NÚCHÍÚ

UTE MOUNTAIN UTE TRIBE
CLIMATE ACTION PLAN

Acknowledgments

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Letter to Our Community

March, 2020

Máik Túgúven,

[Hello Friend]

This Ute Mountain Ute (UMU) Climate Action Plan is dedicated to our children and community members. Our climate is changing because the earth is warming. UMU Tribal lands have experienced severe, sustained drought events that cause devastating impacts to local livelihoods and environmental resources. It is important that we take responsibility and keep future generations in mind as we look for solutions. Ute people have a demonstrated history of adapting and solving difficult problems.

When we burn fossil fuels like oil, natural gas, and coal for energy we release carbon dioxide and other greenhouse gases into the atmosphere. Carbon dioxide is a gas that traps heat. Our planet has warmed 2 degrees Fahrenheit (°F) in the last century, which is causing climate change. Climate change is expected to worsen impacts and increase risks to our people and natural environment in this region. UMU people depend on natural resources to maintain our cultural practices, identity, and sovereignty as a people. These warmer temperatures have caused reduced precipitation, changes in seasonality, and exacerbated health concerns such as asthma and cardiovascular disease, among other things.

UMU leadership is taking efforts towards energy independence. This year a 1-megawatt community solar project was launched. The Tribe is considering other renewable energy proposals. These projects will help create jobs for our people and contribute to the world-wide effort to cool our planet.

Climate change is a challenge that will be with us for many generations. It is important that we care for the land, plants, water, air, and animals that keep us connected to our culture. Our Elders and community members worked together to create this plan with the foresight to help us prepare for the effects of climate change.

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Key Terms

(Source: Institute for Tribal Environmental Professionals Climate Change Adaptation Plan Template, version 2.0, 2015)

Adaptation (climate change): actions in response to actual or expected climate change and its effects, that lessen harm or exploit beneficial opportunities. It includes reducing the vulnerability of people, places, and ecosystems to the impacts of climate change.

Adaptation Actions: actions or activities that the tribe could take to achieve its climate change adaptation or preparedness goals.

Adaptation Goals: what the tribe wants to accomplish in the priority planning areas through adaptation or preparedness actions.

Adaptive Capacity: the ability of a system to accommodate or respond to the changes in climate with minimum disruption or cost. Generally, systems that have high adaptive capacities are better able to deal with climate change.

Climate: the "average weather" generally over a period of three decades. Measures of climate include temperature, precipitation, and wind.

Climate Change: any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer). Climate change may result from natural factors and processes and from human activities that change the atmosphere's composition and land surface.

Evapotranspiration: the process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration of plants.

Global Warming: average increase in the temperature of the atmosphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced.

Greenhouse Gas (GHG): any gas that absorbs infrared radiation in the atmosphere; examples include carbon dioxide, methane, nitrous oxide, ozone, and water vapor.

Mitigation (climate change): actions that reduce the levels of greenhouse gases in the atmosphere; includes reducing emissions of greenhouse gases and enhancing sinks (things that absorb more greenhouse gases than they emit). Examples include switching to renewable energy sources and implementing energy efficiency measures.

Planning Area: this is an area in which the tribal government manages, plans, or makes policy affecting the services and activities associated with built, human, and natural systems. For example, within the sector Utilities, you might have planning areas of Water and Electricity.

Priority planning areas: planning areas of particular importance to the tribal government or community which are vulnerable to climate change impacts.

Resilience: ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to absorb stress and change.

Risk: consequence of an impact X Probability or likelihood that the impact will happen.

Sector: general grouping used to describe any resource, ecological system, species, management area, etc. that may be affected by climate change. For example, Transportation, Utilities, Water Resources, Forest Resources, Human Health, or Cultural Resources and Traditions.

Vulnerability: the susceptibility of a system to harm from climate change impacts. It's a function of how sensitive the system is to climate and the adaptive capacity of the system to respond to such changes. Generally, systems that are sensitive to climate and less able to adapt to changes are considered to be vulnerable to climate change impacts.

Executive Summary

"The old people went by the weather. The climate has really changed. You expect heat in summer; winter is cold. That's how I grew up. Winter was long back then. The snow no longer comes in October. Sometimes, we don't have snow in December. It used to snow into April. A long time ago it used to rain a lot and we played in the mud. The frogs would come out of nowhere. We don't see that rain anymore."

~UMU Elder

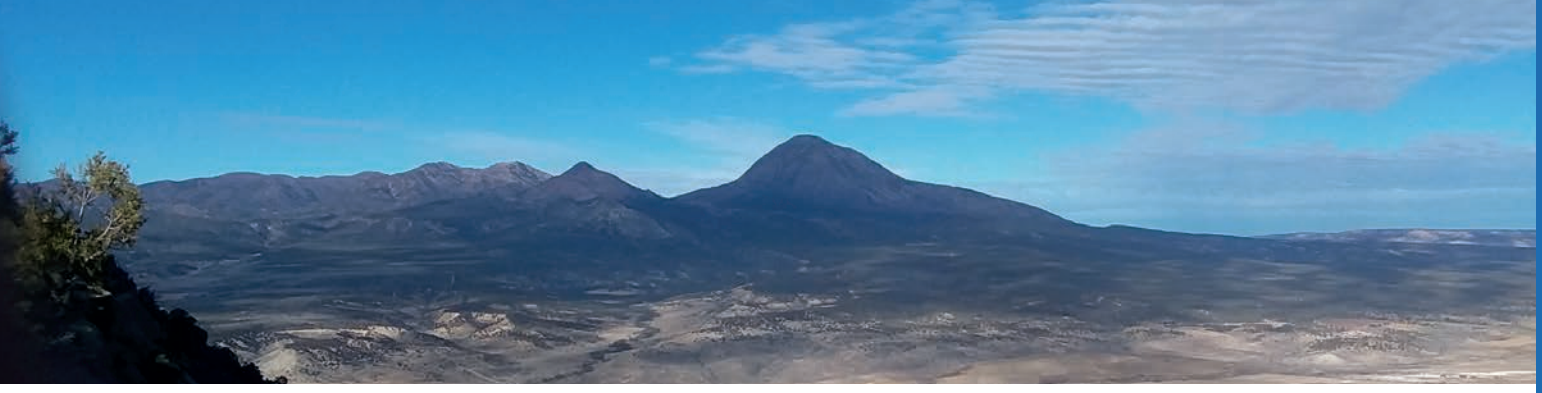
The information in this Climate Action Plan represents an important step in protecting the health and livelihoods of our community members. The climate in this region has warmed 2 degrees Fahrenheit (°F) in the last century. By the middle of this century, the region is expected to warm an additional 3 to 8°F. In response to the growing concerns about extreme drought events from Núchíú (UMU Tribe) Elders, natural resources managers, Tribal leadership, and community members, the Tribe initiated the climate change adaptation planning process.

The Tribe collaborated with Colorado State University to develop the project. In 2015, a community-based Climate Change Vulnerability Assessment proposal, supported by Tribal Council resolution, was submitted to the BIA Tribal Resilience Program to study the impacts of climate change on reservation lands. The vulnerability assessment was designed to honor UMU culture and traditional ecological knowledge. In-depth interviews were conducted with twenty-seven Elders and six natural resource managers. The interview results demonstrated a growing concern about the warming climate and the need for climate adaptation planning.

Community members and natural resource managers observed many climate change impacts, namely warming temperatures, increases in extreme heat, severe and persistent drought, changes to the timing of seasons, and changes to the water cycle. The impacts from these climate changes include reductions in surface and groundwater, deterioration of water quality, diminished forage amount and quality, increases in wildfire frequency and intensity, pest outbreaks in forests, diminished crop yields causing economic losses at the UMU Farm and Ranch Enterprise, and impacts to UMU Tribe community members' physical and mental health.

In response to the vulnerability assessment results, the UMU Tribe applied for additional BIA Tribal Resilience program funding, again supported by a Tribal Council resolution, to develop this Climate Action Plan. A Climate Change Adaptation Planning Working Group was created (see Acknowledgments). The funding was used to host workshops, identify and prioritize adaptation options, create this action plan, and share it with community members.

The group focused on six planning areas including health and livelihoods, water resources, water ecosystems, rangelands and forests, terrestrial and aquatic wildlife, and energy. The plan proposes specific actions and funding sources for each area. This information is located in Section 5. The Climate Action Plan work is a testament to the determination of the Tribe to work towards climate resiliency.



1. Introduction

1.1. Why Tribes are Planning for Climate Change

Indigenous people around the world are seeing and feeling the impacts of climate change and are already preparing for what's to come as the planet continues to warm. Because they are long-term caretakers and observers of the land, the people are concerned about the health of their communities and the natural world that they depend on and to which they have close material and spiritual ties. Climate actions – also known as "adaptation strategies" – are being planned worldwide to protect and preserve the natural environments for current and future generations.

The most important messages from the Tribes and Indigenous Peoples chapter of the Fourth U.S. National Climate Assessment are: [1]

1) Indigenous Livelihoods and Economies are at Risk:

   Climate change threatens Indigenous peoples' livelihoods and economies, including agriculture, hunting and gathering, fishing, forestry, energy, recreation, and tourism enterprises. Indigenous peoples' economies rely on, but face institutional barriers to, their self-determined management of water, land, other natural resources, and infrastructure that will be impacted increasingly by changes in climate.

2) Physical, Mental, and Indigenous Values-based Health are at Risk

   Indigenous health is based on interconnected social and ecological systems that are being disrupted by a changing climate. As these changes continue, the health of individuals and communities will be uniquely challenged by climate impacts to lands, waters, foods, and other plant and animal species. These impacts threaten sites, practices, and relationships with cultural, spiritual, or ceremonial importance that are foundational to Indigenous peoples' cultural heritages, identities, and physical and mental health.

3) Adaptations, Disaster Management, and Community-led Relocations are Critical

   Many Indigenous peoples have been proactively identifying and addressing climate impacts; however, institutional barriers exist in the United States that severely limit their adaptive capacities. These barriers include limited access to traditional territory and resources and the limitations of existing policies, programs, and funding mechanisms in accounting for the unique conditions of Indigenous communities. Successful adaptation in Indigenous contexts relies on use of Indigenous knowledge, resilient and robust social systems and protocols, a commitment to principles of self-determination, and proactive efforts on the part of federal, state, and local governments to alleviate institutional barriers.

   For more on the findings of the U.S. National Climate Assessment see: https://nca2018.globalchange.gov/

In the United States, many tribes and Indigenous communities are already planning for climate change impacts. Supported by funding such as the BIA Tribal Resilience Program (which funded this project) among others, tribes are able to conduct adaptation planning efforts. The UMU people are part of these planning efforts. Community members want to ensure that future generations and reservation lands remain healthy in the face of a changing climate. Rain and snowfall are critical to the survival of the people, especially on this drought-prone reservation. Figure 1 below, shows the various tribal planning efforts across the U.S.

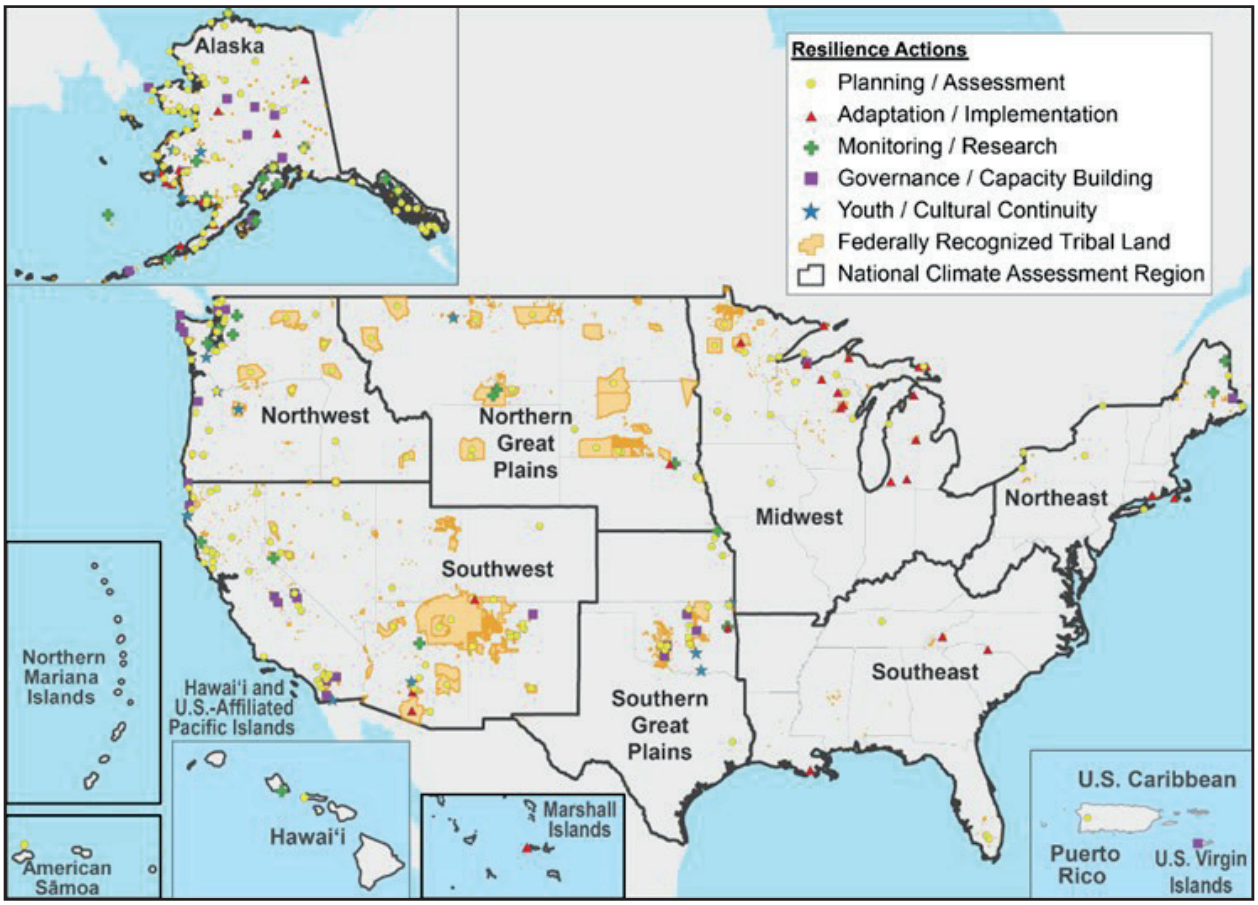


Figure 1. Indigenous Peoples' Climate Initiatives and Plans from the Fourth National Climate Assessment.
Source: https://nca2018.globalchange.gov/chapter/15/

1.2. Ute Mountain Ute Tribe Background: History and Culture

The UMU Tribe is one of 573 federally-recognized Native American and Alaska Native tribes. It has approximately 2,150 enrolled members who traditionally call themselves Núchíú (The People). Its territory is located in a semi-arid expanse of the Four Corners region on the Colorado Plateau over three states: Colorado, Utah, and New Mexico. The majority of the Tribal members reside in the reservation capital of Towaoc, near Cortez, Colorado, but there is a small community of some 250 residents in White Mesa, Utah (Figure 2).

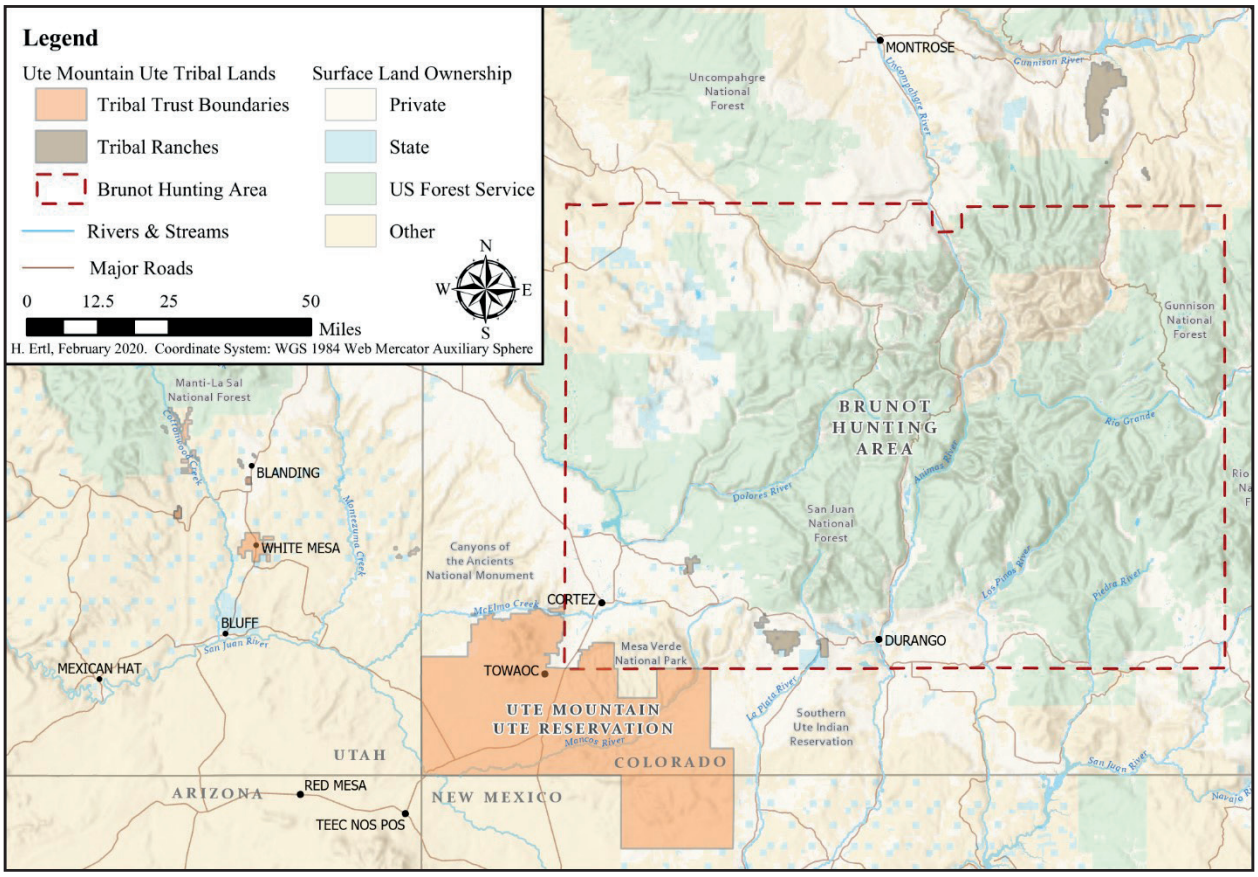


Figure 2. Present Day Ute Mountain Ute Tribal Lands.

Traditional Ute territory included Colorado, Utah, and Northern New Mexico. Ute history passed down through the generations says that the Ute people have lived here since the beginning of time (Figure 3). The Ute people are the oldest tribe in Colorado to continuously occupy the land.

Figure 3. Traditional Ute People and Structures.
Source: University of Utah https://collections.lib.utah.edu/ark:/87278/s65t3w3k

The arrival of Europeans disrupted UMU people's nomadic lifestyle. The Treaty of 1869 reduced Ute lands to approximately 18 million acres. When gold and silver were discovered in the mountainous areas, the 1873 Brunot Treaty was negotiated. It further reduced lands, but it preserved hunting and fishing rights for the Ute people for time immemorial in the Brunot area. Under the Dawes Act, the Capote and Muache bands accepted allotments in the Ignacio, Colorado area. Philosophically opposed to allotments, Chief Ignacio and the Weeminuche band moved to the western part of the Southern Ute Indian Reservation. This land eventually became the Ute Mountain Ute Reservation.

The UMU people living in the White Mesa area experienced lifestyle changes and turmoil when white settlers moved into the area. After the "Posey War" in the 1920s, they accepted allotments in the Allen and Cottonwood Canyon areas. Funds from a lands claims settlement in the 1950s helped to establish the current community of White Mesa.

Present-day UMU Tribal lands encompass a large diversity of landscapes and habitats throughout much of the 597,288 acres of Tribal trust lands, and the 26,013 acres of fee lands. The Tribe has protected its resources for its well-being and future generations. In recent years, the Tribal lands experienced severe sustained drought events that have been associated with human-caused climate change and have caused devastating impacts to the people and environment. Climate change is expected to worsen these drought impacts in the region[2–6].

1.3. Tribal Observations: Ute Mountain Ute Traditional Ecological Knowledge

"Summer is now "k'túrúchí" (too hot)!"

~UMU Elder

In order to document local observations of changes in weather and climate change impacts to the Núchíú and Ute Mountain Ute lands, twenty-seven Elders and six natural resource managers were interviewed between June 2017 and January 2018 [7]. Tribal members were asked to describe any changes in weather and climate on UMU Tribal lands over the course of their lives, and how those changes impacted their traditional activities, and the land they depend on. Natural resource managers were asked similar questions about their respective areas of expertise related to the impacts of changing temperatures and precipitation, long-term drought conditions, changes in seasonality, and other extreme events (the interview questions are located in Appendices II and III). The interview results indicated a growing concern within the community about the changing climate. People noticed a reduction in snow and rainfall. The average and seasonal temperatures were reported to be much warmer, particularly in the winter and summer. The springs and lakes have dried-up on the culturally-significant Ute Mountain. The Mancos River flow is intermittent, and the lack of water in the canyon is impacting fish, wildlife, livestock, and feral horse populations.

Traditional and cultural activities are being impacted by changes in abundance of wildlife and plants for food, medicine, and ceremonies. Subsistence foods such as deer and elk are reportedly in decline. Elders reported changes in the amount and timing of seasonal production among several plants. Changes to seasonal transitions and late freeze/frost events have affected the budding timing in oak trees, for example. There is a reduction in the amount of piñon nuts, wild potatoes, wild onions, buffaloberries, and chokecherries. Cottonwood and willows used in traditional activities are becoming less common on reservation lands. Because of this, community members are procuring materials outside of their traditional gathering areas on non-reservation lands.

"My grandmother and grandfather took care of us. In those years, when we were growing up, we were exposed to a really wet climate in this area. That was probably in the middle of the sixties. The air, as a child from Towaoc looking southward, we could see the mountains. The Chuska Mountains were clear, clear. There was no haze. There was no rust color in the air. It was just so fresh. It was so fresh.

And as time went on, the seasons started to change. Things started to get rough on us. We used to have floods in the monsoon season. The community would flood. Before we had paved roads, we had gravel roads. I lived next to a gravel road on Cottonwood Street. I can still remember seeing the floodwaters coming off the mountains. It was amazing. I thought that it was always going to happen, but as years went by, we stopped seeing those floods. We stopped seeing the runoffs. Things started to change.

As a youngster, we had two foot to three foot of snow by Halloween. I remember treading through the snow to trick or treat. The climate started to change on us. It started impacting, not only the people, but also the wild game and our herb gatherings. We have to go off the reservation to pick up certain herbs to perform our ceremonies. We used to get them on the mountain. Now, we can't do that because they no longer grow there."

~UMU Elder

Tribal Elders' health is being impacted by the combination of a more sedentary lifestyle and extreme heat in the summer time. At times, higher temperatures limit Elders' involvement in traditional activities. Elders are not engaging in garden activities. People report an increase in respiratory conditions such as allergies and asthma. Poor air quality and increases in pollen production can worsen chronic respiratory illness. Electric bills are higher in the summer due to extreme heat. Increased drought conditions have also caused lakes and streams to dry up, which has impacted fishing and swimming opportunities. All of this is putting the Ute people at risk of more health impacts and has constrained the availability of precious resources. These stress factors have created additional economic hardships.

These local observations of impacts were used to guide the development of this Climate Action Plan.

2. Climate Change: Observed Trends and Future Projections

2.1. The Science on Observed Climate Change Trends

In southwest Colorado, average annual temperatures have increased approximately 2°F since the 1900s, and the majority of this warming has occurred in the last 30 years [8]. Spring and summer warming were unprecedented compared to the preceding century (Figure 4). The largest increases in warming were observed in summer maximum and winter minimum temperatures, and there has been an increase in heat waves and drought in the region that has been directly associated with human-induced climate change [4,8–10].

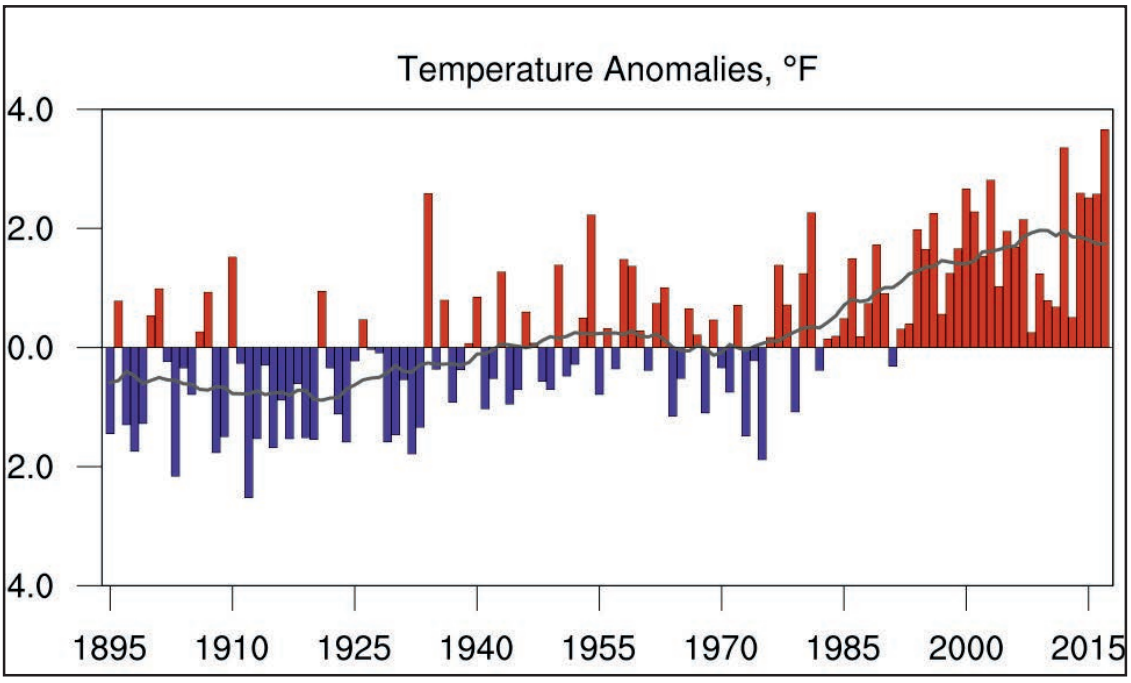


Figure 4. Ute Mountain Ute Tribal Lands long-term annual temperature trends from Colorado Drought Index Portal.
Source: https://droughtindexportal.colorado.edu/

This warming has affected the water cycle in a number of ways that align with the local UMU observations discussed earlier in Section 1.3 including: 1) reductions in snowpack; 2) changes to the timing and amount of snowmelt and runoff; 3) increases in the proportion of precipitation that falls as rain rather than snow; 4) reductions in growing season soil moisture; and 5) increases in more intense precipitation events [4,9,11–15]. For example, April 1 snow water equivalent (i.e., the amount of water contained in snow) has decreased dramatically since the 1950s in southwestern Colorado, while the peak snowmelt and runoff is occurring 2-3 weeks earlier across southwest Colorado from 2001-2010 when compared to 1950-2000 conditions [9,14]. The frequency, intensity, and duration of droughts have increased since 2000 in the southwest U.S. [9]. Southwest Colorado also experienced extreme drought events in 2002, 2012-2013, and 2018 (Figure 5). The high intensity of these droughts may have been aggravated by hotter temperatures.

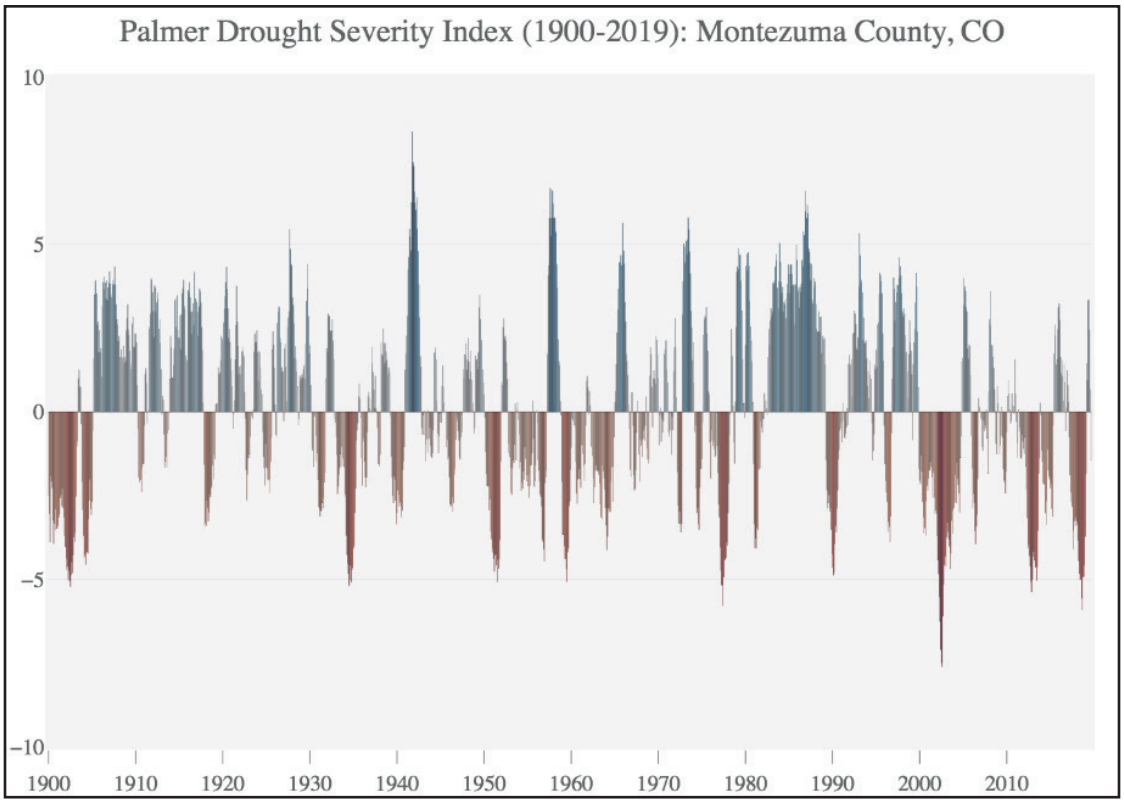


Figure 5. Palmer Drought Index (1900-2019) Montezuma County, CO. This graph shows the major drought events of the last two decades (2002, 2012-13 and 2018) in Montezuma County, Colorado. Note that these droughts are more severe than those previously recorded. *Source:* https://droughtindexportal.colorado.edu/.

2.2. Future Climate Change

By the mid-21st century, the region is projected to warm further by 3 to 8°F on average, which would result in more frequent and more intense heat waves, and 20-60 more days that exceed 90°F [4,9,10,16]. Seasonally, greater warming (more than 5°F) is expected for summer maximum and winter minimum temperatures, which will further contribute to drying soils and insect outbreaks, respectively [16]. Because of higher temperatures, the growing season will increase 20-50 days, and warmer conditions will also create drier conditions (e.g. decreased soil moisture) for part of the growing season. Projected warming will further amplify changes to the water cycle that have been observed in recent decades, including reductions in annual snowpack, soil moisture, and late-season runoff. During the winter, the region will likely experience less snow, more rain, and shorter snowfall seasons. Reductions in snowpack will be driven by more precipitation falling as rain rather than snow. Projected changes to overall precipitation amount in terms of whether it will increase or decrease from present day are less certain. There is some indication from climate models that the summer monsoons will weaken, which could mean fewer days of monsoon rains, although there is higher confidence that the intensity of these rainfall events will increase[17]. The region is also expected to exhibit greater annual and inter-annual precipitation variability, including increases in days with extreme precipitation events and consecutive days without precipitation [4,9,18–20].

Even in the case of more overall precipitation (which some models project), drought frequency, intensity, and persistence will increase as projected warming will reduce soil moisture and snowpack and increase evapotranspiration. In the Colorado River Basin, the likelihood of decadal to multidecadal droughts (or "megadroughts") will increase, which could exceed any previously recorded droughts. A warmer, drier future will increase dustiness, which has implications for snowmelt and runoff by increasing the solar energy absorbed and thereby increasing the rate of melting. Also, it may increase the exposure of air pollutants harmful to human health [4,6,9,21–28].

3. Climate Change Adaptation Planning Process

To ensure that UMU communities and natural landscapes remain healthy in the face of a changing climate, funding was secured through the BIA Tribal Resilience Funding program to develop a UMU climate adaptation plan. An Adaptation Planning Working Group was convened in November 2018 to provide strategic direction. The group included representatives from the following UMU areas: Air Quality, BIA Fuels, BIA Range, Natural Resources, Biology, Climate Change, Colorado State University, Energy, Environmental Programs, Natural Resources, Tribal Park, Tribal Council, and Water Quality.

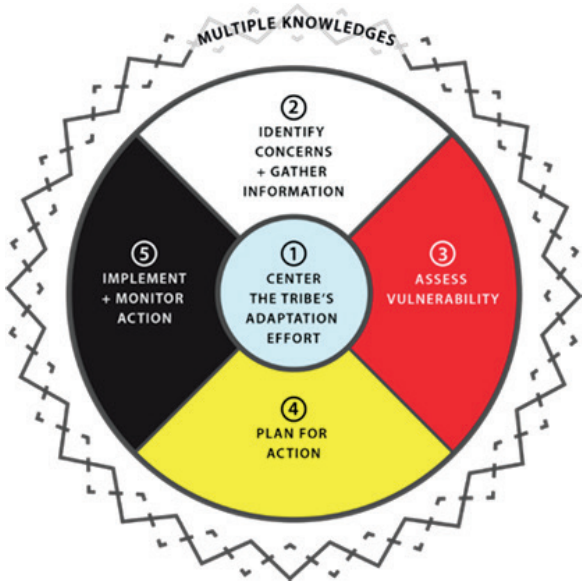


Figure 6. Climate Adaptation Planning Process.
Source: Tribal Climate Adaptation Guidebook Framework.

The Adaptation Planning Working Group built upon the work from the community-based vulnerability assessment (completed in 2018) that outlined climate sensitive sectors and planning areas[7]. Tribal members stressed that they wanted the plan to reflect the community values and guiding principles of the interconnectedness of natural resources and culture, the sacredness of water, community, family, and traditions. The group suggested changing the title from Climate Change Adaptation Plan to Climate Action Plan. The focus of the working group's participation was to help: 1) identify and prioritize adaptation options; 2) compile all relevant UMU Tribe existing documents on existing actions to respond to climate impacts into the draft Plan; 3) co-produce the Climate Action Plan; and 4) share the work with UMU community members.

The Adaptation Planning Working Group met six times, including two half-day workshops. Members also worked individually on providing content from their particular areas of expertise. The priority areas of concern identified were human health and livelihoods, water resources, riparian and wetland habitats, rangelands, fish, wildlife, and energy. Adaptation strategies were generated from existing planning documents and community-members input. The group selected the criteria for prioritizing adaptation actions. The content was placed into a spreadsheet to rank the adaptation strategies. This prioritized list of adaptation strategies is located in Section 5.

4. Current Programs, Actions, and Plans that Lead to Climate Resilience

The UMU Tribe is already actively engaged in efforts that directly and indirectly contribute to building resilience to climate change. The Tribe has managed its water resources for several decades and has secured reliable drinking water for the community. These efforts have increased economic development opportunities, including managing a casino resort and a 7,000-acre agricultural facility. The Tribe is exploring renewable energy projects to meet the increased energy demands in the Four Corners region while decreasing their own dependence on carbon-based energy sources that create climate-warming greenhouse gases. In addition, current climate-smart actions include solar installations, comprehensive water management planning, micro-scale hydroelectric development, energy efficiency upgrades to tribal agricultural enterprises, and diesel emissions reduction. Tribal leadership is supportive of these efforts.

The Adaptation Planning Working Group identified a need to include existing strategies that contribute to climate resilience into this plan. Proposed actions can build on the current operations. This information was collected from the UMU Tribe Climate Change Vulnerability Assessment and planning documents. These plans include: Water Management Plan, Community Wildfire Protection Plan, Fuels Management Plan, Cultural Resources Management Plan, Integrated Resource Management Plan Draft, Hazard Mitigation Plan, Rangeland Assessment, and the Solar Feasibility Study.

The following existing programs and plans are divided into three groups: 1) programs that will help reduce the production of greenhouse gases; 2) programs that monitor our natural resources; and 3) restoration and enhancement projects.

4.1. Greenhouse Gases Reduction

The reduction of greenhouse gases will happen through direct and indirect actions. Projects are underway to reduce greenhouse gas exposure through cleaner energy production, but also by improving access to efficient use of water resources (Figure 7). Programs include:

- A 1 megawatt Community-Scale Solar Farm
- Tribal Administration Building Solar Demonstration Project
- Commercial Scale Solar Feasibility Study
- Hydroelectric Project Proposal on Towaoc Highline Canal
- Adjudication of Water Rights in New Mexico and Utah
- Water Quality Standards for Reservation Surface Waters
- Farm and Ranch Irrigation System Improvements, Farm and Ranch Solar Facility Offsets, and Micro-Hydroelectric Installations
- White Mesa Solar Facility Offsets
- Mancos Creek Farm Ditch Improvement Project
- Mancos River Resilience Project
- Inter-departmental Renewable Energy Committee

Figure 7. Ute Mountain Ute Tribe Officials and Grid Alternatives begin the construction phase of a $2 million solar array.
Source: Cortez Journal, March 15, 2019

4.2. Monitoring and Assessment

Plans to assess resources, monitor changes over time, and create possible strategies for future management of these resources area are ongoing. Programs and plans include:

- Colorado River Basin Ten Tribes Partnership Tribal Water Study
- Tribal Rangelands Vegetation Inventory
- Water Conservation and Management Plan
- Groundwater Monitoring and Protection Plan
- Mancos River Stream Gauges Installment
- Cultural Resources Management Plan
- White Mesa and Towaoc Water Infrastructure Improvement
- Gunnison Sage Grouse Management Plan
- Water Quality Program
- Hazard Mitigation Plan
- Air Quality Monitoring Program
- Wildfire Air Assessment

4.3. Restoration and Enhancement Projects

The UMU community engages in numerous projects to enhance rangelands, wildlife habitat, forests, and residential security. Projects for the restoration and enhancement of critical resources on Tribal lands include the following:

- Water Management Plan
- Range Improvements – Including Livestock Water Pipelines and Drinkers
- Tamarisk Control Program
- Ute Tribal Park: Water Diversions above the Cliff Dwellings, New Shade Structures, Tree Planting in Post Fire Areas
- San Juan Basin Recovery Implementation Program (for endangered fish)
- Three Species Conservation Agreement and Strategy (for state-listed threatened fish)
- Invasive Plant Management in Riparian Areas
- Wetland Fencing to Keep Livestock Out of Riparian Areas
- Solar and Windmill Well Pumps for Livestock
- Native Plant Cultivation
- Forest Restoration
- Forest Thinning (wildfire mitigation)
- Deer, Elk, and Antelope Monitoring and Management

Figure 8. First Lake: April 11, 2019. Temporary spring runoff fill.

5. Priority Planning Areas: Proposed Strategies, Goals, Actions, and Potential Funding Sources

The Adaptation Planning Working Group identified planning areas that the Tribe can focus on in the face of climate change to protect and enhance the cultural and natural resources for people today and future generations. These areas include extreme heat, climate resilient and healthy housing, air quality, tourism, agriculture and food security, aquatic and terrestrial wildlife food security, water quantity, water quality, riparian and wetland systems, rangelands, forest health, terrestrial wildlife, aquatic wildlife, and energy. For each area, an overview and summary table with adaptation actions and possible funding sources is provided.

5.1. Human Health and Livelihoods

Climate change is already affecting the UMU Tribal community as it concerns human health and safety, the economy, and recreational opportunities. Locals observed an increase in respiratory illness due to diminished air quality (e.g., increased particulates, pollen production). Increased summer temperature and summer heat waves have caused heat stress among some tribal members, which is exacerbated because some lack reliable access to air conditioning in their homes. This has resulted in limited time spent outside and, in some cases, decreased elder participation in traditional and cultural activities. Locals noted that electric bills have increased during the summer to keep homes cool, and they also reported increased costs of produce during drought. Reduced water availability in lakes and streams has inhibited fishing and swimming opportunities, while drought has affected gardening activities. The combination of these impacts has also resulted in mental and emotional health problems among some community residents.

Heat-related sickness and death is expected to increase under future climate change due to increases in summer temperatures and the frequency and duration of heat waves [9,16,29,30]. The southwest U.S. could experience the highest increase in annual heat-related premature deaths in the country [4,9]. Marginalized populations (e.g., elderly, individuals lacking access to air conditioning) are at increased risk [4,9,30]. Heat waves, which often coincide with severe drought, will require more water usage to sustain people. Exposure to ground-level ozone, particulate air pollution, and aeroallergens will likely increase, which can increase acute respiratory illness or allergies, or exacerbate chronic respiratory or cardiovascular disease [9,31]. Reductions in water quality and quantity can increase exposure to water-related illness through contaminated drinking and recreational water, or fish [29,32]. Further, many Indigenous populations may experience "ecological grief" and thus impacts to mental health due to future climate changes and variability that will cause significant changes to, their traditional, cultural, and economic livelihoods [1,4,33–35].

5.1.1. Extreme Heat

> ***"Oh goodness, it's dry and hot. It's really hot for me to walk out there…and I have an air conditioner but it seem[s] like it's not really helping that much due to the hot air."***
>
> ***~ UMU Elder***

One of the most certain future impacts of climate change will be an increase in days of extreme heat. The impacts of this on human health and livelihoods will be profound. As such, there is a critical need to start implementing strategies to reduce or prevent human suffering, especially by the Elders. Proposed adaptation actions for extreme heat can be found in Table 1.

Table 1. Proposed adaptation actions for extreme heat.

Observed Changes	• Increase in extreme heat events
Potential Impacts	• People spending more time indoors • Summer ceremonies more difficult to attend, especially for Elders
Consequences of Change	• Increase in electric bills to cool homes • Respiratory health issues • Decreased participation in recreational and traditional activities • Physical and mental illnesses
Potential Adaptation Actions	• Cooling systems such as air conditioning and swamp coolers for Elders and community in homes and tribal buildings • Landscape plan around homes to include drought-tolerant, native plants
Possible Partners and Funding Sources	• EPA Tribal Health Research • Indian Health Service • Kresge Foundation • UMU Tribe Elders Program

5.1.2. Climate Resilient and Healthy Housing

Healthy housing is an integral part of a climate resilient community. As the climate continues to warm, safe energy-efficient houses are critical in times of disaster. Older homes are often are expensive to renovate and are hazardous to people who have respiratory and cardiovascular issues.

The UMU Tiwahe project is addressing housing needs. In the 2019 Tour de Ute Mountain New Housing Construction Project Indian Housing Block Grant (IHBG) the application states:

> There is a severe housing shortage, widespread poverty, overcrowding, and numerous uninhabitable, unsafe, and unhealthy homes. Although the UMUT has worked to meet the housing demand of its residents through rehabilitation of existing homes, placement of mobile homes, and construction of apartment units, it has become increasingly clear that the Tribe and its low and moderate income residents need funding for new construction.
>
> The 2016 IHBG formula documentation shows that 127 Ute Mountain families live in overcrowded conditions. There is no other affordable housing available to the 123 families on the current rental waiting list and 42 families on the current home ownership waiting list. These families want to live on the Ute Mountain Ute Tribe reservation in order to take advantage of tribal benefits such as proximity to family support systems and tribal services like health care, social services, and cultural programs.
>
> Ute Mountain Housing Authority (UMHA) is choosing to purchase modular homes rather than constructing 100% stick-built homes because it is more cost-effective. Utilization of modular construction results in a 30% cost savings at $107.00 per square foot versus a minimum $154.00 per square foot for stick built.

Proposed adaptation actions for healthy housing can be found in Table 2.

Table 2. Proposed adaptation actions for climate resilient and healthy housing.

Observed Changes	• More heat waves
Potential Impacts	• Unhealthy homes
Consequences of Change	• Increase in utility bills • People spending more time indoors • Increase in respiratory and cardiovascular diseases
Potential Adaptation Actions	**Near term (1-3 years)** • Healthy Home Survey - White Mesa **Medium term (3-10) years)** • Sustainable Community Master Planning • Home Rehabilitation Program • Ute Mountain Ute Tribe Tiwahe New Housing Construction
Possible Partners and Funding Sources	• Colorado Department of Local Affairs • Colorado Finance and Financing Authority • HUD - Office of Native American Programs - Indian Housing • Tiwahe Initiative (Dept. of Interior Funded) • United States Department of Veteran Affairs - Veterans Assistance Supportive Housing • United Native American Housing Association Ute Mountain Housing Authority

5.2. Tourism

The UMU Tribal landscapes are rich with cultural and natural resources. Archaeological and historic sites tell the story of how humans have interacted with the environment for thousands of years. The Ute people are the longest continuous residents of this area. The Tribe operates three important cultural resources including the UMU Tribal Park, the Soda Point Area of the Tribal Park at Mesa Verde National Park, and the Colorado corner of the Four Corners Monument.

The UMU Tribal Park, located within the Reservation, consists of approximately 125,000 acres of canyon and plateau land along the Mancos River adjacent to Mesa Verde National Park. Hundreds of surface sites, cliff dwellings, petroglyphs, and rock art drawings of Ancestral Puebloan and Ute cultures are preserved in the Park. Most of the sites remain unexcavated. The Tribal Park was officially listed as a National Historic District in 1972. In 1974, the Tribal Council finalized the establishment of the UMU Tribal Park to protect the area's unique archaeological and natural resources, to provide public access, and to generate employment and revenue for the Tribe and its members. Funding was provided by the Colorado Historical Society, the Tribe, and several foundations. With the establishment of the Tribal Park, several important ancestral Puebloan cliff dwellings were stabilized, including Morris Three, Porcupine House, Lion House, Morris Five, Eagles Nest, Sandal House, Tree House, Bone Awl House, and Two-Story House. The Park also rehabilitates and stores Ancestral Puebloan artifacts that were excavated in the early 1970s during the Mancos Canyon road improvement project.

In addition to the UMU Tribal Park, the Tribe and community also manages the Colorado corner of the Four Corners Monument and the Soda Point Area of the Tribal Park at Mesa Verde National Park. These businesses provide income to community members as well as opportunities for individual vendors.

Increased extreme drought, fire intensity and frequency, and extreme heat all create risks to visitors.

Fires and subsequent runoff could increase problems with erosion of trails and roads. Adaptation strategies include creating shade canopies for the visitors, improving watering systems, developing a solar power plan for the facilities, upgrading signage for the tourists, visitors, and trespassers, and improving maintenance of trails and roads (Table 3).

Table 3. Proposed adaptation actions for tourism.

Observed Changes	• Extended drought; lack of precipitation • Extreme heat • Increased fire intensity and frequency
Potential Impacts	• Forest condition decline; tree mortality • Soil erosion impacts on trail and road maintenance-decreased ability for visitors to use trails and roads • Overgrazing by cattle, wildlife, and feral horses • Tree mortality in Lion Canyon • Heat stress/stroke and air quality impacts (e.g. from dust and smoke) for potential visitors
Consequences of Change	• Reduction in tourism • Decreased visitor experience and/or safety
Potential Adaptation Actions	**Near term (1-3 years)** • Feral horse removal • Water diversions • Wildlife drinkers • Plant trees in post fire areas/Lion Canyon; tree planting and watering; consider habitat suitability under climate change scenarios • More shade areas for visitors and workers; one new metal shade structure at Lion Canyon; shade structure plan • Coordinate with Tribal Historic Preservation Office on protecting cultural resources; ruins stabilization; protect cliff dwellings from water damage and erosion; water diversions above Porcupine House • Forest Fire Fuel Thinning Projects **Medium term (3-10 years)** • Revise Tribal Park Safety Plan in coordination with Mesa Verde National Park to include climate change impacts
Possible Partners and Funding Sources	• Bureau of Indian Affairs • Colorado State Historical Fund • Cultural Resource Fund • Hisatsinom Archaeological Society • United States National Park Service-Save America's Treasures and Preserve America Grants • Volunteers

5.3. Agriculture and Food Security

> ***"We have more droughts now than back then. When we used to water our corn, there was always water but now you see droughts. I don't know how we ever could have done it [water our corn], if we were still to do it now."***
>
> ***~ UMU Elder***

Extended drought and overgrazing by livestock and feral horses have diminished rangeland forage quality and quantity. Severe to exceptional droughts (e.g., 1977, 2002, 2018) have had particularly devastating impacts to ranching operations, and several operators were forced to liquidate their herds over the years. Reduced water availability in the springs, seeps, ponds, and wells that livestock depend on has led to increased congregation at, and competition for, scarce water resources among livestock and wildlife. Wildlife such as deer and elk that are subsistence foods are not as plentiful, and may be locally overharvested. Soil erosion by wind and creation of atmospheric dust is also an important phenomenon contributing to decreased vegetation and agricultural production. This is further discussed in Section 5.7, Rangelands.

Warming temperatures and more frequent and severe droughts will increase evaporation rates, decrease soil moisture, and increase the risk of wildfire and non-native plant invasion (e.g., cheatgrass and toxic weeds). This will reduce rangeland forage production and water availability, and therefore reduce the capability of rangelands to support wildlife and livestock in the future [2,4,5,38,39].

For crop production, despite best efforts to prepare for, and respond to, changes in weather and climate (e.g., crop rotations, crop types, and telemetry-controlled irrigation), severe droughts have contributed to reduced crop yields. This has, in turn, resulted in economic impacts to the Farm and Ranch Enterprise and reduced the amount of food that is produced and provided to the UMUT community. Climate change impacts to agricultural productivity are numerous. Warming temperatures will further increase evapotranspiration, thus requiring more water to irrigate the same number of crops. Heat stress can promote crop failure, which may force producers to leave fields fallow and experience reductions in crop quality and quantity. Increased annual and interannual variability in weather will increase variability in crop production from year to year, which will make planning difficult [4,40]. One agricultural production area on the Reservation is the Mancos Creek Farm. It has a diversion dam on the Mancos River and a recently improved ditch runs water two miles to the farm area. It is dependent on direct river flow, and with earlier spring run-off some crops may be difficult to irrigate.

Many plants used for traditional food, medicines, and ceremonies are less abundant or not found where they were in the past (e.g., chokecherries, wild onions, cottonwoods). For some plants, locals have observed seasonal changes in the timing and amount of production for oak trees, piñon pine nuts, and chokecherries, due to drought or late-season frost events. Regional studies have linked changes in temperature, the timing of spring onset, and the timing and amount of precipitation to changes in flowering onset and duration, the timing of migration in a number of bird species, and mismatches in the peak timing of abundance in predators and prey [4,20,41]. While the extent of these observed changes varies considerably between species, the projected changes in temperature and precipitation amount and timing will likely amplify risks to local plants and wildlife. Proposed adaptation actions for agriculture and food security can be found in Table 4.

Table 4. Proposed adaptation actions for agriculture and food security.

Observed Changes	• Decreased snow accumulation • Changes to timing of seasonal transitions • Warmer spring temperatures • Changes to timing of snowmelt • Species migration
Potential Impacts	**Traditionally-Harvested Native Plants** • Changes in amount and timing of seasonal native plants production • Changes in spatial distribution of native plants • Reduction in diversity of native species **Crops** • Seasonal and inter-annual changes impact decisions regarding crop rotations, crop types (e.g., wheat, corn, alfalfa) and varieties, and fertilizer amount and type; impacts to number of cuttings; and reduced crop yield, which, in turn, causes an increased percentage of non-native weeds
Consequences of Change	**Native Plants** • Decreased abundance and quality of native plants leading to food insecurity **Crops** • Community gardening, professional farming become more challenging • Economic impacts: genetic engineering decisions may come into play
Potential Adaptation Actions	**Near term (1-3 years)** • Farm to Table through new grocery store • Identify additional harvesting locations, enhance viability, maintain genetic integrity • Create a community plan for the tunnel house **Medium term (3-10 years)** • Seed banking, cultivation • Future transition of Farm and Ranch Enterprise role
Possible Partners and Funding Sources	• Colorado Dept. of Public Health • First Nations Grants • Mountain Studies Institute • Quivira Coalition • The Nature Conservancy • Tribal Natural Resources Funds • United States Department of Agriculture • United States National Park Service • UMU Economic Development Dept.: new grocery store

5.4. Air Quality

> ***"The sky is not clean anymore. It's not like when we used to see the clouds come in and you knew it was going to rain. Now the clouds come and it may not rain. The clouds go somewhere else. All this contamination and all this pollution, maybe it was meant to be. We don't know. But we know it's changing. How can we deal with it? We deal with it as best as we can. The Elders said it's the White Man that's doing this to the sky, the clouds and what they understood of the ozone, whatever, all that. They didn't say it was the ozone, this or global warming. They just said it's the White Man with all his whatever, sending all what we now call pollution, into the sky. The sky is not clean anymore."***
>
> ***~UMU Elder***

Air quality has been affected by a number of factors on UMU Tribal lands, including mineral extraction, emissions from nearby coal-fired power plants, increased wildfire, and dust storms. Higher summer temperatures can raise ground-level ozone levels as a consequence of climate change [4,31]. Future climate projections indicate that summer temperatures and the number of extreme heat waves and hot days are expected to increase; the frequency and severity of wildfires and dustiness will likely escalate; and the duration of the flowering period and production of allergenic pollen will likely increase. All of this will contribute to diminished air quality through higher concentrations of ground-level ozone, particulate air pollution, and allergens [4,9,10,16,25,31]. This reduction of air quality due to climate change is another important human health and well-being concern. Exposure to ground-level ozone (exacerbated by warm temperatures), particulate air pollution (from wildfire or dust storms) and allergens (e.g., from increased pollen production) combined with exposure to pollutants, can exacerbate chronic respiratory and cardiovascular disease as well as acute respiratory and allergenic illness.

Tribal enterprises also add to the emissions, such as those from Weeminuche Construction activities, the Casino and Travel Centers, and Farm and Ranch practices. Furthermore, all traffic contributes to pollution and climate change. Oil and gas production on Tribal lands contribute methane, volatile organic compounds (VOCs), and hazardous air pollutants such as benzene, toluene, ethylbenzene, xylenes, and hexane and carbon dioxide. These are linked to numerous human health hazards including cancer and reproductive, developmental, and neurological damage. Similarly, VOCs contribute to smog formation, which can lead to childhood asthma and even premature death. VOCs are precursors to ground-level ozone, which contribute to several harmful health and environmental impacts [36]. A methane "hotspot" was also recently identified in the Four Corners from outer space by NASA in research published in 2016. The anomaly was attributed to a limited number of San Juan Basin gas production facilities. The leaking was roughly 3% of the total Basin gas production. Methane is a strong greenhouse gas in addition to its other ground-level pollutant properties [37].

While a significant portion of the air quality contaminants originate outside of UMU Tribal lands boundaries, there are steps the Tribe can take to eliminate poor air quality. Air pollution controls, such as improved fueling systems and regulations, reduce emissions. In addition, the Tribe can implement actions to help with the health issues such as respiratory illnesses and allergies that are created by poor air quality. Examples of actions that may be implemented to improve air quality indoors are: install air filters in homes, make homes more comfortable for the elderly with air conditioning, provide education for indoor air quality issues such as identification and removal of mold, pollen, and radon. Proposed adaptation actions for air quality can be found in Table 5.

Table 5. Proposed adaptation actions for air quality.

Observed Changes	• Warmer summer temperatures and heat waves • Increase in wildfire smoke, dust storms, mineral extraction dust • Rise in pollen production
Potential Impacts	• Increasing ground-level ozone and smog • Poor visibility across landscape
Consequences of Change	• Impacts on human health as well as wildlife, livestock • Increase in physical, spiritual, and mental illnesses (allergies, heat stroke, heart & lung illnesses) • Rise in respiratory and cardiovascular diseases, allergies, and asthma
Potential Adaptation Actions	**Near term (1-3 years)** • Support air quality program • Emission Inventory of Tribal sources • Assessment of air to determine possible vulnerabilities that could affect human health and environment • Air quality and health education • Daily air assessment "Air Quality Index" and warnings of "unhealthy" days when outdoor activities should be limited • Home air filters and associated maintenance plans for homes • Diesel Emissions Reduction Programs
Possible Partners and Funding Sources	• Albuquerque Area Southwest Tribal Epidemiology Center • Community Health Programs • EPA Grants-CAA103/105 or other EPA Tribal Programs • State of Colorado

5.5. Water Resources

> ***"Our mountain [Ute Mountain] used to have water everywhere. Springs, everywhere. There's no water up in the mountain…we used to have lakes and ponds for the animals. And, now they're dry up on the mountain."***
>
> ***~ UMU Elder***

Locals have observed reduced water availability, especially critical late-season availability in several streams (including Mancos River and Allen Canyon) that support fish, wildlife, plants and people. This is the result of warming temperatures, prolonged drought, changes to the timing of snowmelt and runoff, diversions, and dilapidated physical infrastructure.

Water quality has been affected by several factors, including mineral extraction and agricultural runoff, grazing, and upstream pollutant discharges combined with reductions in water availability and an increase in wildfires. This trend is likely to continue. Reduced water availability may lead to an increase in the concentration of harmful substances already present in local waters. Changes in precipitation intensity, runoff, flooding, and increased sedimentation from wildfires, which is likely to increase by 200% or more in the Mancos River Basin, will further impact water quality [4,9,48,49].

5.5.1. Water Quantity

> ***"The need for water rights defense is becoming more and more profound. We really need to make sure that nobody is taking the Tribe's water. In the last few years in Utah, Allen Canyon, the seasonal home of the folks who live in White Mesa, that's been drying up. We think that somebody upstream is probably diverting some of that water so it's not getting down through there like it used to. So that creates a legal battle that didn't exist before. I mean there's always been water battles, but it's more profound now than it ever has been."***
>
> ***~UMU Natural Resource Manager***

The Tribe's water resources are derived from the Upper San Juan Basin and Dolores watersheds in Colorado and the Abajo Mountains watershed in Utah. The Tribe's Colorado water allocation is stored in McPhee and Lake Nighthorse Reservoirs. The tribally owned off reservation ranches in Colorado and Utah have water rights. The Tribe has completed its tributary groundwater and surface water rights for their Colorado reservation lands. Domestic and agricultural water is provided by the Dolores Project. The Tribe is currently working on securing its federal Indian reserved water rights for the reservation lands located in New Mexico. The federal reserved water rights have not been adjudicated for the reservation lands in Utah.

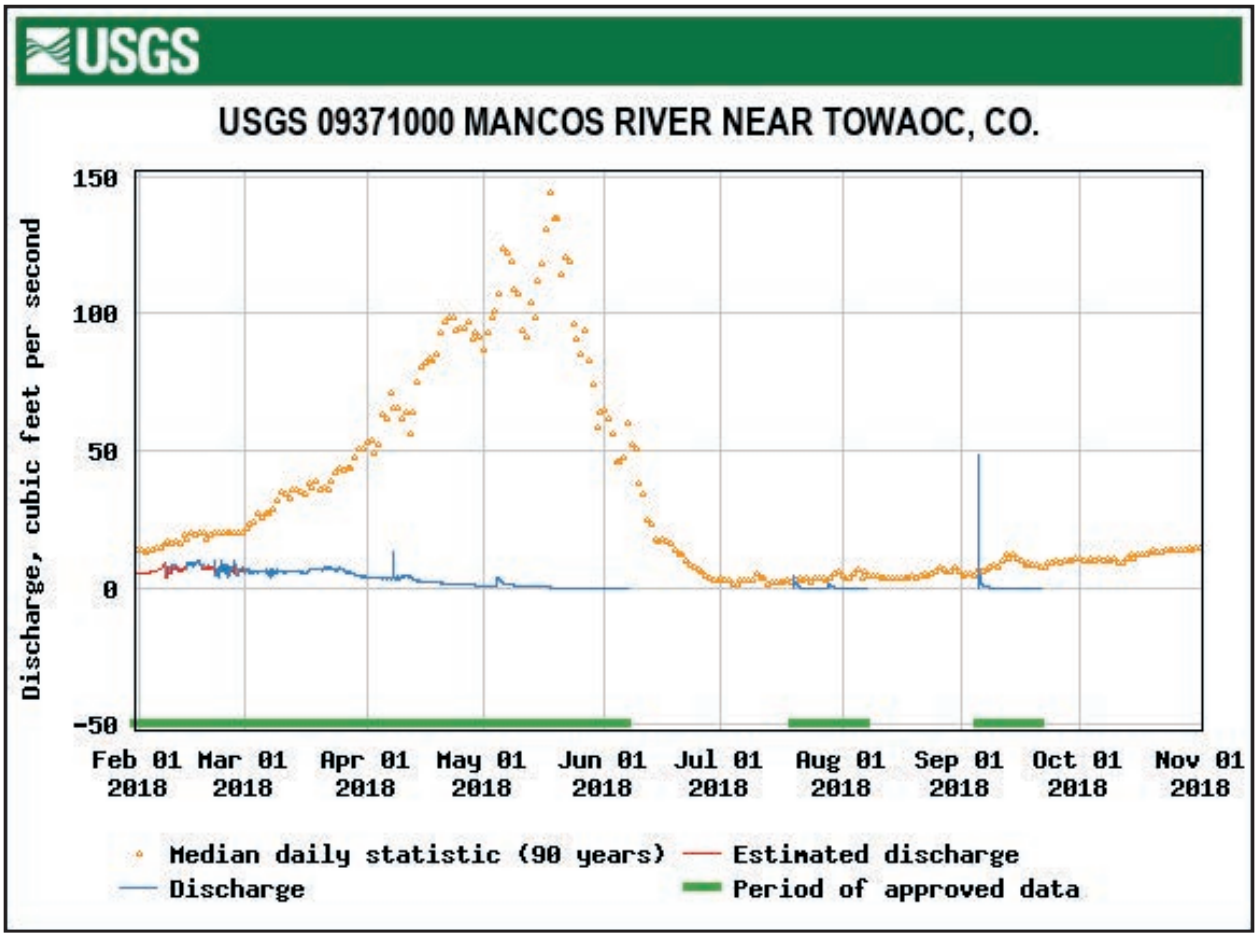


Figure 9. USGS: Mancos River Stream Gauge Discharge Data during the 2018 Drought Year.
Source: https://waterdata.usgs.gov/nwis/rt

Streamflow in the Mancos River experienced record-low flows from 2006-2014 and has declined nearly 60% from 1975-2014 [42]. Further, historical low storage was observed in McPhee Reservoir during the 2002, 2012, and 2018 droughts. Groundwater resources have also declined [43]. Springs and lakes, particularly on Ute Mountain, which are traditionally and culturally important parts of the UMU Tribe landscape, have also dried up.

Surface and groundwater availability will likely continue to decrease under warming temperatures and drought, while shifts to earlier snowmelt and runoff will further diminish late-season water availability [6,9,20,44,45]. By the end of the century, the San Juan Basin can expect a 10-15% decline in annual flows and a 5% reduction in annual groundwater recharge, though summer recharge may decrease by up to 80-90% [43,46,47]. Proposed adaptation actions for water quantity can be found in Table 6.

Table 6. Proposed adaptation actions for water quantity.

Observed Changes	• Warmer temperatures and changes in precipitation patterns are causing earlier snowmelt on Ute Mountain, the La Platas, Abajos, and San Juan Mountains • Less surface and groundwater • Decline in Mancos River, Cottonwood Wash, Allen Canyon, San Juan River flow, and in springs across the Reservation
Potential Impacts	• Ecosystem changes, negative impacts on wildlife, livestock, and native riparian and range flora • Decline in streamflow • Diminished groundwater availability and recharge rates • Reduced soil moisture
Consequences of Change	• Impacts on subsistence activities and community health and agriculture
Potential Adaptation Actions	**Near term (1-3 years)** • Create a water resources division and hire a manager position • Regulatory protection for groundwater • Prepare a drought contingency plan • Water education outreach plan • Enhance irrigation efficiency for landscaping and parks • Minimize new disturbance of intact soils and vegetation **Medium term (3-10 years)** • Groundwater resource characterization • Create and implement groundwater protection plan • Allen Canyon flows protection • First and Last Lakes restoration • Farm and Ranch Enterprise drought tolerant plants initiative • Develop a process for evaluating water supply requests • Emergency evacuation plan for flooding • Acquire senior water rights in the Mancos River Watershed **Long term (more than 10 years)** • Animas-La Plata Project conveyance system plan • Rebuild Cottonwood Wash for flood diversion
Possible Partners and Funding Sources	• Animas-La Plata Project Partners • Bureau of Reclamation • Colorado Water Conservation Board • Dolores Water Conservancy District • Environmental Protection Agency • Natural Resources Conservation Service • New Mexico and Utah Water Rights Settlements • Southwestern Water Conservation District • The Nature Conservancy • United States Department of Agriculture

5.5.2. Water Quality

> ***"With less water you have less high-quality water too. That's definitely a factor. This little creek that runs through town here, Navajo Wash, is a lot of irrigation return water. When the irrigation season ends, the water quality changes profoundly. It goes from being diluted polluted water to not diluted polluted water. And the salinity increases tenfold from summer to winter in there. So as things get drier and drier, that's just going to get worse and worse."***
>
> ***~UMU Natural Resource Manager***

The Tribal Council adopted Water Quality Standards for Surface Waters of the Reservation in 2011. The Tribe manages on-going drinking, ground, and surface water programs and monitors water quality in over 200 locations. The standards aim to protect the water for cultural uses, aquatic life, wildlife, agricultural use, drinking water, and recreation. Water chemistry testing, physical and biological characterization, and wetlands monitoring are conducted regularly. Proposed adaptation actions for water quality can be found in Table 7.

Table 7. Proposed adaptation actions for water quality.

Observed Changes	• High salinity and evaporation rates • Physical and biological impairments • Non-native plant invasion • Mineral extraction and development impacts (oil spills, mine waste, erosion, and sedimentation) • Post wildfire sedimentation, naturally occurring chemicals, increased salinity • Groundwater contamination from White Mesa Mill (currently off reservation)
Potential Impacts	• Ecosystem changes • Impacts on wildlife, livestock, flora, and people • Increased runoff from extreme precipitation events contributing to greater nonpoint source pollution
Consequences of Change	• Impacts on traditional and subsistence activities • Increased costs to provide clean drinking water to Tribal members
Potential Adaptation Actions	**Near term (1-3 years)** • Continue to monitor water chemistry and physical and biological changes over time to protect Tribal uses of water • Regulatory protection for groundwater • Ground water characterization **Medium term (3-10 years)** • Legally protect Tribal surface water resources • Acquire senior water rights to increase stream flows in the Mancos Watershed • Deepen existing wells and/or develop new ones

Possible Partners and Funding Sources	• Bureau of Indian Affairs • Bureau of Reclamation • Colorado Water Conservation Board • Dolores Water Conservancy District • Environmental Protection Agency CWA 106 and 319 base funds • Natural Resources Conservation Service • States of Colorado, New Mexico, and Utah • The Nature Conservancy • United States Department of Agriculture • United States Geological Society

5.6. Riparian and Wetland Systems

Locals observed a reduction in riparian habitats due to prolonged drought, earlier runoff, diversions upstream, increases in wildfire occurrence and sedimentation in local streams, infrastructure failures, and heightened competition from non-native, invasive plants (e.g., tamarisk). This has reduced stream connectivity, contributed to a decline in native vegetation (e.g., cottonwood and willow), caused fish die-out, and impacted water availability for grazing. Low elevation riparian areas in southwest Colorado are considered highly vulnerable to climate change due to: 1) reductions in groundwater availability; 2) earlier peak flow timing and reduced summer flows; 3) potential for increases in extreme weather events; and 4) increased habitat suitability for invasive species [2,20,50]. As such, the abundance and distribution of native riparian species are expected to decrease [2,20]. Three species of Colorado state concern (roundtail chub, flannelmouth sucker, and bluehead sucker) are considered highly vulnerable to climate change due to loss of habitat connectivity, decline in runoff and streamflows, and lack of genetic diversity or hybridization concerns [51].

Wetlands, lakes, springs, and ponds are critical habitats that support sensitive wildlife species (e.g., New Mexico meadow jumping mouse, Northern leopard frog), traditional and cultural activities, and ranching operations on rangelands. Many of these resources have dried up in recent years on UMU Tribal land, especially on Ute Mountain due to drought and diversions. Locals noted the local extirpation of the Northern leopard frog. These habitats in southwest Colorado are moderately (high elevation wetlands) to highly (low elevation wetlands) vulnerable to climate change as they have been impacted by drought and diversions, particularly for low elevation habitats [2]. Warmer and drier conditions are expected to reduce groundwater levels and promote vegetation shifts from riparian to upland species [2,20,50]. Also, earlier and reduced spring runoff will lead to longer drying during the summer, which could reduce the extent of these water features [2]. In southwest Colorado, Northern leopard frogs were ranked as highly vulnerable to climate change. Warming temperatures and drying of ponds can affect reproductive success and contribute to habitat loss, while shifts to earlier timing of runoff can disturb larvae [50].

Climate adaptation goals are to improve water quality, increase or preserve water quantity, and increase the abundance of native riparian plant species while reducing the abundance of invasive range species like cheatgrass. Proposed adaptation actions for riparian and wetland systems can be found in Table 8.

Table 8. Proposed adaptation actions for riparian and wetland systems.

Observed Changes	• Extended drought • Warming air and stream temperatures • Diminished snowpack • Earlier and reduced runoff/streamflows • Wildfire
Potential Impacts	• Loss of habit and biodiversity • Channel incision-narrowing of streambed that prohibits natural regeneration of native riparian species • Changes to course of river • Fisheries (through alteration of water temperature/shading) and to birds/reptiles that rely on them for nesting or aquatic life for food • Reduced water availability can affect livestock and wildlife congregation and competition for water resources and can impact vegetation productivity
Consequences of Change	• Diminished water quality (e.g., sedimentation) • Fish die-out (e.g., roundtail chub) • Dried up/ephemeral streams reduce connectivity and result in loss of habitat (e.g., macroinvertebrates, beaver, fisheries) • Invasive species outcompeting native vegetation (e.g., cottonwood and willow), which can impact water quality • Reduced water availability/dry springs and lakes (e.g., local extirpation of Northern Leopard Frog) • Reduced water availability and quality in streams (fish and amphibian decline, die-out)
Potential Adaptation Actions	**Near term (1-3 years)** • Revegetation with native species • Wildfire mitigation projects • Weed treatments • Seeding programs • Cottonwood and willow pole planting • Wetland and springs protection • Exclusion fencing to keep livestock out of riparian areas • Protective buffer zone delineation and designation: Tribal Park, Ute Mountain, Cliffhouse Sandstone, and springs in New Mexico • Inventory existing and designate additional culturally significant water sources for protection/monitoring **Medium Term (3-10 years)** • Remote irrigation systems • Keep water in stream systems (regulate upstream diversions) • Restore existing resources impacted by drought, diversions (e.g., restore springs/lakes on Ute mountain)

Possible Partners and Funding Sources	• BIA Division of Natural Resources • EPA Nonpoint Source Pollution Funding (Clean Water Act Section 319) • EPA Clean Water Act 105(b)(3) wetland funding • Mountain Studies Institute • Natural Resources Conservation Service • Quivira Coalition • The Nature Conservancy • UMU Cattle Owners • UMU Public Works Department • United States Fish and Wildlife Service • United States National Park Service

5.7. Rangelands

> ***"Older reports talk about like waist-high grasses, kind of a prairie landscape… which is now more of a desert habitat, and that affects groundwater recharge, it affects the ability of the landscape to, you know, foster future vegetative growth."***
>
> ***~ UMU Elder***

For a multitude of reasons, there are many impaired rangelands within the Reservation boundaries. Feral horses and cattle as well as managed livestock overgraze rangelands as heat and prolonged drought reduce forage quality and availability. Drought and overgrazing have led to the land transforming from a prairie landscape dominated by native grasses to a more desert scrub habitat inundated by invasive non-native plants (e.g., cheatgrass, smooth brome). Habitat conversions have resulted in topsoil becoming lost to wind and water erosion. Water catchments, water distribution lines, and other improvements that once enhanced range quality, especially during drought, have not been maintained, and many are no longer operational.

Wind erosion of the topsoil and subsequent dust emissions are occurring. Soils which are mainly intact, upon disturbance by livestock grazing, fire, or vehicles, are loosened and contribute to dust which is subject to the wind and extreme weather events. Deposited dust also affects the snowpack by increasing solar absorption and can reduce water availability by as much as 5%. This also affects plant or agricultural productivity and has economic effects. Dust in the atmosphere reduces visibility (i.e., culturally significant views), influences traffic issues, and contributes to respiratory ailments [52].

> ***"The weather has changed a lot because the livestock don't have very much vegetation out there anymore…But earlier times…most of the Tribe here had livestock. But eventually they disappeared because the rains becoming scarce with the vegetation for the animals and stock. So, we had to reduce our animals."***
>
> ***~UMU Elder***

Significant droughts in the past (1950s, 1977, 2002, 2012-2013, 2018) and long-term drying has resulted in range degradation which has caused reductions in ranching and grazing operations. Feral horses and cattle are a significant problem. Locals observe that range quality and quantity is not rebounding as it once did. The increasing hot weather can stress livestock and increase their health problems. A 2019 vegetation inventory confirmed that many rangelands on the Reservation are overgrazed. This study was conducted by Ecosphere Environmental Services, Inc. with support from the UMU BIA Agency. There is no Tribal range management plan due to social, economic, and political barriers. Proposed adaptation actions for rangelands can be found in Table 9.

Table 9. Proposed adaptation actions for rangelands.

Observed Changes	• Prolonged drought • Increasing temperatures • Increased runoff from extreme precipitation events • Overgrazing
Potential Impacts	• Deterioration of rangeland health: invasion by non-native plants, habitat conversion, and increased soil erosion • Decreased water and forage availability for wildlife and livestock • Impacts on quantity and distribution of wildlife and livestock; risk of disease transmission
Consequences of Change	• Over-utilization near natural water sources, impacts to riparian communities and surface disturbance in these areas • Reduced stocking rates, decrease in cattle owners income, diminished food supply, land use conflicts
Potential Adaptation Actions	**Near term (1-3 years)** • Refurbish existing water improvements and install additional water catchments, solar and windmill wells, and water distribution systems for wildlife and livestock (would require maintenance plan) • Control non-native invasive plants **Medium term (3-10 years)** • Develop a Grazing Range Management Plan (to rotate and rest pastures) that encompasses all lands within the Reservation boundaries
Possible Partners and Funding Sources	• Bureau of Indian Affairs Branch of Agriculture and Rangeland Development • Natural Resources Conservation Service • Utah Department of Agriculture and Food • Utah's Watershed Restoration Initiative

5.8. Forest Health

Extended drought, and warmer temperatures have led to unhealthy mixed conifer, ponderosa pine, and piñon-juniper woodlands on UMU Tribal lands that are susceptible to pest and disease outbreak as well as massive fuel accumulations created from tree mortalities. Multiple disease and pest agents (e.g., piñon ips beetle, leaf beetle, bark beetle) are affecting several tree species simultaneously. Together, these impacts have and will continue to lead to more frequent, higher intensity fires. This is well-documented throughout the western and southwest U.S. The southwest U.S. has experienced a 300% increase in the area burned by wildfire from 1987-2003 relative to 1970-1986, and mid-elevation tree mortality in the western U.S. has more than doubled from 1950-2000 as a result of drought stress, wildfires, and beetles [4,9,53]. On UMU Tribal lands, sedimentation in the Mancos River from the Bircher and Pony fires in 2000 affected water quality and caused fish die-out. Wildfires around the Tribal Park have caused soil erosion issues and concerns about visitor safety. The 2002 drought and associated ips beetle infestation led to 53% mortality of adult trees in southwest Colorado [54].

Climate projections indicate that fire frequency could increase by 25% in the southwest U.S., while the frequency of very large fires could triple [4]. In the Mancos River Basin post-fire sedimentation is expected to increase by more than 200% by mid-century, which will affect water quality and fisheries [48]. The piñon-juniper forests are considered moderately vulnerable to climate change in southwest Colorado, and impacts to these forests are likely to result in altered species composition and forest structure [2,55]. Warming summer temperatures will cause the trees to produce fewer cones [56], and longer and more intense droughts will increase adult mortality from ips beetle outbreaks [51]. Proposed adaptation actions for forest health can be found in Table 10.

Table 10. Proposed adaptation strategies for forest health.

Observed Changes	• Warming temperatures • More frequent drought
Potential Impacts	• Increase in fuel loads and fire frequency • Decline in forest condition due to pests and disease • Increased fire risks
Consequences of Change	• Loss of property and resources upon which the Tribe depends • Decreased air quality from fires; impacts on health • Increased safety concerns for Tribal Park visitors; decreased visitation due to wildfire occurrences in and around Tribal Park • Soil erosion issues, which have impacted road/trail maintenance, tree mortality (e.g., North Lion Canyon) • Successional changes in wildlife habitat resulting from change in fire regime

Potential Adaptation Strategies	**Near term (1-3 years)** • Firewise defensible space around community and Sundance grounds • Education and outreach • Neighborhood Watch • Continued Forestry Management with Colorado State Forest Service Contract and Fund for Fee Lands **Medium Term (3-10 years)** • Fuels management: additional fuels treatment areas • Develop firewood cutting program for tribal members • Construct firebreaks to reduce grass fire risk within the community • Continued Forestry Management with Colorado State Forest Service Contract and Fund for Fee Lands **Long Term (more than ten years)** • Designate focus areas for thinning within the Tribal Park to decrease risks to both Tribal members and Park Visitors • Continued Forestry Management with Colorado State Forest Service Contract and Fund for Fee Lands
Possible Partners and Funding Sources	• BIA Division of Forestry and Wildland Fire Management • Colorado Natural Heritage Program • Colorado State Forest Service • Natural Resources Conservation Service • United States Fish and Wildlife Service • United States National Forest Service

5.9. Terrestrial and Aquatic Wildlife

5.9.1. Terrestrial Wildlife

> ***"I've seen their [deer and elk] build, the way their – you know, the growth of their bodies and things like that have changed. The vegetation has a lot to do with it."***
>
> ***~UMU Elder***

Terrestrial wildlife, including locally sensitive and culturally important animals, has been affected by changes in climate and climate variability, and is vulnerable to projected climate change. Subsistence foods, such as deer and elk, are less abundant and their distribution and migration patterns have changed, thus reducing local hunting opportunity for the UMUT community. Reduced forage and water availability has also contributed to declines in body fat composition and resilience against pests and disease. An increase in human-wildlife conflict among bears and mountain lions has been observed. For example, decreased resource availability and changes in seasonality and timing of hibernation have implications for the safety of local community members and tourists at UMU Tribal Park [57]. Proposed adaptation actions for terrestrial wildlife can be found in Table 11.

Table 11. Proposed adaptation actions for terrestrial wildlife.

Observed Changes	• Warming temperatures • Extended and more severe drought • Reduced snowmelt/runoff
Potential Impacts	• Loss and degradation of habitat for plants and wildlife, including federally threatened and endangered, locally sensitive, and culturally important species • Plant composition and successional changes • Reduced water availability for wildlife • Decreased plant and wildlife resilience from pests
Consequences of Change	• Reduced drinking water availability for wildlife; reduced forage availability and lower water content in forage • Declines in native plant communities including riparian areas which support the highest levels of biodiversity • Increases in non-native invasive plants and noxious weeds • Increased human-wildlife conflict
Potential Adaptation Actions	**Near term (1-3 years)** • Improve wildlife habitat by refurbishing and installing new water catchment systems to provide for year-round drinking water • Develop conservation plans and monitor federally threatened and endangered and locally sensitive plant and wildlife species • Monitor seasonal movement and population parameters of big game species to inform management decisions • Implement riparian restoration efforts that include: 1) revegetation with native plant species following phreatophyte control treatments, and 2) fencing to restrict grazing in critical habitats and revegetated species. • Immobilize and (satellite) collar elk, deer, and antelope and map movement data **Medium Term (3-10 years)** • Control non-native, invasive, and noxious weeds in important wildlife habitats • Increase forest resilience by establishing mixed age and size classes of trees • Explore conservation designations for forest resources for carbon credit • Install additional solar wells for groundwater for wildlife • Decrease human-wildlife conflicts by installing bear-proof dumpsters and educating residents on bear attractants **Long term (more than 10 years)** • Improve plant and wildlife habitats by managing cattle grazing and removing feral horses

Possible Partners and Funding Sources	• Bureau of Indian Affairs • Colorado Parks and Wildlife • Mule Deer Foundation • Natural Resources Conservation Service • Rocky Mountain Elk Foundation • The Nature Conservancy • United States Fish and Wildlife Service

5.9.2. Aquatic Wildlife

Prolonged drought has reduced surface water availability on UMU Tribal lands, shrinking habitat for aquatic wildlife and negatively impacting many species who depend on the limited surface water resources in this arid region. Historically, Tribal waters were host to sensitive native fish including roundtail chub, bluehead sucker, and flannelmouth sucker, though populations have diminished or disappeared over time. The Mancos River flows though UMU Tribal lands in southwestern Colorado and is tributary to the San Juan River (also present on Tribal lands), where critical habitat is designated for two endangered fish species, the razorback sucker and Colorado pike minnow. Irrigation diversions along the Mancos River upstream of Tribal lands have drastically reduced the quantity of water in the river, and connectivity between the Mancos and San Juan Rivers is now seasonal, therefore isolating fish populations in the lower Mancos River. Increased air temperatures, diminished riparian vegetation and reduced surface water flows have led to increased water temperatures, decreased dissolved oxygen, and dry sections of stream channel further impacting habitat for aquatic wildlife and species who depend on them including avian species, bats, otter, and beaver among others. In 2000 and 2012, the Bircher-Pony and Weber fires resulted in a flush of fire retardant, ash, toxic metals, and topsoil down the Mancos River, also causing an oxygen depletion that wiped out populations of aquatic macroinvertebrates in subsequent years. A similar incident occurred in following the 2012 Weber fire, killing the native fish that the Tribe and partners had spent 10 years repopulating in the watershed.

Tribal lands located in Utah are experiencing similar impacts, and intermittent surface water in Allen Canyon and Cottonwood Wash has decreased. Seeps and springs located on Tribal lands provide crucial sources of water for aquatic macroinvertebrates and terrestrial and avian wildlife species and also support cultural practices; however these important water sources are drying up with the changing climate. Springs and reservoirs on the Sleeping Ute Mountain which have been observed to be perennial water sources in the past have been seen waterless in recent years. Historically, some reservoirs on Tribal lands (e.g., Last Lake) were stocked with native trout. Proposed adaptation actions for aquatic wildlife can be found in Table 12.

Table 12. Proposed adaptation actions for aquatic wildlife.

Observed Changes	• Warming temperatures in air and water • Extended and more severe drought • Reduced snowpack • Change in seasonality
Potential Impacts	• Decreased residence time of water in the Mancos River • Loss of connectivity within the Mancos River and decreased connectivity between the Mancos and San Juan Rivers • Degradation of suitable habitats for native fish
Consequences of Change	• Decline of native fish populations, including locally sensitive species
Potential Adaptation Actions	**Medium Term (3-10 years)** • Develop conservation plans and monitor native and non-native fish species • If appropriate, remove non-native fish and stock native fish **Long Term (more than 10 years)** • Improve the resilience of the Mancos River using in-stream restoration techniques as well as phreatophyte control and revegetation with native species
Possible Partners and Funding Sources	• Bureau of Indian Affairs • Colorado Parks and Wildlife • Natural Resources Conservation Service • The Nature Conservancy • United States Fish and Wildlife Service

5.10. Energy

The UMU Tribal Energy Administration oversees and manages the Tribe's mineral resources. Currently the Tribe's energy production comes predominantly from three active oil and gas fields. The revenue from these fields has historically provided a significant contribution to the Tribe's overall economy. Market forces and diminishing yields from developed formations have caused significant and steady declines in oil and gas production in the past 15 years. Fossil fuel resources still exist in potentially profitable plays on the reservation, but a decrease in interest by developers and lack of investment by the Tribe has not changed the current course of the industry on the reservation.

In the past decade the UMU Tribe has expressed an interest in diversifying its energy profile. As stated in a 2014 Feasibility Study funded by the U.S. Department of Energy (Parametrix, 2014) the Tribe's long-term energy goals are "to reduce reliance on fossil fuels and to increase capacity for self-determination through the deployment of energy efficiency measures, and community-scale, and commercial-scale renewable energy systems."

The Tribe is exploring a variety of options for renewable energy development to strengthen tribal sovereignty, become more energy self-sufficient, and provide improved services and economic opportunities to tribal members and reservation residents. The Tribe has formed an ad hoc renewable energy committee to coordinate with potential developers and to pursue funding mechanisms to deploy renewable energy projects and energy efficiency measures. Feasibility studies have been funded by the U.S. Department of Energy (DOE), Department of Interior, and potential project partners. These have included community scale projects, commercial solar projects, energy storage and hydroelectric projects, and interconnection studies. An energy efficiency audit was also funded by DOE to assess measures that could be implemented to decrease the demand for electricity and propane at three large tribal facilities in Towaoc.

Towards these goals, a 1 megawatt community solar project was recently constructed. This project will offset an average of 1515 tons of greenhouse gases annually. The project was commissioned in early 2020 and will help offset electricity costs to the residents of Towaoc and the Tribal government. The Tribal leadership showed their commitment to renewable energy by funding more than half of the $2.2M project, with DOE and a project partner funding the rest. The White Mesa community is likely to be the focus of the second phase of community renewable energy deployment with a long-term goal of a net-zero offset of the electrical needs of the whole Tribe being offset by equivalent renewable deployment projects. As with the current 1 MW solar project, workforce training to empower tribal members with the job skills to build and manage these systems will continue to be a component of projects in the future.

The Tribe is also exploring the potential for developing commercial solar projects and energy storage projects. Multiple potential partners have engaged the Tribe in this regard. The Tribe is excellently positioned geographically to be a major participant in the western electrical generation and storage market. These commercial-scale projects could provide additional revenue for the Tribe and jobs to the local community.

The Tribe will continue to pursue energy production as a long-term and predictable source of revenue. Fossil fuels will likely continue to have a diminishing role in the Tribe's economy, and the continued development of alternative sources of energy production needs to be facilitated. Energy conservation and efficiency programs need to be further implemented. Proposed adaptation actions for energy can be found in Table 13.

Table 13. Proposed adaptation actions for energy.

Observed Changes	• Warming temperatures • Changes in seasonality • Increase in dust and wind storms
Potential Impacts	• Air pollution • Increase in carbon dioxide and methane
Consequences of Change	• Increase in asthma, allergies, and cardiovascular diseases • Contributing more greenhouse gases, which leads to more climate change • Increase in energy demands and electric bills
Potential Adaptation Actions	**Near Term** (1-3 years) • Clean diesel programs • Community solar implementation • Continue low-cost efficiency measure implementation • Volkswagen Settlement funded projects • Emissions reduction • Additional community and commercial solar projects • Micro-scale hydroelectric at Farm and Ranch Enterprise **Medium Term (3-10 years)** • Micro-scale hydroelectric project on Towaoc Highline Canal • Feasibility study of tribal ownership of oil & gas fields • Commercial solar projects • White Mesa Community-Scale Renewable Energy and Efficiency Project • Reduce venting and flaring of oil field gases • Facility-scale energy efficiency and upgrades and solar deployment • Energy efficient construction designs **Long Term (more than 10 years)** • Install efficient energy and cooling systems • Weatherization program • Capture energy to a small generator plant for Farm and Ranch • Install underground electric lines • Closed Loop Pump Storage - Energy Storage Project
Possible Partners and Funding Sources	• Colorado Department of Local Affairs Economic Development Grants • Dolores Water Conservancy District • EPA Clean Diesel and Diesel Emissions Reduction Act • National Renewable Energy Laboratory • State of Colorado • United States Department of Energy • United States Department of Interior Division of Energy and Mineral Development • Ute Mountain Ute Tribe • Western Energy Consumers and Project Partners

6. Next Steps

Building climate resilience for the health and livelihood of the UMU community is the guiding principle for this document. The information in this plan positions the Ute Tribe to successfully implement projects and prepare for the increasing effects of climate change. This Climate Action Plan is flexible. It is meant to be a guide for community decision making. It is time to move forward and build upon this work.

To be successful, the climate change adaptation actions (Section 5) need to be mainstreamed into existing programs and plans for funding opportunities. In order to be effective, it is important that other departments consider this plan and use it in their priorities. One of the challenges of implementing the Climate Change Plan is funding. The BIA Tribal Resilience Funding, which awarded the money for the UMU Tribe Vulnerability Assessment and this Climate Action Plan, does not fund the implementation of projects. It considers implementation of the Climate Action Plan to be the Tribe's responsibility. As such, an implementation plan will help guide the development and funding strategies for the actions outlined in this plan. The following are three proposed steps for actualizing the Plan.

6.1. Community Outreach and Engagement

In order to build strong community support for the Climate Action Plan, it is important that community outreach ensues and is ongoing. Presentations should engage community members, leadership, and natural resource managers' understanding of the science of climate change and the proposed strategies and responses presented here. Outreach materials that highlight climate change science and approaches to heat and drought management need to be shared and distributed. It is urgent to prepare the next generation for climate change. Information will be disseminated through the Tribal newspaper, youth programs, and community outreach events. This Plan will be added to the Environmental Programs Department website upon Tribal Council approval.

6.2. Implementation of the Climate Action Plan

The Climate Action Plan is ready to be implemented. Some of the actions discussed in the Plan are already happening (Section 4). The list of plans and actions included in this document is long, and not everything can be accomplished immediately. The Tribe, with guidance from each department, can prioritize specific projects for immediate action ahead of those that need a longer-term timeline. By focusing on adaptation actions that will not need outside funding and that will provide immediate rewards to the community, implementation of the plan can begin without delay.

Many of the programs, actions, and plans will require more time, more discussion, and additional funding and partnerships. This plan should help facilitate fundraising efforts from outside resources. It demonstrates the determination of the Tribe to take timely actions in attaining climate resilience.

6.3. Keeping the Plan Relevant

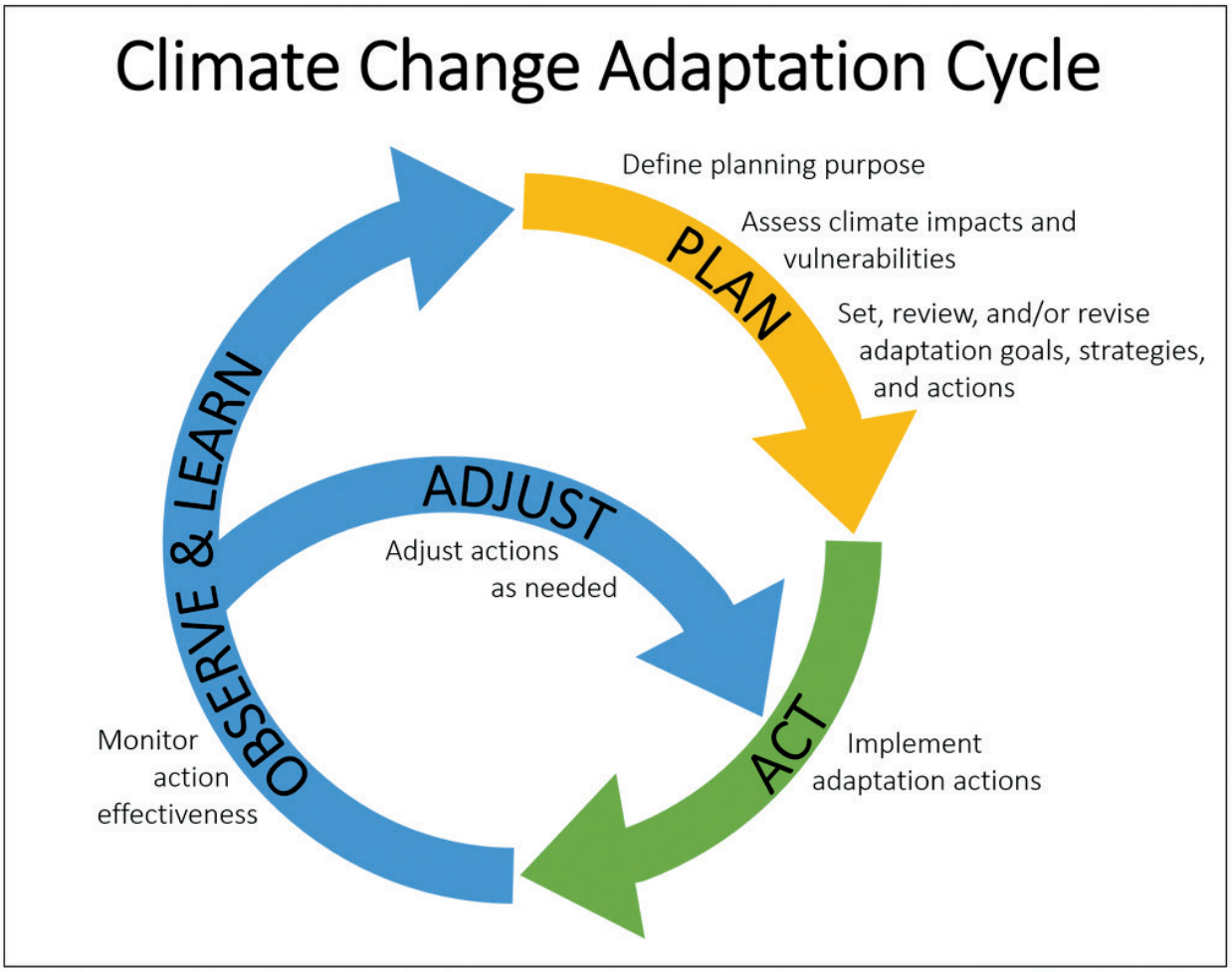


Figure 10. Blackfoot Tribe Climate Adaptation Cycle.
Source: Blackfeet Nation Climate Adaptation Plan- modified from Climate Smart Conservation Cycle Framework in Climate-Smart Conservation: Putting Adaptation Principles into Practice and DPIPWE 2014 after Jones 2005, 2009

The Climate Change Adaptation Cycle is shown in Figure 9. The Plan is considered to be a "living document." It will be adjusted as adaptation actions are implemented and learning occurs about what is working or not. New climate science will be incorporated as it is relevant. Quarterly meetings with the Climate Adaptation Planning Working Group need to continue. Members will monitor the Plan's progress. Funding and partnership opportunities will be shared and pursued. The Plan needs to be updated when appropriate and revised within five years.

Towéiyak.

[Thank you]

Appendix I

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Appendix II

Ute Mountain Ute Climate Change Vulnerability Assessment interview questions for community members and Elders

1. Have you lived here your whole life?
2. What changes in weather have you observed in your lifetime?
3. Have you observed the seasons changing? Has the timing changed when it snows? Winter/Spring/Summer/Fall? Snowfall? Rain?
4. How is it affecting the community?
5. What extreme weather events do you remember? Drought? Snow? Rain? Floods? Heat? Dust? Wind? Water?
6. What did you learn about weather from your Elders?
7. What can you tell us about the springs on Ute Mountain?
8. What plants and animals are important for your traditional activities?
9. Do you do any traditional activities that have been affected by the changes? (Wild plants? Animals? Ceremonies? New plants?)
10. Do you have any additional information that you would like to share?
11. Are there other people we should interview?

Appendix III

Ute Mountain Ute Climate Change Vulnerability Assessment interview questions for Ute Mountain Ute natural resource managers

1. What is your position here and how long have you been in it?
2. What have you observed in terms of impacts of climate variability or change on the Ute Mountain Ute lands or resources you manage?
3. What management decisions do you have to make that are affected by seasonality changes? And by weather or climate extremes?
4. How is the Tribe impacted by those climate changes or extremes?
5. Is the Tribe or your department responding to and preparing for climate change?
6. Are there limitations or barriers that affect your ability to respond to climate change?
7. What information would be helpful to you in understanding the Tribe's risks or vulnerabilities related to climate variability and change?
8. Who do you think is important to interview for this research?

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