obtain a mortgage or other loan since the assets are not held personally. Several options, however, are emerging from consideration of adaptation and coping options.

Enhance Education and Access to Information and Technology

Becoming educated on issues concerning climate change will be critical for Native peoples throughout the country. Both those who live in tribal communities and those who make their homes elsewhere need to develop the understanding and skills to deal with a changing climate⁶. This education needs to be both comprehensive and widespread (see Johnson, 1999). It is especially impor-

tant to improve the quality of education in the sciences and technology in the K-12 schools and tribal colleges that serve Native youth. It will be essential to enlist elders and mentors within each Native community (including within each culturally distinct region) to assist in the integration of contemporary information and traditional values, and of Indian students who choose to pursue university degrees and careers in science with their tribal communities.

Promote Local Land-use and Natural Resource Planning

In 1976, with the passage of the Indian Self-Determination and Education Act, the federal government began to encourage tribal governments to take responsibility for developing and implementing plans for use of tribal lands and natural resources in collaboration with local agencies. Since that action, several tribes have received international recognition for success in managing their local resources. The Menominee Nation of Wisconsin regularly trains managers from all parts of the world because of the effectiveness of the tribe's sustainable timber and forestry practices. The Spokane Tribe has built an exemplary water resources program. Cost-effective ways – using existing networks and organizations – need to be developed to inform decision-makers in tribal communities, and to provide shared access to adequate technical resources. Technologies now exist that can assist tribes to make thoughtful and informed choices. Ways need to be found to provide information that will support the abilities of Native peoples and their leaders to make prudent choices based on appropriate knowledge and appropriate values, using appropriate processes aimed at promoting and enhancing diversified and sustainable economies in tribal communities.

Participate in Regional and National Discussions and Decision-making

One result of the trusteeship system has been the tight concentration of the attentions of tribal governments on their relationships with the Bureau of Indian Affairs. Gradually, since the late 1960s, federal agencies have begun to recognize that the trust responsibility to Native peoples extends through all parts of the federal government. Tribes, which once viewed the creation of relationships with federal agencies other than the BIA risky at best and irrelevant at worst, are working increasingly successfully across agency and departmental lines. Federal agencies are also learning how to provide appropriate kinds and levels of service to Native peoples.

⁶ A variety of professional organizations provide assistance to tribes working on natural resource issues: the Native American Fish and Wildlife Society; Inter-tribal Timber Council; Indian Agriculture Council; National Tribal Environmental Council, and the American Indian Higher Education Consortium, among others.

Although the trust relationships between the federal government and Native peoples are complex, they are not impenetrable. New relationships are essential to address issues of climate change. While creating relationships with agencies of state governments has frequently been viewed by tribes as threatening their sovereignty, serious discussions about climate change – at the regional, state, and national levels – need to include informed stakeholders from every relevant jurisdiction. A pertinent model of interaction and collaboration that provides technical support, advice, and assistance to tribal environmental officers has been developed between tribes in the northern Great Plains and the University of North Dakota. Similarly, the Southwest Strategy, an initiative of all stakeholders in Arizona and New Mexico, serves as a useful framework for strengthening communication and collaboration with tribes and federal agencies. Their success in broadening participation and making knowledge available in useful ways could provide helpful lessons for other states, tribes, and regions.

CRUCIAL UNKNOWNNS AND RESEARCH NEEDS

Because there are many hundreds of tribes, there are many hundreds of situations facing Native peoples as

The Johnstone Strait Diversion at Sockeye Salmon



Figure 3: Changes in Pacific Ocean temperatures associated with the Pacific Decadal Oscillation appear to be the cause of changes in the migration path of salmon returning to spawn (Mysak, 1986). Under normal conditions, the salmon return to spawn by passing through the Juan de Fuca Strait and traditional tribal harvesting areas. Under El Niño conditions, however, the salmon take a path to the north of Vancouver Island, passing through Johnstone Strait and not passing through traditional harvesting areas (Groot and Quinn, 1987; Hsieh and Lee, 1989; McKinnel et al., 1999). As the climate warms, the likelihood of the salmon taking one path versus the other is likely to change, and with further warming, the salmon may no longer return to their traditional streams.

they seek to understand and prepare for climate change. Having better estimates of the patterns, magnitudes, and rates of climatic changes to be expected is essential. Accurate weather data from tribal communities – particularly those in remote rural areas – have rarely been compiled. Little systematic effort has been made by federal, tribal, or state agencies to gather information about the microclimatic conditions associated with the various reservations. One significant research priority, therefore, requires the training of members of tribal communities to collect and interpret weather information, including providing for the acquisition, installation, and maintenance of appropriate instrumentation to support the collection and recording of these data.

A second urgent research need requires inventories of the uses and conditions of land and natural resources on each reservation. Such an inventory can integrate information from remote sensing and geographic information systems as well as tribal information on water quantity and quality and first-hand personal observations and culturally based knowledge. While Native oral histories clearly have many insights to offer, data acquisition and sharing of information have become especially complicated issues for Native peoples. Generations of scholarly objectification of Native peoples, and appropriation of knowledge, objects, and human remains have created severe problems of mistrust of scholarly inquiry, and strong resistance to the sharing of sacred or privileged information. The legitimacy of Native concerns over these issues cannot be dismissed, nor can the urgent needs for research to be conducted from within Native communities. As these essential and primary needs are satisfied, Native peoples have consistently demonstrated willingness to take part in broader conversations, as teachers and students, colleagues and leaders, with individual and culturally based perceptions that can enrich discussions and strengthen decisions for all parties involved. Equipping tribes with the capability to scientifically sample and analyze plant and animal populations will enhance the opportunities for broadening tribal participation in such conversations.

Such inventories are needed to provide the basis for establishing baselines of environmental conditions and economic and cultural activities on each reservation. This needs to be followed by assessments of the opportunities and vulnerabilities that changes in climate might bring. These sector analyses will require regional projections of future changes for a variety of climate variables, so that the wide range of potential impacts (and opportunities) can be evaluated by the various tribes. Especially important are

predictions of changes in water availability, because water is the fundamental resource for agriculture, tourism, and other vital activities.

Native communities also need to understand how ecosystems are likely to respond to climate changes, both large-scale and small. What will happen to migrations of birds, waterfowl, and fish? What will happen to forests and grasslands? What will happen to the rich mix of flora and fauna on which traditional cultures and subsistence economies depend? How will ecosystems function differently in the future? Will they provide greater or fewer resources, and in what mixtures? That large changes are possible is evident from the changes occurring in response to climate variations. For example, variations in Pacific Ocean temperatures associated with the Pacific Decadal Oscillation have been observed to cause changes in the migration path of salmon returning to spawn, thereby affecting whether fish pass through traditional harvesting areas (see Figure 3). Gaining a better understanding of such variations, and then of the changes that will be brought on by climate change, will be essential.

The rates at which Native communities will be able to respond to major changes vary widely from group to group. Many Native peoples continue to view human actions and community decisions in terms of generations. This perspective sometimes means that reaching conclusions may require more time and discussion than is customary in market-driven societies. Other groups clearly thrive on change and move aggressively to take advantage of new opportunities for education, economic development, and technological innovation. Some of the challenges presented by changes in climate may require relatively rapid social adaptation and swift action. Other challenges may require the capacity to endure discomfort and examine new situations from a variety of perspectives until appropriate responses can be formulated.

Education and the exchanges of information across cultural boundaries, activities that enhance the abilities of Native and non-Native peoples to cope with systemic changes, have been occurring at the individual level for generations. The Native Peoples/Native Homelands assessment process has started to advance these interactions.

Whatever changes befall Earth's climate, there is now fresh ground for hope that Native peoples and non-Natives may be able to address the challenges collaboratively, as relatives. *Mitakuye Owasin* (we are all related)!

END NOTES

1. The number of Native Americans depends on the definition that is used. As a result, the number of those counted as Native Americans can differ. For example, the US Bureau of the Census counts as American Indian anyone who identifies himself or herself as such. As in asking about other ancestral connections, census enumerators require no proof of Indian identity. Thus, census data include individuals who may identify themselves culturally and socially as American Indian, but who are not formally enrolled as members of a particular tribe. As a result, the census produces a comparatively high count of the number of American Indian people in the United States (US Bureau of the Census, 1990). The Bureau of Indian Affairs, on the other hand, counts only individuals who are officially enrolled as members of federally recognized tribes. Each tribe has the right to establish its own criteria for enrollment. Most tribes require that a certain percentage of the individual's ancestors must have been members of that tribe. Some tribes recognize only affiliation through the father's family. Still other tribes have residency requirements indicating that the individual must live on the tribe's reservation for a specified number of years. The BIA's total (see http://www.doi.gov/bia/aitoday/q_and_a.html) thus yields a lower number of American Indians. As a further complication, some tribes are recognized by state governments, but not by the Bureau of Indian Affairs (e.g., the Lumbee of North Carolina). Members of these tribes are, therefore, recognized as Indian by some levels and agencies of government, but not by others. Periodically, a tribe may succeed in completing the BIA's rigorous process for obtaining federal recognition, thus increasing the number of Indian people recognized as such by the Department of the Interior. Further, descendants of the original inhabitants of the Hawaiian Islands have, using the Department of the Interior's own criteria, made credible claim for federal recognition as Native Americans (Bordewich, 1996).

2. The presence of non-Native Americans on reservation lands was largely prevented until the Dawes Severalty Act, commonly called the Allotment Act, was passed by Congress in 1887. Prior to this law, reservation lands were held corporately by an entire tribe and no particular individual held title to any particular tract of land. Furthermore, no outsiders, except government officials and soldiers, were permitted to live within reservation borders. The Allotment Act, however, mandated that each member of a tribe receive an individual allotment of land. The allotments varied in

size from 80 to 1,040 acres, depending on the particular reservation. After each head of household and family member had received an allotment, the remaining unassigned lands within the boundaries of each reservation could be opened to non-Indian homesteaders.⁷ These settlers were granted clear title to the lands on which they settled if they fulfilled the normal conditions of homesteading. Land that was conveyed in this way to homesteaders was simply subtracted from the total lands that had been originally reserved for the tribe. As a result, until the passage of the Indian Reorganization Act in 1934, significant amounts of reservation lands passed out of Indian ownership even though they were within the original boundaries of reservation.

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ACKNOWLEDGMENTS

Many of the materials for this chapter are based on contributions from participants on and those working with the

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 Verna Teller, Isleta Pueblo
 Robert Gough, Intertribal Council on Utility Policy
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