



Sustainable Climate Change Adaptation in Indian Country

SHANNON M. MCNEELEY

Natural Resources Ecology Laboratory, North Central Climate Science Center, Colorado State University, Fort Collins, Colorado

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ABSTRACT


Much of the academic literature and policy discussions about sustainable development and climate change adaptation focus on poor and developing nations, yet many tribal communities inside the United States include marginalized peoples and developing nations who face structural barriers to effectively adapt to climate change. There is a need to critically examine diverse climate change risks for indigenous peoples in the United States and the many structural barriers that limit their ability to adapt to climate change. This paper uses a sustainable climate adaptation framework to outline the context and the relationships of power and authority, along with different ways of knowing and meaning, to illustrate the underpinnings of some tribes' barriers to sustainable climate adaptation. The background of those structural barriers for tribes is traced, and then the case of water rights and management at the Wind River Reservation in Wyoming is used to illustrate the interplay of policy, culture, climate, justice, and limits to adaptation. Included is a discussion about how the rulings of the Big Horn general stream adjudication have hindered tribal climate change adaptation by limiting the quantity of tribal reserved water rights, tying those rights to the sole purposes of agriculture, which undermines social and cultural connections to the land and water, and failing to recognizing tribal rights to groundwater. Future climate projections suggest increasing temperatures, and changes in the amount and timing of snowpack, along with receding glaciers, all of which impact water availability downstream. Therefore, building capacity to take control of land and water resources and preparing for climate change and drought at Wind River Reservation is of critical importance.

1. Introduction

In much of the academic literature and in policy discussions about sustainable development and climate change adaptation, the focus has been on poor and developing nations. In the literature and policy related to the United Nations' global climate adaptation financing mechanisms for developing nations, for example, the United States is positioned as a developed, wealthy, and homogenous nation. What is often forgotten or overlooked in the United States is that we have poor and developing nations *inside* the country that are largely invisible and not considered in this context. As the Native American scholar Vine Deloria,

Jr., once said, "Today Indians are not conspicuous by their absence from view. Yet they should be" (Deloria 1988, p. 10). This includes marginalized people who, in times of natural resource scarcity and adapting to climate change, face extensive structural barriers and limitations.

As of 2016, there are 567 federally recognized American Indian and Alaska Native tribes, residing in 34 states and 344 Indian reservations. Reservations and the lands within them are legally referred to as "Indian Country" (Deloria and Lytle 1983), which is the term intentionally used herein to allude to the structural system that underpins many tribes' ability to adapt to climate change. Approximately 22% of the American Indian and Alaska Native population live on reservations or Alaska Native village statistical areas (Norris et al. 2012). About 229 of those tribes are in Alaska and 337 are in contiguous U.S. states (excluding native Hawaiians, who are organized differently and have a unique relationship with the federal government in which they see themselves as illegally occupied by the United States). This also does

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Corresponding author e-mail: Shannon M. McNeeley, shannon.mcneeley@colostate.edu

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not include tribes that have not been afforded state or federal recognition, or tribes recognized only by states: these populations have far fewer rights than the federally recognized tribes (Tsosie 2013). While a small set of researchers around the world have focused on North American indigenous peoples and climate change for decades (Krupnik and Jolly 2002; Nuttall et al. 2005; Maynard 1998; Cruikshank 2001), their work has been marginalized from mainstream science. Yet, there is a growing recognition in the scientific community of this disconnect and the value of incorporating indigenous knowledge and observations into climate change research. Indigenous peoples are astute observers of climate change because they have close connections to the land, and are long-time observers of weather, climate, and the interconnections to the living and nonliving landscapes (McNeeley 2009; McNeeley and Shulski 2011; Fox 2002). As such, more attention is being given to the emerging literature on indigenous peoples and climate change inside the United States. For the first time since the start of the U.S. National Climate Assessment (NCA) in the 1990s, the third NCA in 2014 had a chapter dedicated to indigenous peoples and climate change (Bennett et al. 2014). This precipitated multiple publications on the topic and highlighted the need to examine the diverse climate change risks for indigenous peoples in the United States and the many structural barriers that limit their ability to adapt to climate change (Wildcat 2013; Chief et al. 2014; Whyte 2013).

2. Structural inequities regarding land and natural resources in Indian Country today

Sustainable climate change adaptation occurs when strategic collective actions are taken to respond to, and anticipate, harmful climate change impacts in order to reduce the impacts to well-being and the disruption of key natural resource flows for present and future generations (McNeeley 2012). A sustainable adaptation framework treats issues of poverty, environment, and climate change as linked in a system of interacting causes and effects (Eriksen et al. 2007; O'Brien and Leichenko 2008). It is worth noting that *sustainability* is a contested notion, whereby it has largely been framed in the predominant Western worldview where issues of power and authority have oftentimes eschewed indigenous realities and ways of knowing (Johnson et al. 2016). In this article, I outline the context and the relationships of power and authority, along with different ways of knowing and meaning, to illustrate the underpinnings of some tribes' barriers to sustainable climate change adaptation. I begin by discussing the background of those structural barriers, and then use the

case of water at the Wind River Reservation in Wyoming to illustrate the interplay of policy, culture, climate, justice, and limits to adaptation.

The structural barriers faced by indigenous peoples in the United States are largely the legacy of federal government removal, allotment, and homestead policies of the 1800s and early 1900s. These included the Indian Removal Act of 1830 and the Dawes General Allotment Act (also known as the Dawes Act) of 1887, the latter of which continued until 1934 with the passing of the Indian Reorganization Act (Ford and Giles 2015; Merjian 2011). The Dawes Act, for instance, allotted parcels of land to Native Americans and opened up remaining tracts of "surplus" reservation farmlands (the majority of reservations were established in the 1800s) to white (non Indian) control. This transition of access to, and control of, lands from indigenous peoples to non-Indian people led to the disenfranchisement of Native Americans. As a result, many Native Americans were left landless, even on their own reservations, which engendered resentment and created barriers to prosperity. Lands that are still designated as "tribal" on reservations are not actually owned or entirely controlled by the Native Americans. Instead, they are owned by the U.S. government and held in "trust" for the benefit of the tribes. The result is that many (although not all) reservations are a patchwork of tribal trust land (land for the tribe as a whole), tribal allotted trust (for individuals or families within the tribes), and fee simple land (privately owned, often by nontribal members), making it very difficult for tribal environmental governance and management within the originally established reservation boundaries (Ford and Giles 2015). This land ownership system is unique to Indian reservations in the United States, where many Native Americans themselves are not only landless, but also lack management authority of the resources on that land that were originally granted to them through treaties, agreements, and executive orders. Reservation land and resources are often owned or controlled by white land owners and agencies like the Bureau of Indian Affairs (BIA) or the Bureau of Reclamation (BOR). Native Americans are often in an ongoing and daily battle with state and federal agencies over land boundaries, water, air, and minerals.

Nearly every aspect of the tribes' economic development was historically controlled by federal agencies to some degree, which varied from tribe to tribe depending on factors such as land tenure, tribal economic development history, policies and programs, tribal governance structure, and access to natural resources and markets. In many ways, federal and state policies for economic development and for resource management (e.g., to promote natural resource extraction, such as oil

and gas) have inextricably tied tribes to unsustainable practices. Land was transformed from a homeland to an economic resource, wherein exploitation of natural resources is a primary economic engine (Deloria 1988). However, this is changing in the Self-Determination Era, which began in the 1960s, in which tribes are increasing control of their lands and natural resources through legal and regulatory means. This has occurred either through the courts or evolving federal policies, which has allowed tribes to manage their lands and resources in more culturally sensitive and sustainable ways (Ford and Giles 2015; Deloria and Lytle 1983).

Despite such changes, many structural inequities endure today that limit tribes' ability for sustainable management of resources and climate change adaptation. Freshwater is a critical resource that is imperiled by climate change and has been identified as one of the most important future management issues for tribes, especially in the arid western states, where tribes already face water insecurity issues (Nania et al. 2014). Climate change will exacerbate water scarcity, and water allocation and use will depend on rights to the land and the ability to manage tribal water rights (Cozzetto et al. 2013; Chief et al. 2014; Gautam et al. 2013). Tribes have had to fight states in the courts to get the water rights (i.e., the legal right to use the water on their lands) that they were guaranteed under treaty laws. Many have framed this as a "climate justice" issue, where sovereignty and self-determination over their land and natural resources plays a central role in tribes' ability to adapt to current and future climate change (Banai 2016; Whyte 2013; Tsosie 2013).

Climate adaptation is predicated on the capacity to prepare for, and respond to, climate change. The capacity to adapt is fundamentally determined by both exposure to a physical climate-driven hazard and the socioeconomic structure and property relations (Adger and Kelly 1999). Two things are necessary for sustainable adaptation to climate change: 1) the *authority* to make decisions about access and use of natural resources and 2) having the *flexibility* to respond to the impacts of climate change (Eriksen and Brown 2011; Eriksen and O'Brien 2007). Tribes need flexibility across time and space to adapt. Yet, federal agencies and regulatory structures can be barriers by restricting when and where indigenous peoples can hunt for wild foods, for example (McNeeley 2012). Indigenous scholar Kyle Whyte calls "tribal collective continuance" in the context of climate change adaptation a tribal community's "aptitude for making adjustments to current or predicted change in ways that context colonial hardships and embolden comprehensive claims at robust living" (Whyte 2013, p. 518).

There are many issues affecting sustainable climate change adaptation for tribes in the western United States.

Some, though not all, of the primary issues include land fragmentation and fractionation, authority and control of natural resources (especially water), and the politics of climate change and development (i.e., exploration of fossil fuel reserves). In this article, I will focus on the first two issues. The capacity and flexibility for tribes to respond to and prepare for changing circumstances relies on sovereignty and self-determination. In other words, tribes must have the ability to self-govern and have decision-making authority about natural resources, like water, land, and food.

Following the designation of reservation lands in the 1800s, there was a need to identify the Indian water rights on those lands. The 1908 Winters doctrine was a decision by the U.S. Supreme Court that was intended to clarify Indian water rights and made a ruling that the date of treaties establishing a reservation would also be the appropriation date for the water rights. The appropriation date determines seniority in the U.S. western water rights system, where "first in time, first in right" means that the older rights have seniority to use water over newer "junior" rights in times of water scarcity (Getches 1990). Unfortunately for the tribes, the view that reservations had senior water rights was in direct conflict with that of the states. States viewed water as belonging to them and fought native peoples through the courts to take control of water, which will be discussed in more detail in section 4. Then, in 1952 Congress enacted the McCarran Amendment, 43 U.S.C. § 666, which put the adjudication of tribal federally reserved water rights out of the federal courts and into the state courts. States have interpreted federal water law very differently, with some states ruling unfavorably for the tribes' water rights. This was the case of Wyoming and the Big Horn adjudication (Royster 2013; O'Gara 2000), as demonstrated in the interplay of these issues on the Wind River Reservation, home of the Eastern Shoshone and Northern Arapaho tribes.

3. The Wind River Reservation

Wind River Reservation spans approximately 2.2 million acres (over 3500 square miles). It is the seventh largest reservation in the United States based on land-mass and the fifth largest in population (Fig. 1).

At the time of the 2010 census, there were approximately 26 330 people on the reservation (U.S. Department of Commerce 2012). As of February 2017, tribal membership was 10 198 for the Northern Arapaho tribe and 4336 for the Eastern Shoshone tribe (the exact numbers change regularly) (Eastern Shoshone and Northern Arapaho Tribal Enrollment Offices, 2016, personal communication). This includes enrolled tribal members who

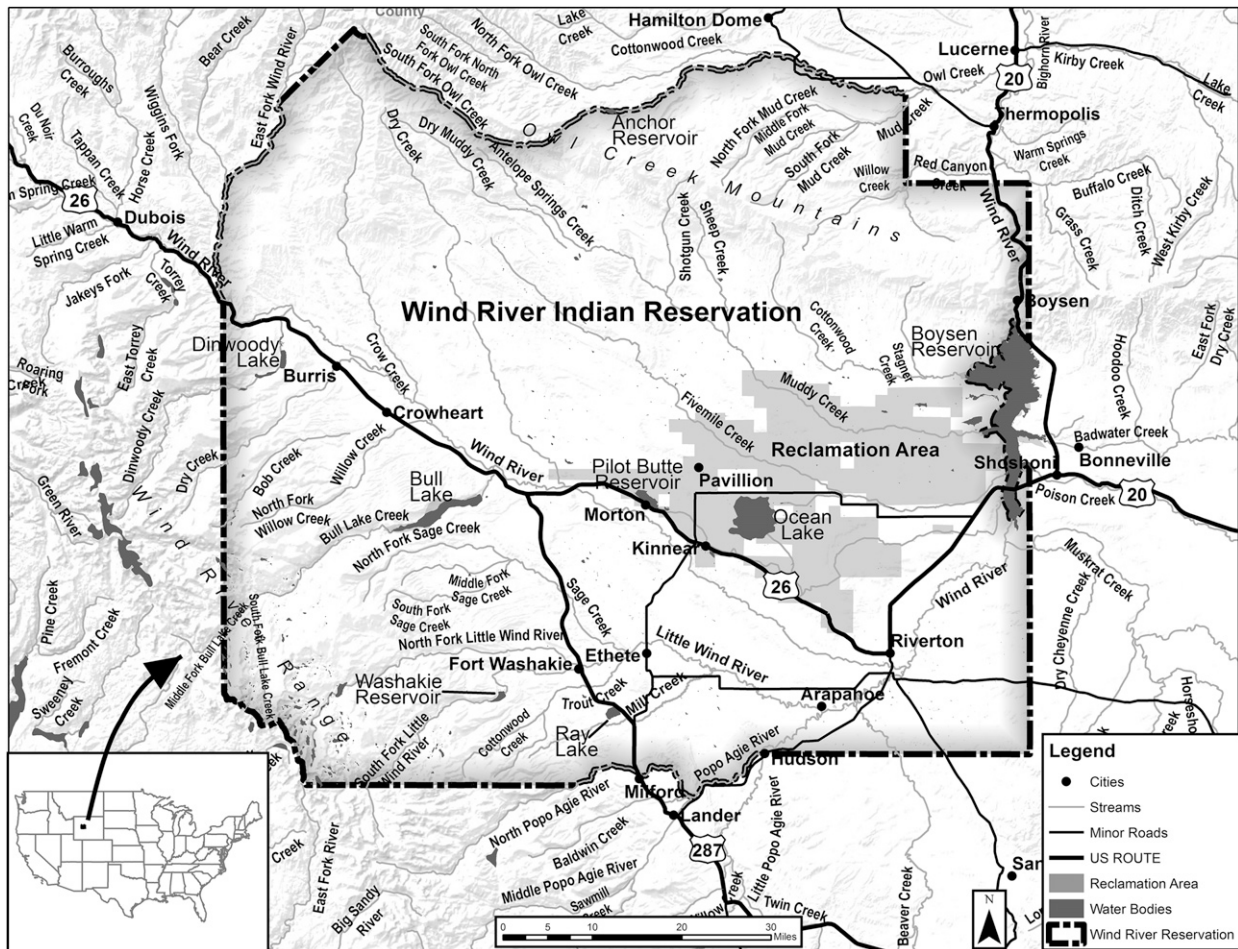


FIG. 1. Map of the Wind River Reservation.

live both on and off the reservation. It does not include people who have family ties and identify as being part of one or both of the tribes, but who do not qualify for enrollment due to blood quantum levels, which decline with intermarriages. Each tribe determines its own blood quantum policy. Both tribes at Wind River Reservation currently have a one-quarter blood quantum requirement for membership. However, blood quantum policies were first imposed by the federal government and represent one of the many tools of colonization that have irreparably impacted tribes throughout the United States (Tuck and Yang 2012).

The Eastern Shoshone tribe is the treaty tribe of Wind River Reservation, meaning it negotiated the establishment of the reservation with the U.S. government in 1868 based on its historical connections to the area (D'Azevedo 1986; Shimkin 1942). It is one of the few tribes that was allowed to select the exact location of its reservation because of its relatively good relationship with the federal government at the time

(Trenholm and Carley 1964). The Northern Arapaho tribe, on the other hand, was forcibly moved to the reservation 10 years later in 1878. The Northern Arapaho tribe had a more contentious relationship with the federal government, and the reservation promised to the tribe in the Fort Laramie Treaty of 1851 in what is now southern Wyoming and northern Colorado was never created (Wiles 2011; Trenholm 1970). The U.S. military suppressed and forcibly established control over the Northern Arapahos through violence and dispossession. The government then decided to relocate them from their homelands in the South Platte and Arkansas Basins to the Shoshone reservation in the Wind River Basin, now the state of Wyoming (the Southern Arapahos were moved to a reservation in Oklahoma). The Shoshones and Arapahos were historically warring tribes, and many of the Shoshones still see themselves as the rightful owners of the reservation. While there is intermixing and joint activities, these tensions endure today. This was exacerbated by the federal government's increasing

insistence, starting in the early 1900s, that the tribes operate as a joint business council (JBC) made up of three members of each tribe's BIA-instituted business council, so that the BIA had only one not two councils with which to deal. This came with an ulterior motive to "de-tribalize" and weaken the respective tribes. The JBC was resisted by both the Shoshone and Arapaho tribes, who viewed their respective general councils, each made up of all members who operated on consensus, as having sovereign political power (Flynn 2008; Fowler 1986). After decades of governance conflict caused by this imposed and dysfunctional JBC structure, the Northern Arapaho tribe made the unilateral decision in 2014 to dissolve the JBC in order to operate separately under its own business council. The Shoshone tribe did not accept this decision, and the two tribes remain in a legal dispute over the matter (in 2016 at the time of this writing).

In addition to undermining tribal governance, the federal government encouraged them to become individual farmers in an effort to "civilize" the tribes (i.e., make them more like white Euro-Americans) (Deloria and Lytle 1983). At Wind River Reservation they became collective ranchers instead, jointly raising livestock instead of food crops. The federal government saw ranching as a problem, because it was viewed as more of a communal activity and countered efforts to make them become more "civilized" (Wilson 1973). The tribal cattle herds that were collectively owned and managed were forcibly disbanded twice by the federal government for this reason (Wilson 1973, p. 412). Yet, in spite of the efforts of the federal government to impose individualism through policies to encourage farming and discourage ranching, the Indians at Wind River Reservation succeeded eventually in becoming ranchers instead of farmers. In many ways, reservations helped to preserve the communal culture of tribes, in defiance of the original intent to destabilize and individualize their members (Wilson 1973).

There are multiple, complex cultural, historical, and environmental reasons why the Indians at Wind River Reservation succeeded at ranching but failed at farming, including local climate and topography, vegetation types, and cultural collectivism. But the most important factor is the reservation regulatory system, in terms of how land tenure and regulations on the use of that land were structured (Wilson 1973). The reservation is composed of a patchwork land ownership pattern that has created both fragmented and fractionated lands, a phenomenon at many reservations. Land fragmentation occurred as a result of the allotment policies of the early 1900s, and it was the primary mechanism used to break up communal land ownership and individualize households. Reservation land was divided into 160-acre, or smaller, parcels and allotted to tribal members. The lands the federal

government deemed as surplus to the tribes, or "idle," were then given or sold to non-Indian homesteaders as private lands. Fractionation is when there are multiple owners of any given tribal allotment. This has worsened over time as tribal land owners die and do not have heirship determined in a will, and ownership is then divided among all living heirs. In some cases, this has resulted in hundreds of owners of an individual allotment, making it nearly impossible for all owners to agree on the use of the land (see Wilson 1973, chapter 7).

Additionally, a large contested area of the Wind River Reservation is referred to as the "Reclamation Area" (see Fig. 1). This was land removed from the reservation and sold to mostly white farmers during the early 1900s' allotment era as mentioned above. In this area, the BOR impounds a large amount of what the tribes consider to be their water, for the purpose of irrigating mostly non-Indian farmlands in the area and off the reservation downstream. The Reclamation Area has the largest reservoirs on the reservation, which also happens to be a far superior storage and irrigation system when compared to the BIA project. It is also the area where a recent Environmental Protection Agency (EPA) 2013 ruling awarded the tribes Treatment as a State (TAS) status, allowing the tribes to better monitor and manage their air space for air quality under the Clean Air Act. As part of the TAS process, the EPA determined that the city of Riverton, Wyoming, was considered to lie inside the boundaries of the Wind River Reservation. Although this determination had no immediate regulatory implications, the boundary determination triggered a major backlash from other state, county, and city jurisdictions, since the reservation boundary has implications for taxation, regulation, and control of those lands. As a result, the state of Wyoming, the city of Riverton, and Fremont County are all legally contesting this ruling at time of writing (2016).

In spite of all the extant forces against them and over a century of assimilation and acculturation policies, the Wind River Reservation tribes are highly adaptive and resilient in many ways. Perhaps one of the most poignant and pertinent examples of their resilience is demonstrated in their resolve to win the 37-yr fight for their tribal reserved water rights.

4. Water and the Big Horn stream adjudication

Water in the arid western United States is a precious economic and cultural resource, and the battle over Indian water rights is highly political and ongoing. As noted earlier, authority over water in the United States is at the state level, and western water law is based on the prior appropriation doctrine, meaning that those who historically put the water to beneficial use first have

TABLE 1. Timeline of events.

Date	Event
1830	Indian Removal Act of 1830—Gave U.S. president authority to exchange Indian land east of the Mississippi River with land west of the Mississippi River and led to forced removal of tribes to the west.
1851	Fort Laramie Treaty.
1868	Wind River Reservation established (originally called Shoshone Reservation).
1878	Northern Arapaho forcibly relocated to Wind River Reservation.
1887	Dawes General Allotment Act (Dawes Act)—Provided legal authority for U.S. government to subdivide reservation land. Individual parcels were allotted to Indians. Land deemed as surplus was then sold or given to primarily non-Indian (white) homesteaders.
1908	Winters doctrine—U.S. Supreme Court ruled in <i>Winters v. United States</i> that the treaty date, which established a reservation, would serve as the appropriation date for tribal water rights.
1934	Indian Reorganization (Howard–Wheeler) Act—Formal end to “allotment era”; provided authority for Secretary of Interior to acquire lands for tribes and hold those lands in trust.
1952	McCarran Amendment—Allowed for federal reserved water rights cases to be heard in state courts, i.e., federal reserve water rights subject to state adjudication.
1975	Former Secretary of Interior Roger Morton implemented a moratorium on approval of tribal water codes, which is still in effect today.
1975	Self-Determination Act (amended in 1994)—Provided regulatory framework for self-determination and self-governance.
1976	<i>Colorado River Water Conservation District v. United States</i> —Extended McCarran Amendment to tribal reserved water rights.
1977	Big Horn general stream adjudication commences.
1978	<i>United States v. New Mexico</i> —Established a precedent in determining the amount of federal reserved water rights. The court ruled that the amount of reserved water should provide only what is necessary to support the very purpose or primary purpose of establishment.
1989	“Bighorn I”—Awarded approximately 500 000 million acre feet of water to tribes at Wind River Reservation with an appropriation date of 1868; ruled primary purpose of reservation was for agriculture and effectively tied water rights to agricultural purposes only.
1991	Tribes created the Wind River Water Code.
1992	“Bighorn III”—Tribes could not convert tribal reserved water right from agriculture to instream flow rights; Wyoming State Engineer’s Office given primary authority to administer all water rights within Wind River Reservation.
2013	EPA acknowledges TAS for Wind River Reservation tribes.
2014	Northern Arapaho Business Council moves to dissolve Wind River JBC.
2014	Official end to Big Horn general stream adjudication.

priority over newer so-called junior uses when there are shortages (see [Getches 1990](#)). This has presented a problem for states, which were created after the treaties of the 1800s between tribes and the federal government that established many of the Indian reservations, and after the associated federally reserved water rights according to subsequent ruling of the 1908 Winters doctrine. Later, the McCarran Amendment of 1952, which essentially placed federal water adjudications in state courts, was officially extended to tribal reserved rights by a 1976 U.S. Supreme Court ruling. As a result, the adjudication of Indian water rights has generated a long and protracted battle for many tribes in the west, including the Wind River Reservation tribes, who had to endure a 37-yr fight with the state of Wyoming (that officially “ended” in 2014) through myriad court cases and lawyers in the Big Horn general stream adjudication process ([Table 1](#)).

In the seminal 1989 “Bighorn I” case (Case I of VII Wyoming Supreme Court cases), the tribes were awarded approximately 500 000 million acre feet of water with an

appropriation date of 1868, the year the reservation was created. However, the fight with the state of Wyoming was ongoing for authority and control over those rights for water management and use. The Wyoming adjudication was the first time that a state court had quantified tribal reserved water rights. The court refused to recognize other nonagricultural tribal needs for water, for example, to hunt and fish, and for ceremonial and domestic purposes. Instead, the state ruled in accordance with the 1978 Supreme Court case *United States v. New Mexico*, declaring that the “very purpose,” or primary purpose, of the reservation was for agriculture only (which includes farming and ranching/livestock), forever tying tribal water rights to irrigation for agriculture ([Blumm et al. 2006](#); [Robison 2015](#)). The negative implications of these rulings cannot be overstated, as this has greatly restricted the tribes’ ability for flexible water management for multiple uses.

During the Big Horn River adjudication process, the Wind River Reservation tribes developed their own

tribal water code that outlined 15 beneficial and equal uses ([Wind River Indian Reservation 1991](#)). Tribal values and uses of water in the code are based on their traditional and cultural worldview that considers “all Reservation natural resources as interconnected; and that the water resource has cultural, spiritual, and economic values that guide the appropriate use, management, and protection” of the water ([Wind River Indian Reservation 1991](#), p. 2). While the state of Wyoming has a narrow view of beneficial use that prioritizes agricultural use and economic profits over other non-consumptive and environmental benefits, the Wind River Water Code holds cultural, spiritual, and traditional uses as equal with agricultural or industrial uses. Some, but not all, tribes in the western United States have developed similar tribal water codes with varying enforcement success. In many cases, tribal constitutions require that tribes gain approval from the U.S. Secretary of the Interior before they can be implemented. Yet, since the 1970s there has been a federal moratorium on tribal water code approvals ([Guarino 2016](#)). Many tribes now have to negotiate with states to accept and enforce their tribal water codes, which are often in conflict with the values of the states, which prioritize economic values over tribal values, such as river health, recreation, and cultural uses ([Clayton 1992](#); [Guarino 2016](#); [Nania and Guarino 2014](#)).

Wyoming water laws based on this Euro-American worldview do not officially reflect or recognize the indigenous knowledge and values in the Wind River Water Code, such as instream flows, cultural, and spiritual uses, for example. For this reason, the Wyoming state engineer does not enforce the code ([Flanagan 2000](#); [Flanagan and Laituri 2004](#); [O’Gara 2000](#)). In fact, a 1992 Wyoming Supreme Court decision ruled that the tribes could not convert their awarded water rights from agricultural use to instream flow rights for fish and overall riparian ecosystem health. Additionally, they lost their right to administer water rights within the boundary of the reservation, which was awarded to the Wyoming State Engineer’s Office ([Kinney 1993](#)). Because the Wyoming Supreme Court ruled that the Wind River Reservation was created for the sole purpose of agriculture (which was essentially upheld by the U.S. Supreme Court), their tribal water rights were interpreted in a way that specified water to be used for agriculture only. The tribes had no right to alternative interpretations, such as those that other state courts used, to allow for a diverse set of uses that might include fisheries protection and enhancement, industrial or mineral development, wildlife, or cultural uses ([Kinney 1993](#)). The Big Horn adjudication case, therefore, was fundamentally about sovereignty and control over natural resources, and is a prime example of

injustice to tribes. One Wyoming Supreme Court judge, Justice Thomas, commented on the case, “I am persuaded that the real battle in this case is now over sovereignty, not over water” ([Wyoming Supreme Court 1992](#)).

This was a landmark case in Indian water law in the western United States. The Wyoming Supreme Court determined that the Wind River Reservation tribes could not convert their future water rights from agriculture to other uses and that the state would have regulatory authority of water rights at the reservation. These decisions influenced how other tribes settled their water law to avoid these detrimental outcomes, as I discuss in more detail below. In a dissenting opinion, another Wyoming Supreme Court judge, Justice Michael Golden, stated, “If one may mark the turn of the 20th Century by the massive expropriation of Indian lands, then the turn of the 21st Century is the era when Indian tribes risk the same fate for their water resources” ([Wyoming Supreme Court 1992](#)).

In the context of climate change, and drought impacts in particular, the ruling of the Big Horn stream adjudication and its impacts on the tribes at Wind River Reservation are significant. It limits how the tribes are able to manage their water in the face of reduced water availability and restricts their flexibility to adapt. Climate adaptation requires being able to reallocate scarce water where and when it is needed, and Wyoming has worked to strip this capability from tribal water managers. Other tribal water adjudications resulted in very different rulings by other state supreme courts, where tribal rights were protected more so than in Wyoming. For example, the Arizona Supreme Court ruled that Indian reserved water rights should be understood more broadly for self-sufficiency and provide a “permanent home and abiding place” for a “livable” environment; rejected the practical irrigable acre (PIA) metric used in Wyoming for quantifying water rights, and instead used a multifactor analysis for quantification of water rights that included master land use plans identifying water uses, tribal history and culture, the geography and natural resources within reservation boundaries, and population, among others; ruled that tribal water rights applied to groundwater; and ruled that tribal water rights deserved greater protection than state water rights holders ([MacDonnell 2015](#)).

Although the Big Horn adjudication was ceremonially terminated by a judicial procedure in September 2014, in which the state of Wyoming declared an official end to the case, it remains to be seen whether there will be any future litigation between the parties ([Robison 2015](#)). This will depend on whether the remaining issues related to the administration of the water rights, unsettled

groundwater rights, the use of the “futures” water rights belonging to the tribes, and additional storage needs in the Big Horn Basin, can be resolved through negotiation and cooperation. All of this brings into question the sustainability of usable tribal water into the future. Further, as I will discuss below, this also threatens sustainable climate change adaptation, which is predicated on cooperation to address the complex, multijurisdictional problems that it presents (Adger 2003).

5. Natural resources, managing for drought

Water shortages are common on the Wind River Reservation, especially in the western and southern areas where the tribes live and ranch. This partially has to do with physical water availability in times of drought. However, it is also largely a result of mismanagement of water releases by the BIA, insufficient water storage, and a badly leaking irrigation infrastructure. The poor irrigation system reflects years of neglect despite the collection of operation and maintenance fees from the tribal water users to pay the BIA (primarily for staff time). Climate change is a risk multiplier and worsens the risk of water scarcity, so looking at analog years of water shortage during times of drought provides a baseline understanding for how the structural underpinnings of policy and management interact with the physical hydroclimatological drivers (Ford et al. 2010).

For example, the year 2012 was an exceptional drought year in the western United States, with minimal snowpack that winter. The drought continued into 2013 and into the irrigation season. Although, there was enough runoff from snowpack to fill the reservoirs at the beginning of the irrigation season at Wind River Reservation, there was not enough water to maintain storage levels and streamflows through the whole season. Water is stored in the BIA-operated Washakie Reservoir from early runoff (in April/May). Once it is filled, the water held in the reservoir is supposed to be released throughout the irrigation season until October to supply the majority of tribal ranchers at the reservation and in the BIA irrigation project. The BIA did not manage for the drought conditions in 2013 and released all the reservoir water early, which resulted in a short 30-day irrigation season rather than the usual 150-day irrigation season. These management issues were further exacerbated by the absence of adequate stream gauges to monitor flows, which together had major impacts on ranching and irrigation. For instance, many of the tribal farmers did not have enough water for hay production or for livestock. It also had widespread impacts on other uses (e.g., fisheries, drinking water, and ceremonial purposes). Although 2012 was worse in terms of drought

conditions, the reservation was most impacted by the drought conditions in 2013 due to the mismanagement of water resources.

The BIA still owns and controls the irrigation infrastructure and continues to collect operation and maintenance fees. The lack of maintenance and seepage from the aging system has resulted in a dilapidated irrigation system one would expect to see in the poorest parts of the world, not in a “wealthy” country like the United States. During the 2013 drought, the BIA lacked (and lacks) adequate funding for tribal needs, and so it had not completed the necessary maintenance and upgrades on the system. Further, the majority of stream gauges were removed, so water managers did not even have measurements of how much water was going through the stream and canal. The most recent estimates of deferred irrigation maintenance costs by the BIA on Wind River Reservation have been estimated to be over \$32 million and the cost to remove and replace the existing system is over \$93 million. The estimate for deferred maintenance for the 16 BIA-operated irrigation projects in the United States (for which BIA collects operation and maintenance fees) is \$500 million dollars and replacement is over \$4 billion (Flores 2015). Decades of neglect have left the tribes with irrigation systems that are grossly inadequate today and likely unsustainable in the future. Under climate change, such decrepit infrastructure will exacerbate the problems of less snowpack, changes to the timing of snow versus rain, and decreased streamflow and water availability (Stonefelt et al. 2000).

Tribal water managers are trying to take matters into their own hands by raising their own funding to mitigate the impacts of the failed irrigation system. For example, starting in 2011, in partnership with Trout Unlimited and the U.S. Fish and Wildlife Service, the Wind River Office of the Tribal Water Engineer secured funding to install fish ladders and screens at major stream diversion structures to maintain the fisheries with minimal impact to irrigation for ranchers. The tribes are also going through the BIA process (Public Law 93-638 Contracts and Compacts, commonly referred to as “638 Contracting,” allows tribes to acquire management authority from the BIA in certain instances) to try to gain authority over the irrigation system and management. But that, of course, has to be approved by the BIA, which has stated that they will not approve a 638 contract until they resolve the legal dispute over the JBC mentioned earlier in section 3. The irony of this is that the federally imposed JBC governance structure, which was contested by the tribes from the beginning and is now dissolved, is hindering the process of getting tribal water authority approved by the very government that imposed the JBC on the tribes in the first place.

A major problem for tribes is that climate change means there is high uncertainty about the future of water availability, yet both tribal water law and western water law in general are predicated on ideas of stability and certainty (Royster 2013). As stated earlier, climate adaptation fundamentally relies on the ability to be flexible and make structural changes to anticipate and respond to change. In the context of water, this means when and where water is stored, allocated, and used. State courts have treated tribes very inconsistently. In some cases, states have structured maladaptive water law through tribal adjudications and hindered tribal climate change adaptation. For instance, courts have limited the quantity of settled tribal water rights, tied their use of those rights narrowly to agriculture, and/or failed to award groundwater rights as part of adjudications. The state of Wyoming did all three to the Wind River Reservation tribes, which limits the tribes' capacity to adapt to climate change. In sum, the policy issues that the Wind River Reservation tribes face include limited water rights to irrigate for agriculture; limited management flexibility; and ambiguity in relation to groundwater rights, which limits conjunctive use management (the management of groundwater and surface water together). The dilapidated irrigation structure and lack of storage, improper water and reservoir management by the BIA, and the climate all interact to create water insecurity and shortages at Wind River Reservation. In the climate adaptation literature, this is referred to as distributive and procedural injustices, meaning the marginalized people who are most affected by climate change impacts who do not have the same influence as more powerful actors in decisions that structure and exacerbate their risks (Adger et al. 2006; Thomas and Twyman 2005).

6. Climate change makes urgent the need for authority over land and resources

Climate change projections for the northern Great Plains and Rocky Mountain regions of the United States, in which the Wind River Reservation is located, indicate that the future is highly likely to see increasing temperatures, changes in the amount and timing of snowpack, and receding glaciers (Hall et al. 2015; Rice et al. 2012; Marston et al. 1989; Oswald and Wohl 2007). This has serious implications where water availability is dependent on snowpack and glacier runoff. Local observers already note that in some years, snow quantity, quality, and timing has changed, resulting in reduced runoff and water availability. Recent changes in weather and seasonality, along with several exceptional drought years in the 2000s, have local water managers concerned

about what climate change will bring to the reservation and its water availability. This is a concern of tribes throughout the arid and semiarid western United States (Collins et al. 2010; Redsteer et al. 2013). Climate change will have other impacts on tribes in the west, including the availability of traditional foods and health, increased wildfires, and impacts to critical vegetation, fish, and wildlife, among others (Lynn et al. 2013; Chief et al. 2014; Ford and Giles 2015; Doyle et al. 2013).

At Wind River Reservation, tribes are building capacity to prepare for drought and climate change, through partnering with universities and agencies to support technical assessment and planning. This is happening with new climate adaptation funding mechanisms and institutional arrangements. Over the last decade, primarily under President Barack Obama's leadership (2008–16), multiple initiatives have focused on climate change adaptation across jurisdictions and for tribes in particular. For example, the BIA Tribal Climate Resilience Program was created to provide funding for tribes to prepare for climate change, including vulnerability assessments, climate change adaptation planning, and capacity building. The funding is, in part, because the Department of Interior (of which the BIA is a part) recognized the disproportionate burden of climate changes on tribes, and it has made a commitment to supporting tribes and incorporating traditional ecological knowledge (TEK) where possible (Department of the Interior 2009). The department also created the Climate Science Centers and Landscape Conservation Cooperatives, which are mandated to support tribes and incorporate TEK into science initiatives where possible. Other federal agencies, such as the U.S. Forest Service and the Environmental Protection Agency, also attempt to include tribes and TEK in climate change adaptation efforts (Vinyeta and Lynn 2013, 2015). As a result, tribes are beginning to build capacity and conduct assessments for climate change adaptation, and to create climate change adaptation plans (see, e.g., CSKT 2013). Yet, they vary tremendously in terms of their capacities to do so. While some tribes have significant capacity and trained staff on hand, many tribes lack the technical capacity and organizational and/or institutional infrastructure required for assessment and planning. Instead, they rely on outside partners through universities, government agencies, and private consultants to support their efforts. It is essential for these partners to understand the contexts, like the one at Wind River Reservation described here, and the structural barriers that underpin tribes' ability to sustainably adapt to climate change. This will not of course enable them to overcome all of the structural barriers described herein. However, it will help bolster them with place-based

and culturally relevant scientific knowledge about how climate change will impact water availability now and into the future. This, in turn, contributes to their ongoing effort to acquire increased sovereignty and self-determination in order to sustainably govern their own natural resources.

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REFERENCES

- Adger, W. N., 2003: Social capital, collective action, and adaptation to climate change. *Econ. Geogr.*, **79**, 387–404, doi:[10.1111/j.1944-8287.2003.tb00220.x](https://doi.org/10.1111/j.1944-8287.2003.tb00220.x).
- , and P. M. Kelly, 1999: Social vulnerability to climate change and the architecture of entitlements. *Mitigation Adapt. Strategies Global Change*, **4**, 253–266, doi:[10.1023/A:1009601904210](https://doi.org/10.1023/A:1009601904210).
- , J. Paavola, and S. Huq, 2006: Toward justice in adaptation to climate change. *Fairness in Adaptation to Climate Change*, W. N. Adger et al., Eds., MIT Press, 1–19.
- Banai, A., 2016: Sovereignty over natural resources and its implications for climate justice. *Wiley Interdiscip. Rev.: Climate Change*, **7**, 238–250, doi:[10.1002/wcc.383](https://doi.org/10.1002/wcc.383).
- Bennett, B. T. M., and Coauthors, 2014: Indigenous peoples, land, and resources. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. Melillo, T. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 297–317.
- Blumm, M., D. Becker, and J. Smith, 2006: Mirage of Indian reserved water rights and western streamflow restoration in the McCarran Amendment era: A promise unfulfilled. Lewis and Clark Law School Legal Studies Research Paper 2007-1, 48 pp.
- Chief, K., J. J. Daigle, K. Lynn, K. P. Hyte, and K. P. Whyte, 2014: Indigenous experiences in the U.S. with climate change and environmental stewardship in the Anthropocene. Forest conservation and management in the Anthropocene: Conference proceedings, V. A. Sample and P. R. Bixler, Eds., USDA, Forest Service, Rocky Mountain Research Station, RMRS-P-71, 161–176.
- Clayton, T. W., 1992: The policy choices tribes face when deciding whether to enact a water code. *Amer. Indian Law Rev.*, **17**, 523–588, doi:[10.2307/20062566](https://doi.org/10.2307/20062566).
- Collins, G., M. H. Redsteer, M. Hayes, M. Svoboda, D. Ferguson, R. Pulwarty, D. Kluck, and C. Alvord, 2010: Climate change, drought and early warning on western native lands report. National Integrated Drought Information System, 35 pp.
- Cozzetto, K., and Coauthors, 2013: Climate change impacts on the water resources of American Indians and Alaska natives in the U.S. *Climatic Change*, **120**, 569–584, doi:[10.1007/s10584-013-0852-y](https://doi.org/10.1007/s10584-013-0852-y).
- Cruikshank, J., 2001: Glaciers and climate change: Perspectives from oral tradition. *Arctic*, **54**, 377–393, doi:[10.14430/arctic795](https://doi.org/10.14430/arctic795).
- CSKT, 2013: Climate change strategic plan: Confederated Salish and Kootenai Tribes of the Flathead Reservation. 83 pp.
- D'Azevedo, W. L., 1986: *Great Basin*. Vol. 11, *Handbook of North American Indians*, Smithsonian Institution, 868 pp.
- Deloria, V., Jr., 1988: *Custer Died for Your Sins: An Indian Manifesto*. 2nd ed. University of Oklahoma Press, 278 pp.
- , and C. M. Lytle, 1983: *American Indians, American Justice*. University of Texas Press, 262 pp.
- Department of the Interior, 2009: Addressing the impacts of climate change on America's water, land and other natural and cultural resources. Secretarial Order 3289 March 11 2009, Amendment to Secretarial Order 3229, Amendment 1, 4 pp.
- Doyle, J. T., M. H. Redsteer, and M. J. Eggers, 2013: Exploring effects of climate change on Northern Plains American Indian health. *Climatic Change*, **120**, 643–655, doi:[10.1007/s10584-013-0799-z](https://doi.org/10.1007/s10584-013-0799-z).
- Eriksen, S. E. H., and K. O'Brien, 2007: Vulnerability, poverty and the need for sustainable adaptation measures. *Climate Policy*, **7**, 337–352, doi:[10.1080/14693062.2007.9685660](https://doi.org/10.1080/14693062.2007.9685660).
- , and K. Brown, 2011: Sustainable adaptation to climate change. *Climate Dev.*, **3**, 3–6, doi:[10.3763/cdev.2010.0064](https://doi.org/10.3763/cdev.2010.0064).
- , R. J. T. Klein, K. Ulsrud, L. O. Naess, and K. O'Brien, 2007: Climate change adaptation and poverty reduction: Key interactions and critical measures. Prepared for the Norwegian Agency for Development Cooperation (Norad), University of Oslo Global Environmental Change and Human Security Rep. 2007:1, 43 pp.
- Flanagan, C. M., 2000: Culturally specific information in water and river corridor management: The Wind River Indian Reservation, Wyoming. M.S. thesis, Dept. of Earth Resources, Colorado State University, 158 pp.
- , and M. Laituri, 2004: Local cultural knowledge and water resource management: The Wind River Indian Reservation. *Environ. Manage.*, **33**, 262–270, doi:[10.1007/s00267-003-2894-9](https://doi.org/10.1007/s00267-003-2894-9).
- Flores, C., Ed., 2015: *Indian Irrigation Projects: Maintenance and Sustainability Issues*. Water Resource Planning, Development and Management, Nova Science Publishers, 109 pp.
- Flynn, J., 2008: *Tribal Government: Wind River Reservation*. Mortimore Publishing, 88 pp.
- Ford, J. D., E. C. H. Keskitalo, T. Smith, T. Pearce, L. Berrang-Ford, F. Duerden, and B. Smit, 2010: Case study and analogue methodologies in climate change vulnerability research. *Wiley Interdiscip. Rev.: Climate Change*, **1**, 374–392, doi:[10.1002/wcc.48](https://doi.org/10.1002/wcc.48).
- Ford, J. K., and E. Giles, 2015: Climate change adaptation in Indian Country: Tribal regulation of reservation lands and natural resources. *William Mitchell Law Rev.*, **41**, 519–551.
- Fowler, L., 1986: *Arapahoe Politics, 1851-1978: Symbols in Crises of Authority*. University of Nebraska Press, 373 pp.
- Fox, S., 2002: These are things that are really happening: Inuit perspectives on the evidence and impacts of climate change

- in Nunavut. *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*, I. Krupnik and D. Jolly, Eds., Arctic Research Consortium of the United States, 12–53.
- Gautam, M. R., K. Chief, and W. J. Smith, 2013: Climate change in arid lands and Native American socioeconomic vulnerability: The case of the Pyramid Lake Paiute Tribe. *Climatic Change*, **120**, 585–599, doi:[10.1007/s10584-013-0737-0](https://doi.org/10.1007/s10584-013-0737-0).
- Getches, D. H., 1990: *Water Law in a Nutshell*. 2nd ed. Nutshell Series, West Publishing Co., 459 pp.
- Guarino, J., 2016: Protecting traditional water resources: Legal options for preserving tribal non-consumptive water use. *Public Land Resour. Law Rev.*, **37**, 89–111.
- Hall, D. K., C. J. Crawford, N. E. DiGirolamo, G. A. Riggs, and J. L. Foster, 2015: Detection of earlier snowmelt in the Wind River Range, Wyoming, using Landsat imagery, 1972–2013. *Remote Sens. Environ.*, **162**, 45–54, doi:[10.1016/j.rse.2015.01.032](https://doi.org/10.1016/j.rse.2015.01.032).
- Johnson, J. T., R. Howitt, G. Cajete, F. Berkes, R. P. Louis, and A. Kliskey, 2016: Weaving indigenous and sustainability sciences to diversify our methods. *Sustainability Sci.*, **11**, 1–11, doi:[10.1007/s11625-015-0349-x](https://doi.org/10.1007/s11625-015-0349-x).
- Kinney, T., 1993: Chasing the wind: Wyoming Supreme Court decision in *Big Horn III* denies beneficial use for instream flow protection, but empowers state to administer federal Indian reserved water right awarded to the Wind River tribes. *Nat. Resour. J.*, **33**, 841–871.
- Krupnik, I., and D. Jolly, Eds., 2002: *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Arctic Research Consortium of the United States, 384 pp.
- Lynn, K., and Coauthors, 2013: The impacts of climate change on tribal traditional foods. *Climatic Change*, **120**, 545–556, doi:[10.1007/s10584-013-0736-1](https://doi.org/10.1007/s10584-013-0736-1).
- MacDonnell, L. J., 2015: General stream adjudications, the McCarran Amendment, and reserved water rights. *Wyoming Law Rev.*, **15**, 313–345, doi:[10.2139/ssrn.2691068](https://doi.org/10.2139/ssrn.2691068).
- Marston, R. A., L. O. Pochop, G. L. Kerr, and M. L. Varuska, 1989: Recent trends in glaciers and glacier runoff, Wind River Range, Wyoming. *Proceedings of the Symposium on Headwaters Hydrology*, W. W. Woessner and D. F. Potts, Eds., American Water Resources Association Technical Publication Series, TPS-89-1, American Water Resources Association, WWRC89-03, 159–169.
- Maynard, N. G., Ed., 1998: Native Peoples-Native Homelands Climate Change Workshop. U.S. Global Change Research Program Final Rep., 93 pp.
- McNeeley, S. M., 2009: Seasons out of balance: Climate change impacts, vulnerability, and sustainable adaptation in Interior Alaska. Ph.D. dissertation, University of Alaska Fairbanks, 240 pp.
- , 2012: Examining barriers and opportunities for sustainable adaptation to climate change in Interior Alaska. *Climatic Change*, **111**, 835–857, doi:[10.1007/s10584-011-0158-x](https://doi.org/10.1007/s10584-011-0158-x).
- , and M. D. Shulski, 2011: Anatomy of a closing window: Vulnerability to changing seasonality in Interior Alaska. *Global Environ. Change*, **21**, 464–473, doi:[10.1016/j.gloenvcha.2011.02.003](https://doi.org/10.1016/j.gloenvcha.2011.02.003).
- Merjian, A. H., 2011: An unbroken chain of injustice: The Dawes Act, Native American trusts, and Cobell v. Salazar. *Gonzaga Law Rev.*, **46**, 609–658.
- Nania, J., and J. Guarino, 2014: Restoring sacred waters: A guide to protecting tribal non-consumptive water uses in the Colorado River Basin. University of Colorado Boulder, 114 pp.
- , K. Cozzetto, N. Gillett, S. Duren, A. M. Tapp, M. Eitner, and B. Baldwin, 2014: Considerations for climate change and variability adaptation on the Navajo Nation. University of Colorado Boulder Rep., 212 pp.
- Norris, T., P. L. Vines, and E. M. Hoeffel, 2012: The American Indian and Alaska native population: 2010: 2010 census briefs. U.S. Census Bureau Rep. C2010BR-10, 21 pp.
- Nuttall, M., F. Berkes, B. Forbes, G. Kofinas, T. Vlassova, and G. Wenzel, 2005: Hunting, herding, fishing, and gathering: Indigenous peoples and renewable resource use in the Arctic. *Arctic Climate Impact Assessment*, C. Symon, L. Arris, and B. Heal, Eds., Cambridge University Press, 649–690.
- O'Brien, K., and R. Leichenko, 2008: Human security, vulnerability and sustainable adaptation. United Nations Development Program Human Development Rep. 2007/2008, 47 pp.
- O'Gara, G., 2000: *What You See in Clear Water: Indians, Whites, and a Battle Over Water in the American West*. Vintage Departures, Vintage Books, 285 pp.
- Oswald, L., and E. Wohl, 2007: Jökulhlaup in the Wind River Mountains, Shoshone National Forest, Wyoming. *Advancing the Fundamental Sciences: Proceedings of the Forest Service National Earth Sciences Conference*, M. Furniss, C. Clifton, and K. Ronnenberg, Eds., Vol. 2, USDA, Forest Service, Pacific Northwest Research Station, General Tech. Rep. PNW-GTR-689, 363–367.
- Redsteer, M. H., K. Bemis, K. Chief, M. Gautam, B. R. Middleton, and R. Tsosie, 2013: Unique challenges facing southwestern tribes. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, G. Garfin et al., Eds., National Climate Assessment Regional Technical Input Report Series, Island Press, 385–404.
- Rice, J., A. Tredennick, and L. A. Joyce, 2012: Climate change on the Shoshone National Forest, Wyoming: A synthesis of past climate, climate projections, and ecosystem implications. USDA, Forest Service, Rocky Mountain Research Station, General Tech. Rep. RMRS-GTR-264, 60 pp.
- Robison, J. A., 2015: Wyoming's Big Horn general stream adjudication. *Wyoming Law Rev.*, **15**, 243–312.
- Royster, J. V., 2013: Climate change and tribal water rights: Removing barriers to adaptation strategies. *Tulane Environ. Law J.*, **26**, 197–219.
- Shimkin, D. B., 1942: Dynamics of recent Wind River Shoshone history. *Amer. Anthropol.*, **44**, 451–462, doi:[10.1525/aa.1942.44.3.02a00100](https://doi.org/10.1525/aa.1942.44.3.02a00100).
- Stonefelt, M. D., T. A. Fontaine, and R. H. Hotchkiss, 2000: Impacts of climate change on water yield in the upper Wind River basin. *J. Amer. Water Resour. Assoc.*, **36**, 321–336, doi:[10.1111/j.1752-1688.2000.tb04271.x](https://doi.org/10.1111/j.1752-1688.2000.tb04271.x).
- Thomas, D. S. G., and C. Twyman, 2005: Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environ. Change*, **15**, 115–124, doi:[10.1016/j.gloenvcha.2004.10.001](https://doi.org/10.1016/j.gloenvcha.2004.10.001).
- Trenholm, V. C., 1970: *The Arapahoes, Our People*. Civilization of the American Indian Series, Vol. 105, University of Oklahoma Press, 372 pp.
- , and M. Carley, 1964: *The Shoshonis: Sentinels of the Rockies*. Civilization of the American Indian Series, Vol. 74, University of Oklahoma Press, 367 pp.
- Tsosie, R., 2013: Climate change and indigenous peoples: Comparative models of sovereignty. *Tulane Environ. Law J.*, **26**, 239–258.
- Tuck, E., and K. W. Yang, 2012: Decolonization is not a metaphor. *Decolon. Indig. Educ. Soc.*, **1**, 1–40.

- U.S. Department of Commerce, 2012: Wyoming: 2010; population and housing unit counts. U.S. Census Bureau CPH-2-52, 55 pp.
- Vinyeta, K., and K. Lynn, 2013: Exploring the role of traditional ecological knowledge in climate change initiatives. USDA, Forest Service, Pacific Northwest Research Station, General Tech. Rep. PNW-GTR-879, 37 pp.
- , and ———, 2015: Strengthening the federal-tribal relationship: A report on monitoring consultation under the Northwest Forest Plan. USDA, Forest Service, Pacific Northwest Research Station, Rep. FS/R6/PNW/2015/0005, 74 pp.
- Whyte, K. P., 2013: Justice forward: Tribes, climate adaptation and responsibility. *Climatic Change*, **120**, 517–530, doi:[10.1007/s10584-013-0743-2](https://doi.org/10.1007/s10584-013-0743-2).
- Wildcat, D. R., 2013: Introduction: Climate change and indigenous peoples of the USA. *Climatic Change*, **120**, 509–515, doi:[10.1007/s10584-013-0849-6](https://doi.org/10.1007/s10584-013-0849-6).
- Wiles, S., 2011: *Arapaho Journeys: Photographs and Stories of the Wind River Reservation*. University of Oklahoma Press, 262 pp.
- Wilson, P. B., 1973: *Farming and Ranching on the Wind River Indian Reservation, Wyoming*. University of Nebraska–Lincoln, 433 pp.
- Wind River Indian Reservation, 1991: Wind River water code 3-18-91. Law and Order Code of the Shoshone and Arapahoe Tribes of the Wind River Reservation, 20 pp.
- Wyoming Supreme Court, 1992: In re: The general adjudication of all rights to use water in the Big Horn River System and all other sources in the State of Wyoming, 835 P.2d 273.