

Change Rippling through Our Waters and Culture

*Christine Martin^{1,2,3}, John Doyle^{1,2,3,4,5}, JoRee LaFrance^{2,6}, Myra J. Lefthand^{1,2,3},
 Sara L. Young^{2,3,7}, Emery Three Irons^{1,2,3}, Margaret J. Eggers^{3,5}

¹Little Big Horn College, Crow Agency, MT

²Crow Tribal member

³Crow Environmental Health Steering Committee, Crow Agency, MT

⁴Plenty Doors Community Development Corporation, Crow Agency, MT

⁵Montana State University Bozeman, Bozeman, MT

⁶University of Arizona, Tucson, AZ

⁷Northern Arizona University, Flagstaff, AZ

*Corresponding author

Abstract: It is well established that climate change is already causing a wide variety of human health impacts in the United States and globally, and that for many reasons Native Americans are particularly vulnerable. Tribal water security is particularly threatened; the ways in which climate changes are damaging community health and well-being through impacts on water resources have been addressed more thoroughly for Tribes in coastal, arid, and sub-arctic/arctic regions of the United States. In this article, Crow Tribal members from the Northern Plains describe the impacts of climate and environmental change on local water resources and ecosystems, and thereby on Tribal community health and well-being. Formal, qualitative research methodology was employed drawing on interviews with 26 Crow Tribal Elders. Multiple determinants of health are addressed, including cultural, social, economic, and environmental factors. The sense of environmental-cultural-health loss and despair at the inability to address the root causes of climate change are widespread. Yet the co-authors and many other Tribal members are actively prioritizing, addressing, and coping with some of the local impacts of these changes, and are carrying on Apsáalooke [Crow] lifeways and values.

Keywords: *climate change, Native American, human health, water resources, Crow Tribe, Apsáalooke, solastalgia, traditional ecological knowledge*

There is widespread consensus that climate change is already causing a wide variety of health impacts in the United States and globally, and that some population groups – including Native Americans – are more vulnerable than others (Ford 2012; Gamble et al. 2016). The U.S. Global Change Research Program states “Vulnerability is the tendency or predisposition to be adversely affected by climate-related health effects. It encompasses three elements – exposure, sensitivity, and adaptive capacity – that also interact with and are influenced by the social determinants of health” (USGCRP 2016, 103). Rural Native American communities may have increased exposure due to greater time spent ranching, farming, hunting,

fishing, gathering, and/or participating in other outdoor work, activities, and traditions. Low socioeconomic status, health disparities, political factors, geographical isolation, older homes, degraded infrastructure, declining ecosystem health and services, and reliance on subsistence foods are additional factors increasing exposure and lowering resilience in many Native American communities (Cozetto et al. 2013; Gamble et al. 2016). Spiritual and cultural values and practices may both increase exposures and provide expertise to increase resilience. A review of climate change impacts on Native American health in the U.S. Global Change Research Program’s 2016 Report summarized them under the themes of food safety and security, water security, loss of cultural

identity, degraded infrastructure, and other (USGCRP 2016). Reviewing impacts of climate change on Tribal water security, a comprehensive nationwide study (Cozetto et al. 2013) describes impacts (a) to water supply, management, and infrastructure; (b) to culturally and nutritionally important aquatic species; and (c) to Tribal rights and sovereignty over water and other natural resources. Additionally, the authors discuss the impacts of droughts, floods, and other extreme climate events on ranching, agriculture, soil degradation, and land loss (Cozetto et al. 2013).

These reports, as well as the majority of the peer-reviewed literature, provide numerous examples of health impacts of climate change to Alaskan Native and Canadian Inuit communities as well as to Tribes in the Southwest, along the western and Gulf coasts and around the Great Lakes (e.g., Weinhold 2010; Brubaker et al. 2011; Ford 2012; Cozetto et al. 2013; Gautam et al. 2013; Lynn et al. 2013; Maldonado et al. 2013; Redsteer et al. 2013; Willox et al. 2013; Shamir et al. 2015; Gamble et al. 2016). However, there is far less published from Tribes in the Northern Great Plains (Cozetto et al. 2013; Doyle et al. 2013). A review of climate change and indigenous health notes that while the broader factors shaping vulnerability are important to understand, the effects of climate change will depend upon a variety of local factors; therefore “[t]his diversity in how climate change will play out locally reinforces the importance of place-based and population-specific studies” (Ford 2012, 5). Ford calls for focusing on geographic gaps in current research, and subsequently identifies research priorities, starting with:

Indigenous conceptualizations on [sic] and approaches to health need to be articulated and central to research if we are to focus on relevant health risks and capture the complex, culturally mediated interaction among social, biophysical, and biomedical determinants of vulnerability (Ford 2012, 5).

This article seeks to address this geographic gap and research priority by providing a Northern Plains case study of the impacts of climate change on local water resources and ecosystems, and thereby on Tribal community health and well-being. As Crow Tribal Elders and young adults,

we provide our understanding of how these changes are impacting our people’s health, broadly speaking, based on our formal qualitative analysis of interviews we conducted with 26 Tribal Elders.

The Apsáalooke [Crow] Community

According to our migration story, the Apsáalooke people split from the Hidatsa in the late 1400s, under the leadership of Chief No Vitals, and by the late 1400s we were settled in the plains and mountains of what is now southcentral Montana and northern Wyoming (McCleary et al. 2000). The Tribe’s first encounter with Europeans is believed to have been in 1743, when a group of Apsáalooke met French Canadian trappers at a confluence of rivers near present day Hardin, Montana. In 1840, a wave of three severe smallpox epidemics afflicted the Tribe, reducing the population from about 10,000 to only 2,000 by 1850. The first Fort Laramie Treaty was signed in 1851, stating that the Tribe controls more than 33 million acres of land in what is now southern Montana and northern Wyoming. The second Fort Laramie Treaty in 1868 took three-fourths of Apsáalooke land, a wicked loss, leaving the Tribe with only 8 million acres in present-day Montana. Further losses of land in 1872 and 1882 treaties and Congressional Acts in 1891 and 1904 reduced the Crow Reservation to its present 2.3 million acres (McCleary et al. 2000; MT OPI 2017). In 1883, the Government boarding school was relocated to Crow Agency, and parents were threatened with the loss of their food rations if they refused to send their children to the boarding school (MT OPI 2017). There are innumerable community stories about how this school and the Catholic boarding schools mistreated and traumatized Crow youth (personal communication, J.T. Doyle January 21, 2020). In 1958, the U.S. Government bought the Tribe’s rights to the Bighorn River for the building of the Yellowtail Dam (MT OPI 2017); when the dam was completed in the 1960s, the upper river valley was entirely flooded. The Federal Government still controls the dam and profits from the electricity generated; for many Tribal members this was yet another bitter loss. (For more on Crow history, see Hoxie 1995.)

We are still here today. Our Reservation, located

in southcentral Montana, encompasses the center of our Tribe's traditional territory, including three mountain ranges and three large river valleys. Approximately 8,000 of the 14,000+ Tribal members reside on the Reservation, primarily along the rivers and creeks. The majority of communities, including the "capital" town of Crow Agency, are situated in the Little Bighorn River Valley (Figure 1). Many cultural traditions continue to be practiced and the Crow language is still widely spoken by people 30 and over, with some families and a new immersion school continuing to pass the language on to younger generations. Water is one of the most important natural resources to the Crow community and has always been held in high respect among Tribal members. River and spring waters are still used

in many ceremonies (Knows His Gun McCormick et al. 2012), and until plumbing was installed in rural districts in the 1960s, served as the primary domestic water source for rural Crow families. Tribal Elders say they "grew up along these rivers," spending their summers playing in the water and along the riverbanks, and still today the rivers are home to children throughout the hot summer days. Local riparian ecosystems are vital to deer, elk, five species of berry shrubs, important medicinal plants, and other species vital to subsistence hunting and gathering, food security, and cultural identity. Additionally, riparian tree species such as cottonwood, water birch, willows, chokecherry, ash, and more continue to be collected for traditional practices and ceremonies. As we live today in a country that has been our ancestral

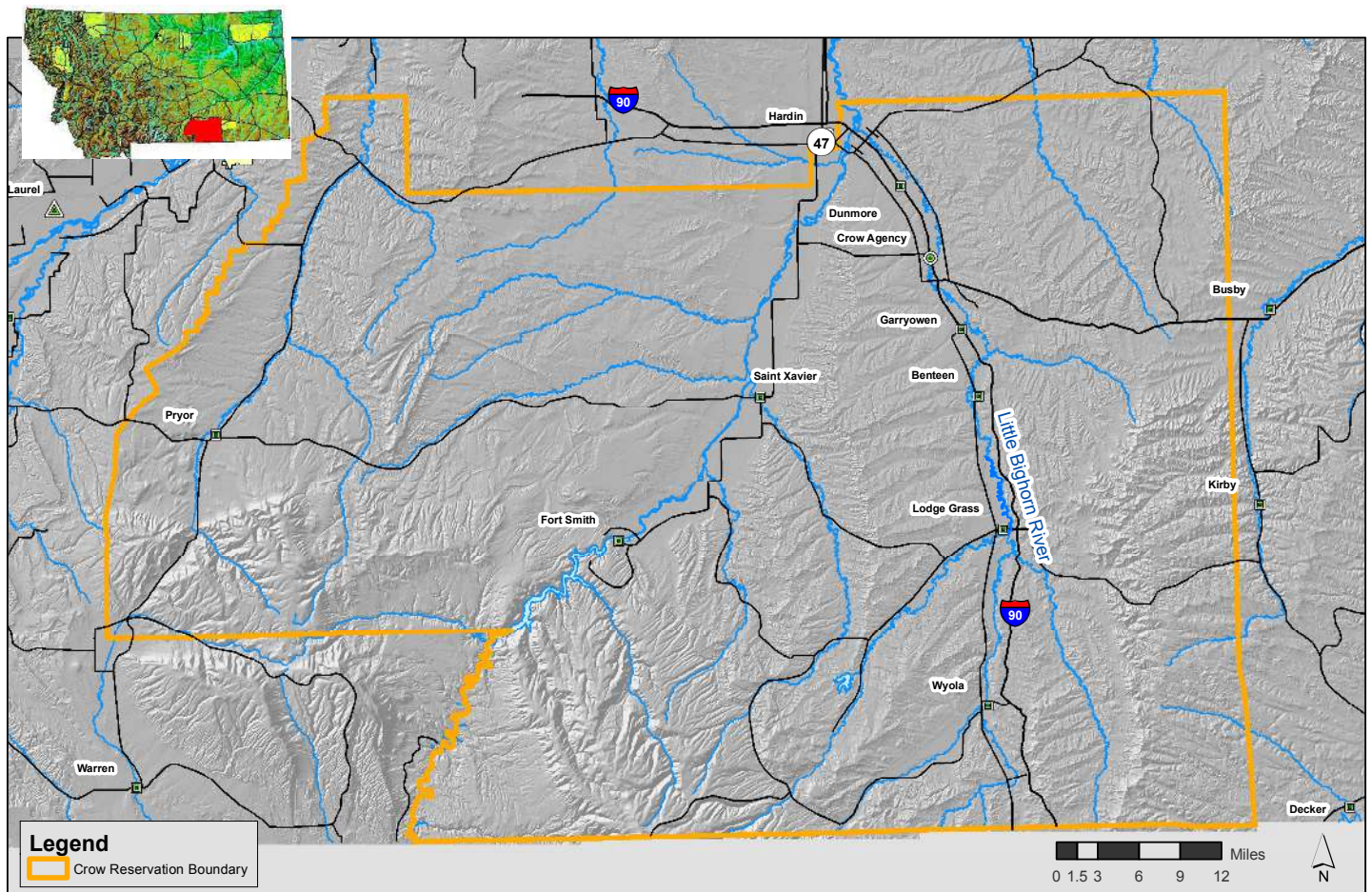


Figure 1. Map delineating the Crow Reservation (in yellow). The Reservation is southeast of Billings, MT, with the Reservation's southern border on the Montana-Wyoming state boundary. (Map prepared by Eggers; inset courtesy of Doyle et al. 2013; U.S. Department of Agriculture 2013.)

homeland for many centuries, our community – especially our older generation – retains significant traditional ecological knowledge.

The Reservation remains largely rural, with an economy based primarily on jobs and royalty from mining of the Tribe's extensive coal reserves (MT OIA 2019). Ranching, the Indian Health Service Hospital, the Bureau of Indian Affairs, Little Big Horn College (LBHC), local schools, and service industries provide other employment opportunities (MT OIA 2019). There is extensive irrigated and dry land agriculture as well as feedlots, however all are operated almost entirely by non-Tribal members. Smaller ranching operations, both Tribal and non-Tribal, are common, especially in the Little Bighorn River Valley. With the expansion of agriculture in the 1960s, Elders note that the river water quality deteriorated: whereas rivers used to “clear up” after spring runoff, they now remain murky all summer long. Populations of local frogs and river mollusks starting declining (Doyle et al. 2013). Rural families switched from collecting river water for domestic use, to relying on newly installed home wells. Recent research initiated by the Crow Environmental Health Steering Committee (CEHSC) at LBHC and conducted with University partners, has documented high levels of fecal contamination in the Little Bighorn River, including pathogenic microorganisms (Hamner et al. 2014; 2018).

Uranium was first discovered in the Pryor Mountains adjoining the Crow Reservation in 1955; within a year 315 claims had been staked and mining initiated (Patterson et al. 1988; Kerschen et al. 2003). The U.S. Department of Energy subsequently produced a Technical Report on these uranium resources (Hart 1958). Mining for both uranium and vanadium was conducted until the early 1980s, including in the headwaters of the Bighorn River Valley (Patterson et al. 1988; Eggers et al. 2015). These mines are now abandoned, and the federal agencies owning the lands have closed these areas to the public due to the radiation risk (French 2003). Many home wells in the lower part of that valley are now contaminated with uranium above the Environmental Protection Agency (EPA) drinking water standard (Eggers et al. 2015; 2018; EPA n.d.), but whether and to what extent mining has contributed to this contamination is unknown.

Changing Climate Conditions on the Crow Reservation

Organized as a grassroots group of diverse Tribal members and a non-native partner, the CEHSC conducted a community wide assessment of environmental health risks in 2005. Through this process, we came to a consensus that waterborne contaminants and pathogens constituted the greatest environmental health risks to our people, and we have been working together to understand, communicate, and mitigate these risks ever since (Cummins et al. 2010; Doyle et al. 2013; Eggers 2014; Hamner et al. 2014; Eggers et al. 2015; McOliver et al. 2015; Doyle and Eggers 2017; Doyle et al. 2018; Eggers et al. 2018; Hamner et al. 2018; Richards et al. 2018). Our Committee includes Tribal members from Elders (some with graduate degrees) to young adults, including graduate students. The older members began discussing how winters have become much milder with far less snow, leading to discussions of how climate changes were already impacting Tribal water resources and hence Tribal health. This resulted in research to determine what climate data from Western science would tell us in comparison to our anecdotal understanding from conversations with fellow Tribal members.

We learned that local environmental knowledge and Western science concurred that total snowfall has been declining for decades, winters are becoming milder and summers hotter, and that total annual precipitation is declining (Doyle et al. 2013). Spring runoff in the Little Bighorn River, central to our Reservation, appears to be coming earlier in the year, with more frequent severe spring flooding yet overall reduced total discharge. Forest fires are becoming more frequent (Doyle et al. 2013). In informal conversations with fellow Tribal members about climate change impacts, we realized that our people have a wealth of complementary local knowledge about our water resources, aquatic life, animals of all sorts, plants, soils, and weather patterns that is unique and has never been recorded by Western science. We reported previously on these anecdotal observations (Doyle et al. 2013), while realizing we needed to undertake a structured research study of the impacts of climate change on our water sources and ecosystems, and hence on community well-being. Here we describe what we

have learned, based on a formal qualitative analysis of new interviews with a diverse and geographically representative group of Crow Tribal Elders.

Methods

Working together as the CEHSC, we developed survey questions based on co-author knowledge, as well as the original, informal discussions with other Crow Tribal members and our earlier analysis of Western climate data (Doyle et al. 2013). In absence of a Crow Tribal Institutional Review Board (IRB), we submitted this study to the Montana State University Bozeman IRB, which deemed it exempt. Potential interviewees, representing the six Districts of the Reservation, were identified by consensus of our CEHSC, and invited to participate. We used purposive sampling to ensure a broad range of perspectives. Sample size was determined to be sufficient based on adequate geographic representation and diversity of life experiences. All interviewees, men (n=14) and women (n=12), reside within the boundaries of the Crow Indian Reservation in southcentral Montana. After providing informed consent, participants answered 28 open-ended interview questions about perceived changes in local weather patterns and ecosystems throughout their lifetime, and the impacts of these changes on Tribal well-being. Interviews lasted no more than an hour and participants received a stipend for their time. Two Crow co-authors – one trained in qualitative research design and the other a Tribal Elder – conducted the interviews. The interviews were audio recorded and transcribed by two of the Crow co-authors.

Interviews were analyzed using thematic analysis (Braun et al. 2018). Five CEHSC members read through and open coded all 26 interviews, compared codes, and developed themes. Two of the Crow CEHSC members then refined the codes and applied them to the interviews and met again to confirm coding strategies. Discrepancies were reviewed and resolved through in-depth discussion. Analysis of transcripts produced themes related to changes in weather patterns, the resulting impacts on wildlife, water, plants, animals, and ecosystems, and the effects these interrelated changes have had on Crow Tribal cultural practices and community well-being.

Results

Traditional Indicators of Changes in the Weather and in the Seasons

Participants described many different indicators they use to predict changes in weather and seasons. Some participants talked about predictors they use to tell the changes in weather. Other participants talked about the distinct actions they observe in the plants and animals around them, which help them predict upcoming changes in the weather or mark the changes in season. Several noted that these traditional indicators are no longer reliable or may not even be available:

Birds will start to gather and start heading south to warmer weather. Bees are not as active which means the temperature is starting to cool off. You can tell by the amount of sunlight in the day that it is going to get cooler when the sun sets early. When the deer start to group together, the weather is getting cooler. Leaves falling are an indicator that it's getting cooler. In the spring, when the cheat grass grows that's an indicator that spring is coming.

Bees can tell you what the weather is going to be like. They do certain things when certain weather is coming. Their chemicals acting with the chemicals in the atmosphere, it allows them to behave accordingly and get prepared.

Birds used to help indicate the weather but birds are hardly coming back nowadays. The thunder and lightning would give warning of rain but now it just rains out of nowhere and there is no warning.

When there is a halo around the moon we're going to have storm and rain for that month. Some indicators have changed with climate change. You can use the plants to indicate the changes but because the changes are so rapid and inconsistent the plants are unable to detect or predict the weather that is to come.

Climate Change

Participants described the changes they have noticed in the weather throughout their lifetime, especially in precipitation, temperatures, and

predictability. There was widespread agreement that winters are milder and shorter in duration, with far less snowfall than there used to be. Now winters generally start later in the year: trees are losing their leaves later in the fall and snowfall is coming later. When they were younger, there was snow cover on both mountains and prairies winterlong, with deep snowdrifts. Now the prairies are more often brown – lacking snow cover altogether – throughout the winter. Interviewees explained:

Winter is coming later. Snowfall is coming later in the fall. The freezing period for the fall is coming later so the leaves are falling later as well. Warmer temperatures in the fall.

When I was a child back in the '70s the snow was very deep every year to where I remember there was snow drifts every year and they were at least 3-6 feet high. We used to build tunnels in them every year when we were kids. Nowadays, in the winter, we don't see that drift that high. Nowadays, the snow drifts are about 6 inches to a foot high.

Temperature. Temperatures used to stay below freezing throughout the winter – as kids, ice skating was a winterlong pastime. Now winter temperatures are milder with fewer periods of subzero temperatures. Spring is coming earlier:

I think that the winters are different. There's fewer days that are subzero that I would observe. It seems to me that I used to count on a month of subzero weather maybe six weeks especially in January and February. And not before Christmas or not before the holiday or the new year.

Snowpack in the mountains is melting sooner so you are able to go into the mountains in June when they would usually go up in July.

Winter Weather. Winter weather has become unstable and unpredictable, with periods of thaw. Elders commented on this in various ways:

Weather patterns have changed.

It's cold at the wrong times.

We are seeing more dramatic events in our weather. There is rapid change and no consistency in our rivers.

Snowfalls sometimes turn to rain, even into thunder and lightning storms, a new phenomenon. One Elder related:

One of the most dramatic changes was during the Tobacco Society ceremony in May.¹ They experienced four different changes in one day. It was sunny, windy, rainy, and snow. All four very extreme and this happened during the ceremony. They had never seen something like this, said it was unreal.

River Ice. Many Elders commented on how the rivers used to freeze solid, with thick ice for ice skating. During ice break up in springtime, there used to be massive ice jams, with risks of severe flooding. Ice break-up was a culturally significant event, the Crow term is *buluxchiatacha* and it was the signal for the Old Warrior Society to meet. Now, the rivers hardly ever freeze, and when they do, the ice is too thin for skating:

Ice break-up is a rare commodity. I recall a time when they would float down the river on ice chunks that were about nine inches thick and the size of a car hood. Ice jams haven't occurred for years. The ice break-ups don't happen like they used to and if they do, the timing is off.

One Elder remarked how these huge ice chunks would scour the river bottoms, then melt away on the banks of the rivers – and wondered if without this process, there is now more sediment in the river bottom gravels, in turn affecting the fish and other river life?

Spring Floods. Severe spring floods are happening more often, with major floods causing extensive damage in 1978, 2007, and 2011:

...that floodwater came through their houses, and that house is condemned. For people that is such a hardship because we just don't have to money to relocate. So they just had to let their house dry out and move back in, even with the same carpet. So that was a community health concern.

¹ The authors do not wish to explain Apsáalooke religious traditions in this article. Readers interested in learning more are referred to Linderman 1932; Medicine Crow 1992; Frey 1993; Snell 2000; McCleary 2012.

Precipitation. There was a consensus among the Elders that there is less precipitation now than in the past. Other participants talked about how there is less water in the rivers and more contamination today when compared to growing up, making it impossible for their families to use the river during the summer months. Grasses and cattails are not growing as high as they once did. For instance, participants noted:

We used to get squalls all the time. The old people used to follow the rivers when they flow but the water has decreased. It only rains in the mountains and not in the valleys anymore.

The rainfall is very inconsistent and is throwing off the growth of the plants. The [ceremonial] tobacco seed is growing later than when it's supposed to be.

We're losing the annual precipitation that we enjoyed in the years that have gone by. All we can do is just have memories and hope that eventually the cycle will come back to that time when we had ample moisture and we were at leisure with plant life, berry picking, root gathering and other ceremonial activities that go on here year after year.

Where they had the sundance, the ground never used to hold as much heat as it does now. The ground was moist but now it is dried out and has a lot more dirt.

Springs. Many Elders remarked that springs they are familiar with have decreased in flow or dried up altogether. One Elder remarked that some mountain springs are now originating further downslope than they used to, perhaps because the water table has dropped.

The spring behind our house went out during the hot spell of 1988. The spring fed a pond that is dried out now. The groundwater and spring levels have depleted. We are using the annual precipitation and getting less snow that recharges our springs. A place where berry picking was noted by one of our chiefs, Crazy Head, that spring no longer exists.

There were special warriors who had medicine to look for places to camp. They would always make sure that their camps had water, either

waterholes or springs. Some of these places where they camped no longer have water.

Summer Heat. Nearly all participants observed that summers are hotter and are lasting longer than in the past. One participant put it this way:

We have a few days of hot weather in March, then some in April but the hot weather comes in June and lasts until September; it's longer, the heat, it appears to me to be longer and hotter... more uncomfortable.

Wildfires. Interviewees observed that wildfires are starting earlier in the spring and are more frequent and widespread. The majority thought fires were more severe than they used to be, but not all agreed. Some are concerned that where the ground is really scorched, plants will not fully recover and there will be less forage for the deer. As one Elder summarized it:

There are more fires now days and they're more severe and more widespread and they do more damage. To me it's all obvious and apparent that we in fact are in global warming... When it rains, the mudslides wash away everything...

Mammals. Participants noticed changes in the presence of wild animals in their area. Most are seeing fewer deer, elk, and antelope, with a couple exceptions. Two people remarked on declining deer health:

Heard of hunters finding some type of disease inside the deer that they killed. Unknown what it was.

The deer are not as healthy as they once were. The meat is in smaller portions and is not as lean. They are also decreasing in size.

Elders also commented on decreases in small mammal populations, including raccoons, badgers, skunks, fox, and squirrels. Several people noted that there are fewer road kills than there used to be.

Birds. Almost all the Elders talked about the loss of bird species, collectively mentioning decreases in sage grouse, prairie chickens, mourning doves, bluebirds, woodpeckers, magpies, wild turkeys, snipes, ducks, and even robins. The owl they knew has disappeared and different species of owl are coming in.

One big thing I noticed is that the dove that we used to have here it had its own song and I always really liked that song. I could hear it and other birds in the morning... their different sounds all blended together in one big ol' symphony. It was just a great thing to me. But that dove is no longer here...

Prairie chickens [sage grouse] used to be more plentiful. I remember when I was a little guy we used to cruise around and see them all the time... they would be just right alongside of the road, eating or doing their thing. I don't see them around much anymore the way we used to.

Fish. Fish populations have also declined, with participants noting:

They don't eat fish like they used to anymore; you can barely find them anymore.

Decrease in the amount of fish you would catch when you go fishing.

Because the streams are lowered, the population isn't able to bounce back the way it used to.

One person commented that there is increasing "moss at the riverbed" [a local reference to algae]. An Elder who used to fish regularly for food as a young man, remarked that he started catching fish with sores, so he quit fishing.

Riparian and River Life. Many participants talked about how they have witnessed a significant decline in frogs and other riparian species compared to their childhoods. For example:

When we were little we used to catch and release frogs and that was part of our activity at the river... there would just be tons of frogs in those little water holes next to the river, and turtles and salamanders... We used to see who could find the most... there was about five or six of us playing that game where we could each collect our own frogs... But now when I go over there, the frogs are still there but they're not all along the river like they used to be... you kind of have to hunt them out.

Decrease in frogs. You don't hear them as much anymore. There used to be small clams in the rivers but you don't see those anymore.

You don't see the small lizards that used to be around the rivers.

Insects. In response to an open-ended question about any changes in insect populations, many respondents noted declines in bee populations:

There aren't as many wild bees anymore. The weather change can be contributing to the loss of these insects.

Decrease in bees, decrease in pollination of gardens.

One interviewee added that "There are more grasshoppers. The temperatures are warmer and dryer for them to thrive."

Plants. Nearly all participants discussed decreases in availability and changes in the phenology of culturally important plants, mentioning bitterroot, wild turnips, wild onions, and especially berry species and medicinal plants such as mint, bear root, Echinacea, and sweet sage. Buffaloberries were traditionally harvested after the first frost, as they are sweeter then, but now the berries deteriorate before frost comes. Some suspect that the midwinter thaws are damaging the many species of berry shrubs. Russian olive, spotted knapweed, and other invasive plants are contributing to the decline of important native plant species.

There used to be a bunch of patches of raspberries and now they only know of one or two patches. And now they won't tell me where they're at. They said, 'They're rare and I'm not going to tell you, they're mine.' The chokecherries weren't as delicious, they weren't as sweet. None of them are as sweet as they used to be. That might have something to do with the decrease in bees... or the frost and thawing period, or it could be the late precipitation. Because if you are not getting the water then you are not growing as early in the season...

You don't see a lot of these plants like we used to. There are less and less berries that my grandma used to pick. Everything is living so with climate change everything is confused.

Buffaloberries were not ready to be picked when we went to go picking during the harvest

season we know of. Chokecherries bloomed late in the season as well.

I don't remember a year where there just weren't any [choke]cherries. I would say late '80s. There might've been a year when there was a slight [harvest]. And then more recently it's like every other year. If you don't get in there and get a lot you could easily have a year where you won't have any. I have been down to like no jars [of chokecherries].

When my family was younger, we did a lot of just going around in the mountains, a lot of hunting and camping. Now that I am older and my kids have their own families, they're camping and I'm not so much. So I am thinking I won't see so much change. When I get next to the rivers, what I am doing is usually searching for things. Like I am looking for mint or I am picking berries of different kinds. Or maybe I am looking for wild onions and carrots and things. And those things changed, they've changed a lot. I feel like I can hardly ever find mint where I would use to find it a lot. And that is really usually along water ways. So there is a difference in growth. Why? I don't know. But why plants move around so much, I just don't know. But I do think that it probably has to do with water and the season of time when the water is available. There are places where I used to constantly go for certain things that I have had to look for new places because things just aren't growing where they used to... [Interviewer: So do you find them?] Not always. I've felt like . . . well you know at the sundance we go and look for mint. There is plenty of cattails. That's never a problem and you go look for mint or even sweet sage. Not just any old sage but sweet sage, sometimes you just have to go a tremendous distance to find it... The last time I went looking for mint to any extent was in the Wolf Mountains and I am very familiar with the Wolf Mountains. That's if I was going to go to the mountains, that's where I would go for walking, for picking, just exploring, hunting. Things change.

Ceremonially important plants including cottonwood trees and lodgepole pine are also on

the decline and many are harder to find. Lodgepole is harvested for teepee poles:

Good teepee poles are hard to find. The poles are dried out so they are harder to peel. We used to go to the Pryor Mountains and each year we would go deeper and deeper [into the mountains] because the poles are getting more scarce.

People mentioned multiple factors contributing to these losses and changes: less precipitation; declining springs for riparian species; warmer temperatures including winter thaws damaging the berry shrubs; pesticides and loss of pollinators; greed for money (obtained by selling wild plant foods); loss of knowledge as to how to harvest plants properly so they will regrow; and increases in invasive plants.

Mint tea grows near springs so it is disappearing with the springs. Most of our plants only grow in certain locations now. Wild turnips are decreasing. Chokecherry tree is a vital plant to grow; it is a food we rely on and it initiates other ceremonies that we do like the Tobacco Society and adoption ceremonies.

Impacts of Climate Changes on Community Health

Participants shared many concerns with health issues related to the changes in lifestyle as a result of increased spring flooding, contamination of the rivers, increased wildfires, milder winters and hotter summers, and loss of cultural practices.

Milder Winters. There is a widely held community understanding that the milder winter temperatures are no longer cold enough to kill disease and this is resulting in increased illness in the community:

Winter temperature and snow kills bacteria so now with warming temperatures or warming homes the bacteria can thrive. People are getting sick because the bacteria and illnesses aren't being killed.

Spring Flooding. Before the severe spring flood of 1978, there had only been one disastrous flood in living memory, in the 1920s. Then disastrous floods hit again in 2007 and 2011, causing widespread home damage and financial distress, with many

lacking the resources to repair the damage:

There was financial distress from homes being destroyed by the floods, people not being able to relocate. They had to let their houses dry out and they moved back into their homes.

The flood caused a lot of destruction to the Little Bighorn River and surrounding areas. It caused a lot of health problems for people. Financial distress on people who couldn't relocate or rehabilitate their homes.

Rivers. The rivers have long been sacred to the Crow community, the source of domestic and ceremonial drinking water, vital to many ceremonies, the center of summer life for children. Nearly all interviewees commented on the connections between deteriorating river water quality and quantity, and the many resulting negative impacts on community health. People have lost river water as a source of home and ceremonial drinking water, many have even stopped swimming in it and several mentioned they have quit fishing.

Industry, farming, power plant, pollution... all these changes have affected the river. The poisons and pollutions that get into the water systems have increased, it never used to be like this when we were younger. We don't ingest the water anymore, just splash the water on my face and body. Toxins could be in the water.

We can't swim in our rivers anymore. Have to boil the water if you are going to use it, because of contamination.

This has affected our health because kids are not able to swim in the rivers as much or drink the water as it could cause health problems. They aren't able to go outside and play like they used to when it gets hot.

We still have our sweat[lodge] because the Crows believe that the Creator gave us 100 gifts and said that these are the gifts I'm giving you so that you can survive as Apsáalooke people. Those gifts have been dwindling down until we only have maybe ten and so. One of the gifts that the Creator [gave] was the sweat so that we can continue to be Apsáalooke people and if we held on to those then our people will not perish, we will always have

Crow people. That is our belief so we always have a sweat... Part of that is when we use the sweat we get water from the river cause it's right close to the river bank and we still do that today... we pour the water on the rocks and we bath in it but the one thing we don't do that we used to, is we don't drink the water; we do not drink the water. If it's like for ceremony, like when we build a new sweat[lodge], then we will drink some of the water but it's not like the continuing usage we had when we built a sweat every time. Now we only use it when we do it for ceremonial purposes but all the other times we use tap water that we bring and drink from that.

Summer Heat and Wildfire Smoke. Several participants mentioned the impacts of increased summer heat on health. For instance:

When it gets hot, people are irritated so it makes people unhappy.

People aren't able to go outside as much so it causes health problems.

Warmer temperatures can cause heat exhaustion.

One participant observed that wildfire smoke is especially hard on people with asthma.

Culture and Loss

Participants talked about their beliefs and how this guides their ways of knowing. Some participants talked about the oral stories they heard growing up and how this has helped them engage with what was going on around them. Other participants talked about the ceremonies they witnessed growing up as well as the old ways of knowing versus current Western lifestyles. These changes have impacted the community and people's knowledge, the depth of conversation among individuals as well as how aware they are of what is going on around them. Losses of cultural practices and beliefs were described by many:

They used to camp but they haven't camped in a while. People aren't interested in it anymore or they don't have the time to do it anymore.

The campsites were different back in the buffalo days. They don't advertise where their

traditional campsites are because people vandalize too much. People don't have respect for our traditional places like we used to.

We don't pray for these things when we use them so they are not coming back like they should be. We are dominated by European society so we don't use them as much anymore. People are relying on Western medicine so they don't need these anymore.

We went to go check on the plants and foods that we used to harvest and everything had disappeared. Young people aren't attuned to these changes so they don't know.

The loss of culture, of the close traditional connection to the land, especially in the younger generations, is exacerbated by climate change and environmental deterioration; these multiple losses interact in contributing to poorer health.

Maybe I'm an old timer. Maybe older generations before have said this about the younger generations. Our younger people are addicted to video, audio, cell phones. They don't sit down and eat breakfast and dinner together... that real strong element of our tradition and culture – I see it kind of going away... We're losing all of the good stuff that we think about with culture, society, family, and tribe – a lot of that is being lost.

Families are not going outdoors as much as they used to anymore and it's causing health problems such as diabetes and obesity. People are eating more and more processed food and not the food that they harvest. Families aren't doing things together any more so they aren't having these things taught to them. We are not eating as healthy and being active like we used to anymore.

Discussion

The results of this formal, qualitative research study confirm and strengthen the consensus heard earlier from our conversations with fellow Tribal members and from our analysis of Western science climate data (Doyle et al. 2013): snowfall is declining and winters are milder, increased spring flooding has been devastating for many families,

summers are hotter, and wildfires are increasing in frequency, and the impacts on local animals and plants are many. Going beyond our earlier work, we have gained a deeper insight into community understanding, beliefs, and practices and the complex challenges we face in coping with and adapting to multiple environmental and climate change impacts on our water sources, animal and plant life, ecosystems, and our people. In particular, climate impacts on our waters and well-being are both direct and indirect: less snow and rainfall, more frequent severe spring floods, with earlier and apparently declining total spring runoff, and worse summer droughts. Deep soil moisture is not replenished as it once was, resulting in long-term drier conditions for plant growth, some mountain springs moving downslope, and perhaps reduced river recharge. Important riparian plants such as mint have become less available. Drier fuels are contributing to more frequent wildfires, in turn reducing air quality. Reduced river flow with deteriorating water quality especially impacts our traditional practices, outdoor summer recreation for our children, and our river-dependent public water supply in Crow Agency.

Community members recognize that changes in climate are exacerbating the many other ongoing factors which contribute to environmental change: pollution – especially water pollution from agriculture, ranching, mining, and home wastewater; invasive plant species; pesticides and loss of pollinators; commoditization of traditional plant foods and medicines leading to overharvesting (especially by non-native residents); and the dominance of Western culture and loss of Crow knowledge and traditional values leading to inadequate or nonexistent stewardship.

Many Elders made observations which parallel and enrich data from Western science. In Crow culture, the appropriate times to do certain things have long been, and still are, tied to specific seasonal changes, hence we continue to be very observant of our environment. This traditional knowledge and Western science complement each other and bringing them together tells a more complete story. For instance, the comments about deer in poorer health or with obvious disease, echo Montana and Wyoming chronic wasting disease (CWD) maps which show CWD has been found in free ranging

cervids on all sides of the Crow Reservation (Thuemer 2015; MT Fish, Wildlife and Parks 2019). Although testing of deer and elk meat is available to Tribal members, the authors could find no on-line information about CWD occurrence within the Reservation boundary. Currently, there are no carcass movement regulations in place on either the Crow or neighboring Northern Cheyenne Reservations, as there are in other parts of Montana under state government jurisdiction. This is a serious issue for us, as many families rely on subsistence hunting of deer and elk and are beginning to question the safety of this vital food source.

The increase in “moss” [algae] in the rivers, coupled with the observation that fish with skin sores are being caught, suggests bacterial infections in fish associated with nutrient pollution of the rivers (Johnson and Carpenter 2008). Both agricultural fertilizer and unregulated draining of septage into local rivers could be contributing to nutrient pollution. Elevated nitrate in home wells in the Bighorn River Valley – where extensive irrigated agriculture takes place – has already been identified (Eggers et al. 2018). Families whose wells tested above the maximum contaminant level for nitrate were educated about the risks and provided with free home water coolers (Eggers et al. 2018), but our rivers are not being tested nor monitored for elevated nitrate.

When we initiated this study and started to recruit participants, we found that some people see the acknowledgement of climate change as conflicting with their hopes for restoration of the Tribe’s former income level from coal tax revenue. The severe downturn in our Tribe’s economy from major reductions in coal mining for electricity generation has caused tremendous financial distress for many if not the majority of Tribal families. One outcome is that it has become difficult to discuss and plan for alternate economic development paths and for adaptation to climate changes already impacting us.

In the interviews, nearly all participants described a sense of loss related to changing climate and environmental conditions on our land, where generations of families have lived and have gathered for celebrations and traditional ceremonies. They shared their observations about

surrounding wildlife, noting that they have seen less and less of familiar wildlife around, and sometimes see new wildlife. Participants shared their experiences of how their use of nearby rivers, familiar plants, and animals has changed throughout their lifetimes and in comparison to the previous generations. They talked about the loss of culturally significant plants, such as bear root, mint, and berries, how they are harder to find and harvest. Sometimes they are competing with wildlife for the picking and other times there is no harvest of berries or medicinal plants where they have found them in the past. Other participants talked about the changes they have noticed in the river as compared to previous years growing up. Changes in the river have changed the land and that has ripple effects throughout our lives. The sense of loss, tragic loss, is pervasive.

Other Native American researchers have identified impacts on spiritual, mental, and physical health when the environment is contaminated and traditional foods or water sources are unsafe for consumption (e.g., Donatuto et al. 2011; Cozetto et al. 2013; Willox et al. 2013). This widespread anguish is akin to what some have called solastalgia, described as “the distress that is produced by environmental change impacting on people while they are directly connected to their home environment” (Albrecht et al. 2007; Tschakert and Tutu 2010). Other studies are also finding that climatic and environmental change can have profound impacts on human well-being through multiple pathways (e.g., Bourque and Willox 2014; Gifford and Gifford 2016). Indeed, the American Psychological Association and collaborators recently published an entire report entitled “Mental Health and our Changing Climate: Impacts, Implications and Guidance” (Clayton et al. 2017). For us, and perhaps for many other indigenous people, the changes are not simply unfamiliar alterations in our home environment causing discomfort – *they are direct threats to our ability to carry on the traditional practices which define us as a people.*

It is history repeating itself in an even more insidious way. We lost the majority of our lands through treaties and Congressional acts. We lost generations of raising and educating our own children through federal boarding schools

starting in the 1880s. We have since lost the Upper Bighorn River to Yellowtail Dam, agricultural and recreational lands to non-Tribal members, much of our traditional diet – the list goes on. Now, even though we live in our traditional territory, the changes in climate are changing our homelands all around us, and this time there is no single enemy to fight.

In just the past couple years since these interviews were conducted, community conversations around climate change have become different. We hear more and more comments that the sudden and extreme weather events we are now experiencing are abnormal, they are not in the living memories of the older generations. For those younger than 40, however, the current weather patterns are their “normal.” These extreme weather events are very hard on our communities, but when the topic is raised there are comments of “there is nothing we can do about it” and fearful silence. We hear that kind of despair more and more often.

As the CEHSC, we are working to support rural families’ access to safe drinking water, to increase community understanding about the health risks from contaminated surface and groundwater, to develop and provide a water quality course at our local Tribal College, and to develop a Geographic Information System for the Reservation to include environmental data (especially water quality data). We prioritize mentoring Crow undergraduate and graduate students in our environmental health research and mitigation projects. For instance, one of our co-authors recently earned his Master’s degree in environmental science with a geospatial emphasis; another is currently working on her doctorate in soil and water sciences. Most of us collaborate with the local Guardians of the Living Waters program to engage Crow youth in understanding and protecting our waters from a multidisciplinary perspective, including Crow history and traditional values and practices (Milakovich et al. 2018; Simonds et al. 2019a, 2019b). Some of us work on community economic development with another Tribal grassroots organization, Plenty Doors Community Development Corporation (see references). We have recently initiated a new partnership with a local foundation, seeking strategies and funding to reduce environmental impacts on and improve

the health of our rivers so that we can maintain essential traditional practices for the well-being of our people. We carry on diverse cultural traditions in our personal lives, and are passing these on to our children, grandchildren, and great grandchildren. Our younger co-authors also emphasize the need to research, document, and preserve more of Crow culture as another way of allowing youth to learn from older Tribal members. Collectively and individually, we are finding ways to address these issues and give back to our Tribal community.

Conclusion

Through these interviews and subsequent discussions, we have gained a better understanding of all the environmental, historical, economic, and cultural factors which interact to increase our vulnerability to the impacts of climate change on our waters and ecosystems, and hence on our Tribal community health and well-being. We are using what we have learned to identify, prioritize, fund, and implement strategies to cope with and adapt to the changes impacting our Tribe.

Regardless of these many challenges, we still manage to practice our beliefs and traditions, such as berry picking, hunting, getting tipi poles, “feeding” the river, holding sweats and sundances, and following the clan system. We strive to live a traditional Crow lifestyle, in spite of assimilation and conditioning to incorporate Western thinking into our way of living. We care for our Elders and youth, and have a collective responsibility to pass on our beliefs and traditional knowledge to our next generation, so they can carry on our culture and traditions in a good way. We must maintain the gifts we have from our Creator, which sustain us and are what make us Apsáalooke.

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Author Bio and Contact Information

CHRISTINE N. MARTIN (corresponding author), an enrolled member of the Crow Tribe, has a BS and MS in community health. She has knowledge of and experience in community health behavior theory and Community Based Participatory Research (CBPR), with specific training in qualitative research and design. Her CBPR research in her Tribal community has included diabetes prevention among Native American adults through diet and exercise, surface and groundwater quality assessment and mitigation, mental health among Tribal youth, engagement of Tribal youth with tradition with the transfer of Western and Crow traditional knowledge, and the impacts of climate change on Tribal ecosystems and health. As a climate change adaptation coordinator, she helps coordinate and facilitate Tribal networking and community engagement. She may be contacted at martinc@lbhc.edu or via mail at: Little Big Horn College, Crow Water Quality Project, Principal Investigator, USDA grant, PO Box 370, Crow Agency, MT 59022.

JOHN DOYLE, Crow Tribal member, has been working to improve understanding and management of Crow Reservation water resources and community health for some 40 years, including 24 years as a County Commissioner and Health Board member, 15+ years as Co-Director of the Tribe's Water Authority, and 15 years as a founding and ongoing member of the Crow Environmental Health Steering Committee. He oversees testing of home well water and springs as well as community education and risk mitigation addressing water contamination across the Crow Reservation, researches climate change impacts on Tribal waters and health, serves as Principal Investigator on these grants, and has co-authored half a dozen publications on this research. Mr. Doyle currently serves on the EPA's National Environmental Justice Advisory Council. He may be contacted at doylej@lbhc.edu.

JOREE LAFRANCE comes from the Crow Reservation located in southeastern Montana and is Apsáalooke [Crow]. Her Apsáalooke name is Ichiinmaaáatchilash – Fortunate with Horses and she comes from the Greasy Mouth clan and is a child of Ties in the Bundle clan. She graduated in June 2017 from Dartmouth College with a Bachelor's of Arts in Earth Sciences and Native American Studies. She is now a second-year PhD student at the University of Arizona in the Department of Environmental Sciences in Tucson, AZ. Her research focuses on surface water contamination in the Little Bighorn River watershed. She may be contacted at joreevlafrance@gmail.com.

MYRA LEFTHAND, Crow Tribal member, maintains

traditional Crow beliefs and practices, and speaks the Crow language fluently. She holds a Master's in Social Work and has been serving the Crow community for decades. After retiring from the local Indian Health Service Hospital as the Community Health Educator, she became the Coordinator for the Violence Against Women Project at Little Big Horn College. A founding and ongoing member of the Crow Environmental Health Steering Committee, Myra has been helping guide our work to address drinking water security and water contamination issues for the past 15 years. She may be contacted at myrajlefthand@gmail.com.

SARA YOUNG is an enrolled member of the Crow Tribe. She taught school on the Crow Reservation, earned a master's degree in School Administration, and spent 13 years as a school administrator. At Montana State University, she worked as the Director of American Indian Research Opportunities and for Montana's IDEA Network of Biomedical Research Excellence (MT INBRE), building research capacity at Montana Tribal Colleges. She has received state and national awards for her work in mentoring American Indian students in STEM majors. Sara currently consults for an NIH grant to Northern Arizona University to improve oral health of American Indian children on the Crow Reservation. She has been on the Crow Environmental Health Steering Committee for almost 15 years. She may be contacted at saralyoung@hotmail.com.

EMERY THREE IRONS is the GIS manager for the Crow Water Quality Project at LBHC. Emery was raised to understand that the world works in a spiritual way and has learned there is a scientific way. He aspires to bring spirit and science together. His graduate research used spatial analytic methods to understand coliform contamination of private well water on the Crow Reservation in relationship to physical characteristics and well protection factors. He currently is developing a GIS-based watershed management plan for Little Bighorn River. Emery has a B.S. in Geospatial & Environmental Analysis and an M.S. in Land Resources Environmental Sciences (MSU Bozeman). He may be contacted at threeironse@lbhc.edu.

MARGARET (MARI) EGGERS is an environmental health research assistant professor at Montana State University Bozeman (MSU). She previously lived in Crow Agency and taught science at Little Big Horn College for a decade. As a founding and ongoing member of the Crow Environmental Health Steering Committee, she has been working with Crow colleagues for the past 15 years on community-engaged research and mitigation to reduce exposure to waterborne contaminants, improve access to safe drinking water, and understand the impacts of climate change on local water resources and

health. Eggers teaches environmental health at MSU and serves on the Gallatin County Board of Health. Eggers has a B.A. and M.A. (Stanford), an M.S. in Ecology and a PhD and post-doc in environmental science/health (MSU). She may be contacted at mari.eggers@montana.edu.

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