Chapter 8

Great Plains Societal Considerations

Impacts and Consequences, Vulnerability and Risk, Adaptive Capacity, Response Options

A variety of factors related to climate variability and change will impact the Great Plains across human and ecological communities. The changes and associated stress are triggering response strategies and other mitigation and adaptation measures from land managers, government officials and staff, and various industries. The impacts and responses address water, energy, and other essential resources for both human and environmental well-being.

Based on modeled projections of climate change, scientists, land managers, city-managers and others are already implementing mitigation and adaptation strategies for agriculture and livestock production and other elements of the regional economy. Response strategies consider ecosystem services that benefit Great Plains communities and the biological and ecological changes that may affect wildlife and their habitats, including wetlands and river systems.

Low-income communities, including Native American reservations and colonias along the US-Mexico border, are among the most vulnerable to climate change effects in the Great Plains. In many of these places as well as in cities and urban regions, managers and businesses are establishing pilot projects to adapt more resilient resource uses and construction practices.

Trends and models also suggest changes in regional climate and the frequency and severity of extreme weather events. Additional impacts include shifts in disease distributions, representing health risks through potential outbreaks. These factors have led the insurance industries to reconsider the elevated economic and human risks and vulnerabilities, complementing scientific research of ongoing and projected climate change.

Urban-Rural Dynamics

Climate Change Impacts on Urban Areas

Urban areas currently face a wide variety of environmental challenges, many of which may be exacerbated by climate change. One such issue is ground-level ozone. Ground-level ozone is a known pulmonary irritant and is the primary constituent of smog (Ebi and Mcgregor 2008). A number of Great Plains urban areas have issues with ozone compliance, but the Houston area in particular, has been in non-attainment of the EPA ozone standard since it was set in 1977 (Raun 2010). Higher temperatures may result in greater ozone formation because the chemical reactions resulting in ozone formation are
temperature dependent (Bell et al. 2005a). In addition, biogenic volatile organic compounds, which are ozone precursors, increase as temperatures rise (Bell et al. 2005b).

Suspended particulate matter also presents a potential air quality issue in cities. Sources of particulate matter (PM) include construction sites, smokestacks, fires, emissions from power plants, and automobiles (U.S. Environmental Protection Agency 2012). PMs can penetrate deep into the lungs and cause health problems. Prolonged or severe droughts may result in dusty conditions and wildfires that can cause an increase in suspended particulates including smoke, pollen, and fluorocarbons (Centers for Disease Control and Prevention et al. 2010).

The urban heat island (UHI) effect occurs when cities have warmer air and surface temperatures than surrounding rural areas, particularly at night (Grimm et al. 2008, U.S. Environmental Protection Agency 2008a). This is attributable to a variety of causes, including decreased vegetation, lower albedo from impervious surfaces, and urban building morphology (Grimm et al. 2008, U.S. Environmental Protection Agency 2008a). In urban areas with 1 million or more people, annual average air temperatures can be 2-5 °F (1-3 °C) higher than surrounding areas. On individual clear, calm nights the UHI can be as much as 22 °F (12 °C) warmer. Smaller cities and towns can create heat islands as well, although the urban-rural temperature differences often decrease as the city size decreases (U.S. Environmental Protection Agency 2008a). UHIs can act in conjunction with climate change to create more extreme temperatures.

An increase in high temperatures, particularly long stretches of days over 100 °F, will damage the integrity of transportation systems. High temperatures, particularly those exceeding 90 °F (32 °C), can cause pavements to degrade faster, compromising their integrity (Savonis et al. 2008, Bjune et al. 2009). Increased temperatures can also cause some types of rail to develop “sun kinks” in which sections of the rail buckle (Savonis et al. 2008). Increased cooling and thus energy consumption may be required for freight and passenger operations (Savonis et al. 2008). Compounding the problem, crews responsible for construction and maintenance may not be able to work during times of extreme heat (Savonis et al. 2008, Bjune et al. 2009).

Extreme rain events could result in increased flooding if flows start to exceed the design capacity of a city’s culverts and storm sewer system (Savonis et al. 2008, Bjune et al. 2009). Bjune et al. (2009) assess that this would present a problem for cities lying on flat terrain, as is the case with many Great Plains metro areas. More intense storms will also reduce clearance under bridges and increase erosion of road bases and bridge supports (Savonis et al. 2008, Bjune et al. 2009).

Climate change could also have a variety of impacts on municipal water supplies. The headwaters of many Great Plains rivers are in the Rocky Mountains, and cities in the western part of the region, such as Denver, are often dependent on snowmelt. The snowpack acts as a natural and massive reservoir for water storage, holding water historically until late spring or early summer. Warming temperatures will not only result in a decreased amount of snow and reduced water storage in the snowpack, but it will also cause snow to melt earlier in the spring (Barnett et al. 2005). In the absence of precipitation changes, maximum runoff will shift to earlier in the season, further from the peak water demand months of July and August.
In addition to shifting times of peak runoff, warmer temperatures may also affect evaporation rates. Many cities in the Great Plains are dependent on reservoirs for their water supplies, and these reservoirs currently lose considerable amounts of water to evaporation. Annual evaporation from the six largest reservoirs on the Missouri River’s main stem, for instance, has been estimated to be about 5% of the average annual river discharge (Benke and Cushing 2005). In the Rio Grande, evaporation from the major reservoirs has been estimated to exceed municipal water usage in the basin (Benke and Cushing 2005). Such reservoir losses could increase if warmer temperatures persist without an increase in precipitation.

Increases in precipitation intensity could adversely affect municipal water supplies by causing elevated levels of turbidity, organic matter, pathogens, and pesticides in source waters, associated with either rises in nonpoint source pollution loads or increased infiltration influencing groundwater quality (Kundzewicz et al. 2008, Clark et al. 2011). For cities, such as Kansas City, in which storm and wastewater sewers are combined, high rainfall events could also overload the capacity of wastewater treatment plants leading to situations in which untreated or partially treated sewage may be discharged into streams (Kundzewicz et al. 2008, Delpa et al. 2009, Struck et al. 2009).

Droughts can lead to water-quality problems for municipalities, as well as water-quantity issues. In some areas, droughts may result in elevated levels of toxic algae and organic matter in source waters, and lower streamflows may lead to the concentration of pollutants. Such factors may adversely affect the ability of treatment plants to meet safe drinking water standards (Centers for Disease Control and Prevention et al. 2010). Excessive drying of soils can damage pipes leading to breaks in water mains, such as those experienced in Texas during the state’s most severe one-year drought on record. In Houston alone, over 6000 water main breaks were reported during summer 2011 (Climatologist 2011, Houston City Council 2011, Royal Academy of Engineering 2011).

Green infrastructure is one approach that cities can use to simultaneously address these issues as they upgrade aging, outdated infrastructure. Although the term green infrastructure can have alternative meanings in different contexts, it often refers to landscapes that have been specially conserved or sometimes designed and engineered to mimic natural processes and provide ecosystem services, such as flood control (U.S. Environmental Protection Agency 2010, Foster et al. 2011). Sometimes the definition of green infrastructure is expanded to include additional approaches (not always vegetation-related) that cities use to try and achieve environmental goals (Foster et al. 2011). In the text below, it is this broader definition that is considered.

Green infrastructure can benefit climate change adaptation strategies through its ability to curb the impacts associated with the anticipated increases in air temperatures and in extreme precipitation events (Foster et al. 2011). Benefits associated with climate change mitigation are generally related to the ability of green infrastructure to decrease energy usage and sequester carbon. In addition, green infrastructure can also contribute to recreational space and aesthetic value that can improve health and provide a better quality of life (Tzoulas et al. 2007, Foster et al. 2011).

Green infrastructure approaches can be incorporated into new developments, completed as a retrofit or included as repairs or replacements are made. They can be
implemented at an assortment of spatial scales ranging from individual house lots to entire metropolitan regions (Foster et al. 2011). Although green infrastructure may be implemented to meet a single, specific goal, such as reducing ambient air temperatures, it often provides additional benefits, and the full value of a project stems from the multiple functions that green infrastructure performs. A variety of cities within the Great Plains are beginning to incorporate green infrastructure into existing building codes and city plans as a pragmatic way to update current infrastructure to meet climate challenges.

Examples of initiatives being taken include: eco-roofs, such as cool roofs or white roofs (U.S. Environmental Protection Agency 2008b, Energy 2011, Foster et al. 2011); bio-retention, to address flood control and water quality protection by creating vegetated depressions that receive, absorb, and treat stormwater runoff from impervious surfaces (U.S. Environmental Protection Agency 2010, Foster et al. 2011) to capture and remove contaminants and sedimentation; and urban forestry or greenways which can be developed to sequester greenhouse gases, providing natural cooling to buildings and pavement, improving air quality, reducing energy bills, decreasing stormwater runoff, controlling erosion, and adding attractive landscapes (Mid-America Regional Council n.d., Briechle 2009, University of Nebraska 2011, City of Grand Forks 2012, Denver Mile High Million Initiative 2012).

GREAT PLAINS URBAN WATER SUPPLY STRATEGIES

In the face of both population growth and greater uncertainty in precipitation and runoff regimes stemming from climate change, cities throughout the Great Plains are starting to explore and implement ways to diversify their water sources. Strategies include water conservation, the use of nonpotable water, aquifer storage and recovery, desalination, and water reuse, with the latter approach being the subject of more in-depth discussion in this Chapter.

Water conservation is becoming a priority throughout Great Plains cities. Cities, including Austin, Dallas, Denver, and San Antonio, all have water conservation plans or programs. The resulting decrease in demand can act as an “effective” new water source. Components of the plans vary and include indoor residential, commercial, and industrial approaches as well as outdoor conservation approaches. An example of an indoor residential conservation measure is Dallas Water Utilities’, “New Throne for Your Home” program that provides vouchers to replace older, pre-1992 toilets with newer, more efficient models (City of Dallas 2010). An example of an outdoor conservation measure is Denver Water’s soil amendment program that requires property owners to till compost into their soil before Denver Water will set meters so that the soil will retain water more efficiently, reducing irrigation requirements (Denver Water 2011a).

The use of nonpotable water in situations when water of drinking-water caliber is not required is a strategy being implemented in Norman, Oklahoma. The city, for example, is using wells not suitable for drinking water to help irrigate the Westwood Golf Course and the Griffin park complex (City of Norman, 2011).

Aquifer storage and recovery involves the injection of water into a well when water is available for storage underground. When needed, the water is then recovered from the
Greensburg, Kansas, serves as an example of a town that embraced sustainability and used a tragedy as an opportunity to rebuild in a greener manner. Prior to May 4, 2007, it was a rural town similar to other Great Plains farming communities. The energy structure of the town, developed in the 1960s, was similar to many rural towns in the Great Plains, with electricity created largely from coal-based sources. On the evening of May 4, 2007, an EF-5, 1.7-mile- (2.7-km) wide tornado with wind speeds over 200 mph (320 km per hour) hit the town, destroying or severely damaging 90% of its structures and killing 11 people.

In the aftermath of the storm, community citizens resolved to rebuild a town that is prepared to face 21st century challenges. Key city leaders expressed interest in rebuilding a model green community, which generated enthusiasm among residents eager to demonstrate that challenges present opportunities and a disaster can be turned into a chance to foster resilience. The Department of Energy and other key organizations, including the National Renewable Energy Laboratory, quickly aligned their support and interest in helping Greensburg rebuild and demonstrate energy solutions that could be replicated in other communities. Other federal and state agencies, nonprofit, professional organizations and individuals reached out to Greensburg with professional expertise and donations of materials or cash.

On August 15, 2007, the City of Greensburg adopted a Long-Term Community Recovery Plan that was prepared through FEMA’s Long-Term Community Recovery program, which included strategies to rebuild sustainably. The residents then developed a Sustainable Comprehensive Master Plan for the town’s next 20 years. It states, “A truly sustainable community is one that balances the economic, ecological, and social impacts of development.” In implementing the recovery plan, Greensburg has set a new standard for other rural and urban communities. It has become a net-zero energy community, generating as much electricity from renewable sources as it consumes. The city council passed a resolution requiring all new city buildings larger than 4,000 square feet (370 square meters) to reduce energy consumption by 42% (compared to standard buildings) and pass US Green Building Council LEED Platinum certification. An 11,000-BTU per second (12-megawatt) wind energy system will be installed near Greensburg that will meet its pre-tornado electricity needs. Additionally, the city has entered into a power purchase agreement from a renewable energy provider that will deliver 100% renewable electricity from wind, hydro, and other renewable energy electricity generation sources.

Greensburg citizens acknowledge that there is potential for similar disasters in the future and have adopted building code standards to be better prepared for severe wind events. It has also embraced tornado preparedness education within the community, and schools have implemented programs to educate students about storm safety and sustainable living. (City of Greensburg, 2008; National Renewable Energy Laboratory, 2009)
same well (National Research Council 2008). If water is recovered via a different well, the process is called aquifer storage transfer and recovery. The cities of El Paso, Kerrville, and San Antonio in Texas all have aquifer storage and recovery programs making use of treated wastewater, treated river water, and groundwater for injection, respectively (Texas Water Development Board 2011). San Antonio, for instance, pumps water from the Edwards Aquifer during wet periods and stores it underground in the Carrizo Aquifer. During times of drought, the stored water is then recovered to help meet peak water demands (San Antonio Water System 2009).

Advantages of water reuse include improved water supply reliability, in particular during droughts, and reduced dependence on imported water supplies. In some instances, reuse may increase the amount of water for the environment; for example, if it replaces some existing surface or groundwater supplies, thereby increasing instream flows or decreasing groundwater pumping. Water reuse may also improve surface water quality when nutrient-laden effluent is diverted for the irrigation of landscapes and crops (National Research Council 2011).

At the same time, water reuse could also potentially have negative effects on downstream flows and water quality. Depending on its extent and context, reuse may decrease downstream flows, adversely affecting downstream users and ecosystems, particularly in water-limited environments. If irrigation application rates exceed the ability for plants to make use of the nutrients in the reclaimed water, this could result in excess nutrient levels in ground- or surface water, which could lead to human health and environmental effects (National Research Council 2011). Irrigation with reclaimed water could possibly produce excess levels of salinity in soils, which can be detrimental to plant growth. Denver Water has been studying this and exploring options for decreasing impacts (Denver Water 2011b). Depending on project design and energy sources, reuse projects also have the potential to increase the carbon footprint of water supplies (National Research Council 2011).

The financial costs of water reuse projects vary and are highly site specific (National Research Council 2011). They depend on a variety of factors including the degree, if any, of additional treatment needed before reuse, pumping requirements, timing and storage requirements, and the extent of any new transmission pipelines. This latter factor is related to the distance between a wastewater treatment plant and reclamation plant, the need for and sizing of any piping for the conveyance of nonpotable water, which has to be kept separate from the potable transmission lines already in place, and the distances between the reclamation plant and non-potable water customers (National Research Council 2011). In combination with water conservation, water reuse could potentially decrease seasonal peak demands, which can reduce capital and operating costs (National Research Council 2011).

A 2011 National Research Council report on US water reuse notes that if utilities decide to start placing more emphasis on water reuse, moving towards having multiple smaller, decentralized wastewater treatment plants could make more sense. Currently, wastewater treatment plants are generally constructed at low elevations near a discharge point such as a river or lake. Consequently, reclaimed water must generally be pumped uphill for use. A more decentralized system in which reclaimed water is closer to potential customers could reduce pumping costs as well as the costs of transmission
and distribution infrastructure. In addition, such a system might be able to better accommodate demand fluctuations in contrast to a large, centralized plant.

The 2011 National Research Council report on water reuse in the US also notes a variety of research needs. Included among these are conducting an analysis of the extent of de facto potable water reuse in the US and improving our understanding of the health impacts of human exposure to constituents in recycled water. The report also notes that while water reuse for ecological enhancement is promising, few studies have examined possible environmental risks.

**Rural and Tribal Landscapes: Contrast and Comparison Vulnerability, Opportunity, and Adaptive Capacity**

**CLIMATE CHANGE IMPACTS ON RURAL AREAS**

The impacts of climate change on rural communities are determined by a set of complex interactions among the environment, different sectors, and population groups (Parton et al. 2005, 2007, Hartman et al. 2011). The potential impacts of climate change include the modified vulnerability of rural families dependent on farm and ranching activities to climate and market stresses; the modification of crop and livestock production systems; water use competition; changed water quality; expansion of weeds, pests, and diseases; a change in plant-animal communities; altered fire and storm patterns; changes in grassland ecosystems and species composition; disruption of pollinator relationships; tree mortality; enhanced vulnerability to drought conditions, and insect or disease outbreaks in a number of ecosystems (Parmesan and Yohe 2003, Parmesan 2006, Field et al. 2007, U.S. Climate Change Science Program 2008a, 2008b). There is a scarcity of information and literature on the interface of how socioeconomic and demographic factors will interact with the biophysical changes accompanying global change and almost no information on how the interconnected socio-economic / ecological systems will respond (Lal et al. 2011).

One certainty is that vulnerability to climate change is intensified in rural areas with highly climate-sensitive livelihoods, where communities have fewer resources and alternatives than metro areas. Lal et al. (2011) suggest that rural areas typically have higher poverty rates and lower household incomes, historically putting them at higher climate-related risk from weather-related shocks. The impacts of climate change and capacity to manage resulting challenges will vary across the region and within communities, just as households have differentiated vulnerabilities and coping mechanisms. A range of impacts will be felt across different communities, with some benefiting from climate-induced changes, and other facing devastating losses. Further regional research that improves upon current understanding of socio-economic and biophysical impacts of global change on rural communities would be useful to develop appropriate policies and mitigate negative consequences (Lal et al. 2011).

As stated in Chapter 7, the response of agricultural systems to climate change will vary across the region. However, the disproportionate percentage of rural counties (versus metro counties) reliant on agriculture as a primary source of economic activity suggests rural communities will experience the brunt of climate impacts on agriculture.
NATURAL RESOURCE VULNERABILITIES AND CHALLENGES FACED BY THE GREAT PLAINS

(Lal et al. 2011, USDA Economic Research Service 2012). If yields decrease, not only will profits and income be lowered, but families reliant on agriculture for subsistence will be doubly impacted by both a loss of income and food source. Similarly, farming communities are expected to experience additional water stress from climate change, particularly in counties reliant on irrigation. Chapter 4 details critical issues related to the effects climate change will have on water. Aquifers in the Great Plains continue to be tapped faster than the recharge rates, causing unsustainable water-use in the region (Barnett et al. 2008). Although urban areas are using more total water, the greatest percentage is surface-water. On average, rural communities (including agriculture) use more groundwater and almost eight times the total water of urban areas (U.S. Geological Survey 2005).

Effects of climate-related events on social systems are less known but can be expected to be negative in remote areas. As previously stated, the accessibility of health care resources tends to deteriorate as population density declines. With decreased access to health infrastructure and a higher proportion of income spent on health services, rural communities are likely to become more vulnerable to the harmful climate change health impacts discussed later in this chapter.

The Native American people of the Great Plains have lived in this region for thousands of years. However, as the region deals with the current challenges of the 21st century, the added stress of climate change on socioeconomic and political factors of the Great Plains is further exacerbating the degrading conditions of many of these tribal communities. How climate change impacts tribes in the Great Plains, with changing water conditions, health implications, and energy challenges are a concern throughout the region. How tribes in this region can draw on their cultural values in developing strategies that can be used to adapt to and mitigate climate change are lessons which can be shared across the rural communities in the region.

A number of tribal communities living in the rural areas have limited capacities to respond to climate change. Many reservations already face severe problems with water quantity and quality – problems likely to be exacerbated by climate change and other human-induced stresses. However, a number of communities and tribal governments are establishing strategies to cope with these social-ecological challenges related to environmental and climate changes taking place on their lands. These activities recognize the socioeconomic challenges faced by these communities, isolated areas where housing often lacks electricity and running water. Communities dealing with high poverty rates and poor health levels are indicators of communities more at risk to climate change. Native American populations on rural tribal lands have limited capacities to respond to climate change and ability to move is constrained by cultural and other socio-economic linked to the tribal lands.

Tribes are disproportionately impacted by rapidly changing climates, manifested in ecological shifts and extreme weather events, as compared to the general population, due to the often marginal nature and/or location of many tribal lands. The high dependence of tribes upon their lands and natural resources to sustain their economic, cultural, and spiritual practices, the relatively poor state of their infrastructure, and the need for financial and technical resources to recover from such events all contribute to the disproportionate impact on tribes (Intertribal Climate Change Working Group 2009). Tribal
communities are deeply connected to local ecosystems and are economically and culturally dependent on the fish, wildlife, plants, and other resources of their lands. However, this connection to the local ecosystems and ecosystem services also provides potential long-term solutions for adaptation as these strategies incorporate ecosystem services as part of these actions to deal with climate changes in their social-ecological system. So there are ways which the various Indian tribes have shown significant strengths and resiliency to meet these challenges.

WATER

Water is vital for drinking, agriculture, economic activities, and ecological habitats – basically, for life. And while tribes have adapted to the water cycles of the Great Plains over generations, population growth, region-wide increased industrialization, and climate change are making the variable water supply and regimes in this area more uncertain. Tribes already face significant challenges in providing adequate water supply and wastewater treatment for their communities. Climate change will add to these challenges.

In addition, the uncertainty associated with undefined tribal water rights results in constraints in developing strategies to deal with water resource issues. These water right issues are made even more complicated by the fact that these are often cross-jurisdictional, cutting across intersecting tribal, municipal, state, and federal boundaries. Various court cases have attempted to resolve these issues (e.g., Winters vs. US 1908, Arizona vs. California 1963), however, questions still are unsettled. In many areas of tribal lands, water infrastructure is in disrepair or lacking (U.S. Environmental Protection Agency 2011). According to a 2007 Indian Health Services Report, approximately 40,000 tribal homes in the Great Plains region had water supply deficiencies and 24,000 had deficiencies related to wastewater treatment (Rogers 2007). Roughly 9,700 homes completely lacked either a safe water supply system or a sewage disposal system or both (Rogers 2007). These conditions lead to increased vulnerability to climate extremes, and emergency fixes may take time to implement and can be costly. For instance, during a 2003 drought in the Missouri River Basin, Lake Oahe levels dropped so low that silt and sludge clogged the sole intake pipe at Fort Yates, North Dakota, cutting off the water supply for residents of the Standing Rock Sioux Tribe for several days and causing an Indian Health Services hospital to be temporarily shut down. A temporary intake system was installed at a cost of about $3 million (Albrecht 2003, O’Driscoll and Kenworthy 2005). Such situations across the Great Plains further affect people’s well-being, and constrain their ability to further cope with other stresses in their socio-ecological system.

Although the challenges can be numerous, tribes have initiated water-related projects that can help them prepare for climate variability and change. These strategies cover a range of actions, which can be identified as assessment, diversification, restoration, and emergency planning. The assessment strategy provides a way to analyze the future needs of a community for various environmental stresses. On the Wind River Reservation in west-central Wyoming, the Bureau of Reclamation examined current municipal and rural water supply systems and wastewater disposal, and also assessed the reservation’s future needs (U.S. Bureau of Reclamation 1996). The assessment incorporated
water demands for enhanced fire protection capabilities as part of the future needs. Recommendations included the installation of metering to help identify where water leaks in the system were occurring, and the development and implementation of a watershed protection plan to maintain the quality of source waters.

In other communities, actions have been taken to diversify water sources to reduce vulnerability to drought or other catastrophic impacts to their sole water source. On the Rosebud Sioux Reservation in South Dakota, work through the Mni Wiconi—“Water is life” in the Lakota language—Rural Water Project (Hall 1998, Rosebud Sioux Tribe 2012) expanded access to the Missouri River sources. Restoration of degraded watersheds and wetlands have also been undertaken to reduce risks to water quality and flood abatement measures. The Potawatomi Reservation in Kansas has worked with Kansas State University to establish several demonstration projects showcasing riparian forest buffers and streambank stabilization techniques for streams that drain cropland. These streams have been subject to erosion and may contain high levels of nutrients and pesticides. Emergency planning has also been effective in reducing risks. In 2007, the Northern Cheyenne Tribe in Montana worked with a consulting firm to develop a Drought Mitigation Plan (Northern Cheyenne Tribe 2007). The plan outlined action items, such as identifying emergency water supplies for each public drinking water system and for the Indian Health Services Clinic. The tribe also plans to continue working with the USGS, EPA, and the Montana Bureau of Mines and Geology to monitor water quantity and quality on the reservation.

HEALTH

Tribes currently face a variety of health care issues, and climate change may act to exacerbate. Expected increases in hot extremes and heat waves may put the elderly and the very young at an increased risk of illness and death (Intertribal Council on Utility Policy n.d., Maynard 1998, Kovats and Hajat 2008). As life spans increase, people in the elderly category will increase as well (Houser et al. 2000). Another group of people vulnerable to heat extremes are those with diabetes (Intertribal Council on Utility Policy n.d., Maynard 1998, Kovats and Hajat 2008). In Native American communities the adult-onset of diabetes has become pandemic (Houser et al. 2000). In tribes in North and South Dakota, one study found the prevalence rate of type-2 diabetes for people aged 45 to 74 to be 33% among men and 40% among women (Lee et al. 1995, Struthers et al. 2003) which is over 4 times the national average. Another factor that makes tribal communities more vulnerable to extreme heat is the high proportion of inadequate housing that provides little protection against excessive temperatures (Houser et al. 2000). Many tribal homes also lack air conditioning or insulation, and residents may not be able to afford the additional costs that air conditioning would entail. Moreover, nationwide, about 14% of Indian households have no access to any electricity, which is ten times the national average (1.4%) (Energy Information Administration 2000).

In addition to extreme heat, other anticipated consequences of climate change in the Great Plains include increases in drought severity and frequency and greater wildfire risks. These factors could lead to a rise in respiratory ailments from increases in dust and smoke (Houser et al. 2000). Asthma sufferers may be particularly vulnerable,
and as with diabetes, rates of asthma among Native Americans are higher than the national average. According to the Office of Minority Health, data from 2004-2008 show that American Indian/Native Native adults over 18 years of age were 20% more likely to have asthma than non-Hispanic white adults (14.2% vs. 11.6%) and 40% more likely to die (1.3 vs. 0.9 deaths per 100,000).

Climate change health adaptation strategies include programs, such as the diabetes prevention demonstration project of the Winnebago Tribe in Nebraska. This project, sponsored by the Indian Health Service’s Division of Diabetes Prevention and Treatment, involves a series of 16 group education sessions using a specially prepared curriculum as well as individual coaching and monitoring (McLaughlin 2010).

Another strategy is a public health campaign, such as the Native American Asthma Radio Campaign, launched by the EPA in 2001 and broadcast in Native American languages, to educate listeners on how to reduce environmental triggers of asthma attacks. Further adaptation measures include the development of tribal energy efficiency codes and weatherization programs (Maynard 1998), the building of new housing units to decrease overcrowding, and the construction of better quality housing units overall to protect against the elements. Improvements in infrastructure, such as road-paving and drainage and strengthening communication links and power supplies, would help decrease health risks from natural disasters (Houser et al. 2000). Recent efforts by Native Great Plains tribal communities include protecting medicinal plants and transporting them to safe areas, developing sustainable agriculture to address nutritional issues in Native diets, obtaining information about social and environmental stress management as climate change action strategies, and obtaining training from the Federal Emergency Management Agency on the development of Emergency Response Plans (Maynard 1998).

ENERGY

Energy concerns on reservations can be framed both in smaller-scale terms of energy use, including supply for residences and vehicles, and in larger-scale terms of energy production as a source of economic development and jobs (see Chapter 6). In a climate change context, energy concerns center primarily around energy usage as a source of greenhouse gas emissions. On Great Plains reservations, many synergies exist for addressing the two sets of small-scale and large-scale concerns.

One of the major concerns surrounding energy usage can be framed in terms of access and efficiency of usage. In many regions, availability of reliable power to many households is lacking. Secondly, due to substandard housing and buildings, energy is wasted in cooling and heating costs. The improvements in affordable and accessible housing materials would greatly alleviate some of the chronic stresses these communities experience.

Development of small- to large-scale energy sources, such as wind, solar, and hydro, would lead to improved access and, possibly, dependable power. This could also lead to improved economic viability of tribal communities if, for instance, tribal wind energy operations were sold through the sale of renewable energy certificates or “green tags” (Gough 2002). Through green tags, the environmental benefits of wind or other
renewable energy sources are quantified and sold as a commodity separate from the electricity itself, which is sold as a second commodity with no particular environmental attributes and at a price comparable to its fossil-fuel-based counterparts. An advantage of green tags is that they may be bought by individuals, organizations, or utilities anywhere in the US that would like to support renewable energy development. The tags thus allow consumers to support green power even if their local utility does not directly offer it, and they broaden the potential market for a renewable energy project. The revenue generated through the sale of green tags can significantly boost a project’s financial feasibility.

Despite the challenges, the rewards of large-scale tribal renewable energy development in terms of creating long-term sustainable livelihoods, reducing greenhouse gas emissions, and addressing the future energy needs of the Great Plains region could be great both on and off the reservation.

RURAL AND TRIBAL HOUSING

Sustainable, affordable, and energy efficient housing is key for creating community resilience to climate change. It provides major opportunities for both adaptation and mitigation by supplying protection against climate and weather extremes, promoting human health, and reducing greenhouse gas emissions. In the rural Great Plains, there are a variety of housing issues including rural foreclosures, the rehabilitation of housing, the preservation of affordable rental properties, manufactured housing, rural homelessness, and more. Inadequate housing is pervasive among certain groups in the Great Plains, in particular Native Americans and those living along the US-Mexico border.

These communities share certain characteristics, including lower median incomes, higher rates of poverty, and younger populations. According to the 2000 census, the median on-reservation/Oklahoma Tribal Statistical Area (OTSA) Native household income was about $26,700, which was roughly 36% below the national average of $42,000. In border areas, the median household income, as a whole, was $28,000 according to a 2002 Housing Assistance Council report. According to the 2000 census, the percentage of individuals of partial or full Native American descent living below the poverty level on reservations or OTSAs ranged from 13.7% in Kansas to 50.5% in South Dakota, and averaged 26.6% for reservations/OTSAs over the entire Great Plains region. This latter percentage was a little over twice the national average of 12.4%. According to the 2002 Housing Assistance Council report, for the border region as a whole, 18% of residents had incomes below the poverty level. The percentage for Hispanic residents living in non-metro areas was 32%.

Native American Indian reservations are currently suffering from a severe shortage of healthy, safe, and affordable housing, and have been since they were established over a century ago. The need for adequate housing stems back to the 18th and 19th centuries during the eras of removal, reservation and, later, allotment (U.S. Commission on Civil Rights 2003). During this time, tens of millions of acres of tribal lands were either forcibly surrendered or were lost through sales to white settlers. Many native peoples from east of the Mississippi River were relocated from their traditional woodland homelands to unfamiliar, undeveloped, and often barren areas in the Southern Plains. In the
Northern Plains, once nomadic tribes were confined to much smaller portions of their traditional homelands or settled onto lands allotted for farming or ranching, requiring a shift away from tipis to more permanent housing.

In addition to poor building conditions, more than 30% of reservation households nationwide are considered to be crowded and 18% are considered to be severely crowded (U.S. Commission on Civil Rights 2003). Twenty-five to thirty people, for instance, may share a single home (U.S. Commission on Civil Rights 2003). The percentages of overcrowding may be underestimated as no extensive study has ever been done. Also, the census relies on self-reporting, and public housing tenants may not provide an accurate accounting for fear of violating occupancy rules (U.S. Commission on Civil Rights 2003). Homelessness, in which families may live in cars, tents, storage sheds, or abandoned buildings, is also being increasingly observed on reservations (U.S. Commission on Civil Rights 2003). However, no firm statistics for homelessness on reservations are currently available.

In addition to carryover from previous generations, housing continues to be an issue today for a variety of reasons. Many Native communities are geographically isolated and distant from urban centers, which increase the costs of both supplies and labor. Harsh climates may limit the construction season. The construction of public housing on reservations can be very time-consuming because efforts may have to be coordinated among several federal agencies (HUD, BIA, USDA, HHS) and among state agencies as well (U.S. Commission on Civil Rights 2003). Also, there are a variety of complicated and unique land tenure issues in Indian Country. In terms of home ownership, issues, such as predatory lending, insufficient credit ratings, and a general lack of banks and mortgage lenders, are barriers (U.S. Commission on Civil Rights 2003). Additionally, land held in federal trust status, such as land on reservations, cannot be used as collateral for loans. Banks may thus not be inclined to make loans to tribal members for permanent homes, but may provide loans for mobile homes, which they would then have the ability to repossess.

In order to address some of the Indian Country housing issues from the public housing perspective, the Native American Housing Assistance and Self-Determination Act was passed in 1996 separating Native American Housing from other public housing both administratively and financially. The act recognizes Native rights to self-determination and allows the tribes to plan, manage, and monitor housing assistance programs instead of the US government. This should permit each tribe to take into account its unique situation and provide some leeway for tribes to address their housing needs as they see fit. From the private housing perspective, some recommend trying to attract more private mortgage lending to Indian Country (U.S. Department of Housing and Urban Development 1996). However, new housing strategies implemented without simultaneous economic development likely won’t work because tribal residents won’t be able to pay the rent needed or be able to afford to maintain their homes.

One BIA-funded program on the Crow Reservation in Montana is using the housing shortage as an opportunity to create on-reservation jobs by both producing building materials and constructing high-quality, resilient housing on Crow lands. Awe’-Itche Ashé (Good Earth Lodges) has partnered with the University of Colorado’s Mortenson Center to start manufacturing compressed earth blocks using resources from the local area,
the location furthest north in the US to do so. Awe‘-Itche Ashé is using these blocks to build houses with a passive solar design, thermally efficient windows and doors, and a geothermal system for radiant heating and cooling. The aim is to create long-term, high quality careers for tribal members and create hundreds of sustainable, energy efficient homes on the Crow Reservation.

A second innovative project is taking place on the Pine Ridge Reservation in South Dakota where Oglala Lakota College, the Thunder Valley Development Corporation, the Oyate Omnicye Regional Planning Project, and the University of Colorado’s Environmental Design Program are all partnering on a Native American Sustainable Housing Initiative which started in January 2012. The initiative will provide energy efficient housing for Pine Ridge residents and hands-on learning experiences for students. A research component to the project will involve constructing four houses made of different building materials on the Oglala Lakota College campus in Kyle, South Dakota, and monitoring them for indoor air temperature, humidity, and air quality, energy performance, and durability. The homes will be designed with cultural appropriateness as a major consideration, and life-cycle cost analyses will be performed that will account not only for financial costs, but also greenhouse gas emissions, associated with creating the housing materials, constructing the house, and living in and maintaining the house. The ultimate goal of the project is to identify housing options within the community that are healthy, affordable, and sustainable.

Other programs are emerging which provide more financial and technical support for affordable and weather-resilient housing. In the colonias areas, the Nuestra Casa Home Improvement Lending Program of the nonprofit Community Resource Group has been developed to provide better housing. The program is a revolving fund, short-term micro-credit loan system in which a low-income homeowner can borrow $2,500 to be repaid over a two-year period at a 9% interest rate (Giusti 2002, Squires and Korete 2009). The Nuestra Casa program provides a great deal of flexibility in how the borrower can use the funds (Giusti 2002). Another innovative program is Proyecto Azteca’s Self-Help New Construction program. Proyecto Azteca is a nonprofit rural housing development organization, based in San Juan, Texas, that serves colonias residents (Arzamendi 2003, Annie E. Casey Foundation 2005a, 2005b). The families receive materials, tools, and instruction, and work together under the supervision of construction trainers to build homes in Proyecto Azteca’s construction yard, learning new potential job skills in the process.

**Human Health and Disease Considerations**

**POTENTIAL EFFECTS OF CLIMATE CHANGE ON DISEASE: IMPLICATIONS FOR THE GREAT PLAINS REGION OF THE US**

In terms of health risks associated with climate change, the primary concern is with infectious diseases (those resulting from the presence and activity of a pathogenic, microbial agent that can be spread among hosts) and *vector-borne diseases* (those resulting from an infection transmitted by blood-feeding arthropods, such as mosquitoes, ticks, and fleas). Only diseases affecting vertebrates will be considered here, but the effects of climate change on plant species can have equally far-reaching effects. In general, these
Great Plains Societal Considerations

BOX 8.2

Case Study: Development potential on tribal lands

Tribal residential concerns are often focused around the rising costs of fuel sources used for domestic heating due to poorly insulated housing (Maynard 1998, U.S. Commission on Civil Rights 2003). In order to meet local needs, the Lakota Solar Enterprises founded in 2006, is one of the first 100% Native-owned renewable energy companies in the US and is located on the Pine Ridge Reservation. Lakota Solar Enterprises provides opportunities to reduce both their heating costs and greenhouse gas emissions while simultaneously providing green jobs and training for tribal members, including the manufacture and installation of solar air heaters on Pine Ridge (Koshmrl 2011).

Lakota Solar Enterprises has also been collaborating with the nonprofit Trees, Water, and People to plant wind breaks and shade trees around residences to further reduce energy costs. At the Red Cloud Renewable Energy Center on Pine Ridge, tribal members from all over the US can receive hands-on training in renewable energy applications from Native Lakota Solar Enterprises employees (Koshmrl 2011). In addition, Lakota Solar Enterprises in collaboration with Trees, Water, and People, has implemented the Little Thunder single-home renewable energy demonstration project on the neighboring Rosebud Sioux Reservation, which includes photovoltaic solar panels, a small wind turbine, a solar air heater and a windbreak. These efforts provide additional opportunities in new jobs, more energy efficient housing, and renewable energy sources.

At a larger scale, Great Plains tribal governments and communities as a whole may also be involved in and affected by energy production. Oil and gas operations on tribal lands provide income for the tribal governments in the form of leases and royalties. However, concerns about resulting water pollution and environmental contamination often compete with the desire to develop such resources for the benefit of tribal economic development (Maynard 1998). In some cases, large-scale renewable energy development also has serious impacts on Native communities. Hydroelectric power on the Missouri River has adversely affected Great Plains tribes through the historic relocation of riverside communities, the associated loss of their traditional environs, and the eventual erosion of culturally important gravesites (Gough 2002). Yet, these lands may be ideal for renewable energy production. The Great Plains are home to a phenomenal wind resource on millions of acres of unobstructed, undeveloped land (Garry et al. 2009, Koshmrl 2011). On reservation lands in North and South Dakota alone, the wind power potential is over 240 million BTUs per second (250 gigawatts) (Gough 2002). This is at least one hundred times the hydroelectric power produced by the six large dams on the Missouri River (30). Moreover, development of tribal wind power in the Great Plains could not only reduce greenhouse gas emissions but also help alleviate some of the current and future management demands on the Missouri River (Houser et al. 2000).

However, there are certain considerations in development of energy resources on Native American lands. The Owl Feather War Bonnet wind energy project highlights some of these challenges (Garry et al. 2009). The Owl Feather War Bonnet concerns include consideration of protecting sacred sites and cultural resources (Gough 2002, Garry et al. 2009) in the siting requirements; consideration of tribal council involvement in agreements; and the need for development and access to transmission facilities (Garry et al. 2009). Additional legal issues are associated due to the unique status tribes hold as “domestic dependent nation status” and the access to certain of the existing incentives in further developing energy resource (Garry et al. 2009).
diseases involve a pathogen, one or more hosts, and the environment, which makes these diseases particularly sensitive to changes in conditions. Concerns about infectious and vector-borne diseases in vertebrates can be categorized as affecting:

- Human health because they cause illness and mortality in humans.
- Agricultural health because they cause illness and mortality in livestock and plants, which have direct economic effects on producers and consumers.
- Wildlife conservation and biodiversity because they threaten population viability of native species, especially those that are currently considered threatened and endangered, through changes in life-history traits.

Diseases can be specific to one of these categories or involve all three. For example, West Nile virus is a vector-borne pathogen, introduced into the US in 1993, which causes disease in humans, livestock (primarily horses) and wildlife (primarily birds) (McLean 2008). In addition, wildlife are associated with a number of diseases that are zoonotic (disease normally existing in animals that can infect humans) and play a key role in both the emergence of novel diseases and in the maintenance and spread of pathogens causing currently known diseases. Of the 1,415 infectious organisms known to cause disease in humans, 61% are zoonotic (Taylor et al. 2001, Jones et al. 2008). In addition, the incidence of emerging diseases has increased dramatically since 1940 and, primarily, has been caused by 1) newly evolved strains of pathogens, such as drug-resistant strains of bacteria and the Asian-strain of the H5N1 avian influenza virus; 2) pathogens that have recently entered populations for the first time, such as a corona virus-causing SARS in humans and Nipah virus in domestic swine; and 3) pathogens that have been present historically but have recently increased in incidence, such as Lyme disease in humans (Wolfe et al. 2007, Jones et al. 2008).

Wildlife also plays a critical role in both the emergence and increased prevalence of new pathogens in livestock and humans. Recent increases in incidence of emerging diseases in humans have largely been of zoonotic origin (60.3%), and 71.8% of these were caused by pathogens that originated in wildlife (Jones et al. 2008). In addition, there is an inextricable linkage among pathogens affecting wildlife, domestic animals, and humans, with these pathogens often originating in wildlife and subsequently moving to domestic animal hosts and then humans (Wolfe et al. 2007, Dobson and Foufopoulos 2011). In general, the effects of climate change in creating environments in the US for pathogens emerging outside of the country (e.g., Africa and Asia) have largely been overlooked. For example, if climate change fosters conditions for pathogens, such as Rift Valley fever virus from east Africa (Gerdes 2004), in the US, then introductions of those pathogens are more likely to take hold.

Thus, understanding the effects of climate change on disease requires an understanding of those effects on a wide variety of ecological processes, ranging from pathogen persistence in the environment to vector and host population dynamics to the ability of pathogens to infect new hosts and become established in new environments.

There is general consensus that climate change will affect the geographic distribution of diseases, seasonality of disease incidence, and variation and magnitude of disease outbreaks. However, there is little consensus on how and where this will occur.
While conventional wisdom suggests that climate change will result in the expansion of tropical diseases, especially vector-borne diseases, into more temperate regions (Epstein 2001, Lafferty 2009), there is considerable debate of whether this will occur, at least on a global scale. Randolph (2009) argues that the assumption that climate change will result only in a worsening of worldwide health have become unsubstantiated dogma.

Predictions on the effects of climate change on pathogens and diseases are predicated on the assumption that climate constrains the range of infectious and vector-borne diseases while extreme weather events affect the timing and intensity of outbreaks of those diseases (Epstein 2001). Some of the general hypotheses considered (Harvell et al. 2002) for predicting how climate warming will affect host-pathogen interactions include:

- Increasing pathogen development rates, transmission and number of annual generations;
- Relaxing overwintering restrictions on pathogen life cycles;
- Modifying host susceptibility to infection;
- Disproportionately affecting pathogens with complex life cycles

In general, the effects of climate change are considered to be positive for disease emergence, spread, and incidence. Vector-borne diseases appear to be the strongest candidates for increased abundance and geographic range shifts because many of these are climate-limited with pathogens or parasites that cannot complete development before the vectors die (Harvell et al. 2002). Harvell et al. (2002) also suggest that the greatest impacts of disease due to climate change may result from a small number of emergent pathogens.

CLIMATE CHANGE AND GEOGRAPHIC SHIFTS IN THE DISTRIBUTION OF DISEASES

Vector-borne diseases are especially correlated with changes in climatic conditions (Epstein 2001), primarily in response to the ability of insect vectors to increase in abundance, survive, and transmit pathogens to susceptible organisms. Temperature thresholds generally limit the geographic range of vectors. Expanding tropical conditions can enlarge geographic ranges of vectors and extend the season of pathogen transmission, given precipitation conditions remain equal (Epstein 2001). A number of vector-borne diseases have expanded their geographic ranges into more northern latitudes along with their relevant vectors (see (Harvell et al. 2009)).

Warm nights and warm winters favor insect survival (Epstein 2001), and warm winters tend to facilitate overwintering of both vectors and the pathogens they carry. For example, ticks carrying tick-borne encephalitis and Lyme disease have expanded northward and are predicted to expand even further (Ogden et al. 2008), especially when wild birds are included as a potential transport mechanism for ticks. In addition, conditions during heat waves (high temperatures and high humidity) that often challenge human and livestock health are also the conditions that may favor insect vectors, such as mosquitoes (Epstein 2001).
Of particular concern to human, agricultural, and wildlife health are diseases transmitted by mosquitoes. Dynamic models of the effects of climate change on the global distribution of malaria predicted that climate change will expand the geographic distribution of malaria into North America (Martin and Lefebvre 1995, Martens et al. 1997, Rogers and Randolph 2000). However, the predictions on the extent of this spread vary considerably, depending on model structure and which climate change models were used. For example, Rogers and Randolph (2000) predicted that malaria will occur only in the southern portion of the Great Plains region, whereas Martin and Lefebvre (1995) predicted that, at least under one model, malaria would be more patchily distributed across the entire Great Plains region. Contrary to Epstein (2001) and Lafferty (2009, 2010) argued there is little evidence that existing climate changes have favored infectious diseases. More recent process-based models suggest range expansions or shifts, but little net increase in actual area because increases in habitat suitability for pathogens and vectors have been offset by decreases in habitat suitability elsewhere. This is supported by the models developed by Rogers and Randolph (2000) for malaria spread.

One factor rarely considered in predicting climate change impacts on disease is the effect of restructuring of ecological communities concomitant with changes in environmental conditions that promote pathogen spread and persistence. If climate change reduces the diversity of wild hosts, then pathogens invading a new area will focus on fewer novel hosts and have the capability to have a larger impact, spread further, and have stronger seasonal effects because the ‘dilution effect’ of multiple potential hosts will be reduced (Schmidt and Ostfeld 2001, Swaddle and Calos 2008, Garrett et al. 2009, Johnson and Thieltges 2010). Thus, there may be synergistic linkages with climate effects on both biodiversity and disease.

CLIMATE CHANGE AND SEASONAL EFFECTS ON DISEASE
In temperate zones, both temperature and precipitation vary seasonally, which has strong effects on disease transmission, especially with vector-borne diseases. Since changes in seasonal patterns are expected with climate change, theoretically this should also affect disease transmission, either in a positive or negative fashion (Lafferty 2009).

There are a number of hypotheses on how climate change could affect seasonal frequency of disease. For example, climate change can lead to an increase in vector abundance while staying within the same seasonal time period, it can extend the season of high abundance, or may lead to a shift in the season of peak abundance to later in the year. Two of the hypotheses were also further explored by Harvell et al. (2002) in terms of $R_0$ (basic reproductive ratio of a disease), which defines the number of secondary cases produced by an infected individual in an entirely susceptible population. When $R_0 < 1$, the infection will die out in the long run and when $R_0 > 1$, a pathogen will increase and the infection will be able to spread in a population. Hypothetically, increases in temperature not only allow the peak value of $R_0$ to increase, but also lead to an increased annual duration of the period during which the pathogen is a problem.

CLIMATE CHANGE AND DISEASE OUTBREAKS
While increased warming may encourage changes in geographical distributions of diseases and shifts in seasonal incidence, Epstein (2001) argues that extreme weather events
would have the most profound impacts on health issues. However, Pascual and Bouma (2009) point out that variability in infectious disease incidence can be intrinsically cyclic, nonlinear and variable in the absence of any relationship with interannual climate variability. Even so, interannual climatic variability has been shown to influence the size of outbreaks for a number of infectious diseases, especially vector-borne diseases (Pascual and Bouma 2009).

Although higher than average precipitation levels are usually associated with mosquito outbreaks, drought conditions also can play important roles. Landesman et al. (2007) found that West Nile virus outbreaks in humans in the western US were more strongly associated with below-average precipitation in the preceding year. Through wetland surveys and mesocosm experiments, Chase and Knight (2003) found evidence that elimination of mosquito predators in semi-permanent wetlands during droughts allowed populations of mosquitoes to increase substantially in following years, because mosquito predators were unable to recolonize as fast as mosquito production.

**Vulnerability, Risk, and Economy; Insurance Industry Perspective**

In recent years, the implications of climate change have gained recognition among business leaders worldwide. A prominent example is the insurance and reinsurance sector, which is at considerable risk from the impacts of climate change. These impacts include sea level rise, melting permafrost, floods, heat waves, and an increase in wildfires, drought, and extreme precipitation events (U.S. Climate Change Science Program 2009). Although the scientific community cannot yet prove a definitive link between the planet’s warmer climate and individual extreme weather events, the insurance industry has not waited for this causal link to react (Mills 2009).

As the vanguard of risk management, the insurance industry helps society understand and adapt to emerging and evolving risks. Insurers have channeled this expertise into the field of climate change. They have been utilizing data collection, catastrophic modeling, and risk analysis as a means to track trends, define the risks, and formulate solutions for their industry and society at large (Mills 2009). Because of this analysis, they have come to view climate change as a significant cost to their industry, which has resulted in changes in insurance underwriting, investments, and lending credit. A lack of action in response to climate change would constitute a threat to the economy and the insurance industry as a whole (Mills 2009).

The American insurance industry has recently begun to be more engaged in spearheading initiatives and actions on climate change. The National Association of Mutual Insurance Companies have initiated climate change-related action plans and initiatives, and are urging its members to reflect this risk in policies (National Association of Mutual Insurance Companies 2011). Despite the climate-related products and policies now widely available, many insurers initially focused on financial means to limit their exposure to losses related to extreme weather events and natural disasters. This included limiting the availability of policies in certain areas, tightening terms, and raising premiums (Mills et al. 2006).

An example of the industry rationale behind these policy losses and premium hikes can be found with Allstate Insurance, the largest publicly traded insurance company in the United States. Allstate recognizes that there is a relationship between increased
extreme weather, catastrophic events, and climate change (Mills 2009). An insurance company that insures one in every nine vehicles and one in every eight houses in the United States, Allstate concedes that climate change contributes to rising temperatures and changing weather patterns. The company believes that these contributions will impact the frequency and severity of extreme weather occurrences and wildfires. Allstate uses this rationale to justify changes in the affordability and availability of homeowners insurance in the US (Mills 2009).

As risks associated with extreme weather events have lowered the availability and the affordability of homeowners insurance in high-risk areas, the responsibility has fallen on the shoulders of the federal government. This scenario is best illustrated by the National Flood Insurance Program (NFIP), which is managed by the Federal Emergency Management Agency (FEMA). The NFIP is a federal subsidy-backed public flood insurance program. It was created in response to a lack of private sector policies for American citizens that live within close proximity to floodplains. Policies are sold by private insurers, but the premiums go directly to FEMA (Drawbaugh 2011). The NFIP has continually been rendered insolvent by extreme weather events.

The NFIP currently is running a deficit of $18 billion and cannot cover its losses without increasing the government’s debt burden. In October 2011, the NFIP, which was set to expire in November 2011, was renewed through September 2016. This new bill lowers government subsidies for high-risk property owners, while allowing the insurance industry to raise its premiums in flood areas to reflect the actual risk (Drawbaugh 2011). The insurance industry’s heightened participation in the NFIP is expected to strengthen land-use planning and hazard mitigation through market-based signals on risk and remediation (Nutter 2011).

Even though 2010 had a greater number of extreme events than 2011, the total damage in 2011 was more expensive. From extreme drought, heat waves and floods to unprecedented tornado outbreaks, hurricanes, wildfires and winter storms, a record 14 weather and climate disasters in 2011 each caused $1 billion or more in damages and, most regrettably, loss of human lives and property, according to the National Oceanic and Atmospheric Administration (NOAA) (National Oceanic and Atmospheric Administration 2011). The Great Plains experienced damages associated with spring flooding along the Missouri and the Souris rivers in the northern portion, drought and fire losses in the southern region, and tornados in central and southern areas, adding to this total. These occurrences of natural disasters and extreme weather events are consistent with scientific predictions related to climate change.

Thunderstorms, which are common in the Great Plains, are beginning to receive the attention of the insurance industry as high risks. Illustrates the increase in frequency of thunderstorms throughout the United States. Allstate is predicting an increase in violent thunderstorms, which are known as “non-model catastrophes” (Lehmann 2011). The insurance company views the increase of these non-model catastrophes as permanent changes and understands the need to recover the costs associated with these events (Lehmann 2011). This permanence will likely be reflected in rate increases for areas affected by thunderstorms.

The insurance and reinsurance industries operate their businesses with the perspective that the climate system is in the process of changing due in large part to human
emissions of greenhouse gases. The world’s largest insurance and reinsurance companies see the risk posed by climate change as one that poses a risk to their bottom line. While the scientific community is still studying the link between climate change and extreme weather events, these industries have already adapted their business to the realities and uncertainties associated with these impacts.

Insurance and reinsurance companies are sending a clear market signal regarding the economic impacts of climate change. They have changed their risk analyses for extreme weather events and natural disasters to include macroeconomic modeling and catastrophic risk modeling. It is no surprise that, when it comes to reporting on climate change, this industry works hand in hand with the scientific community to develop new risk models for trends deviating from historical realities. Their prioritization of the risks associated with climate change signifies that the insurance and reinsurance industries view the escalating impacts of climate change as definitive aspects of the world’s future.