



“It’s Not Balancing out Like It Should Be”: Perceptions of Local Climate Variability in Native Oklahoma

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ABSTRACT

Fieldwork was conducted in 2009–11 with Native American agriculturalists and traditionalists in southwestern Oklahoma on the form and use of their weather and climate knowledge: how it is constituted, how it is used in agricultural decision-making, and the extent to which their own weather knowledge is valued in light of other forms of weather information available. Conversations rekindled memories of knowledge imparted and stories told by previous generations and illuminated observational signs some still rely upon. Conversations also revealed that while the agriculturalists and traditionalists are acculturated into contemporary society, they still hold tightly to culturally important ways of knowing about and being in the world and are keen observers of their local environments. Given the contemporary relevance of climate change and its impacts on Indigenous peoples, this paper focuses on their observations and thoughts about climate variability: Have you noticed changes? What impacts do these changes have on you, including both on your agricultural activities and your trusted observational signs? What do you think about the public discourse on climate change? According to most, a changing climate is a real phenomenon perceived at the local scale and is impacting their ability to observe relied-upon indicators, and has caused them to make changes in their agricultural endeavors. The knowledge professed by those in this study can be placed within the larger context of Indigenous environmental knowledge formation, as it follows closely with that discovered through archival research and that described by other inquiries from around the world.

1. Introduction

In 1965, Bob Dylan sang, “You don’t need a weather man to know which way the wind blows” (*Subterranean Homesick Blues*). To “know which way the wind blows” is to understand what is happening around you, to adapt to changing circumstances, and to anticipate the future. I found this to closely describe the weather and climate insights and practices of Native American agriculturalists (active farmers, ranchers, and gardeners and those who were seeking to become one) and traditionalists (both tribal elders and younger people who seek to perpetuate traditional ways) with whom I interacted during fieldwork in 2009–11 in southwestern Oklahoma (Peppler 2012). That inquiry sought to uncover the insights possessed and how they are constituted, how they are used in agricultural decision-making, and the extent to which they are valued in light of other forms of weather and climate

information available. The fieldwork was a consequence of exploratory archival research conducted to help establish historical context (Peppler 2010, 2017). Members of the Kiowa, Comanche, Apache, Wichita, and Delaware tribes and nations of southwestern Oklahoma were collaborators in the fieldwork, as was a member of the Muscogee (Creek) Nation of eastern Oklahoma.

Fieldwork focused mostly on agriculturalists because they are people who work on the land, and as such must be keen observers of weather and seasonal climate and their indicators to help ensure their livelihoods. While the agriculturalists’ existence is contemporary, their daily interactions with the environment may be more direct, or less mediated by modernity, than those of most people. It has been written that Native Americans view events taking place in the nonhuman world as a “blend of physical and spiritual parts ... the sun, wind, and clouds were believed to be living entities with a spirit and personality of their own” (Vogel 2001, p. 8). Minnis and Elisens (2000) demonstrated that “Indigenous science” discovers ecological relationships unknown to

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Western science, with the implication being that society could benefit from a more sophisticated understanding of Indigenous knowledge. Such inquiry has potential to contribute unexpected and nonintuitive insights into conceptualizing and understanding elements of the nonhuman world (e.g., [Berkes 1999](#); [Suzuki and Knudtson 1992](#); [Pierotti and Wildcat 2000](#)).

Our conversations rekindled memories of weather knowledge and stories handed down from family members and illuminated observational signs some still rely upon. Conversations revealed that while the people I interacted with are acculturated into contemporary American society, they still hold tightly to culturally and tribally important ways of knowing about and being in the world. Conversations revealed deeply held feelings about a proper relationship with the nonhuman world, and strong desires to maintain and pass along their knowledge to future generations. These conversations contribute to scholarship *with* Indigenous peoples and to the fledgling field of “ethnclimatology” (e.g., [Orlove et al. 2002](#)).

Given the contemporary relevance of climate change and its impacts on Indigenous peoples in general (e.g., [Wildcat 2013](#)) and on specific aspects of their culture and existence such as traditional foods (e.g., [Lynn et al. 2013](#)), water resources (e.g., [Cozzetto et al. 2013](#)), displacement and relocation (e.g., [Farbotko and Lazrus 2012](#); [Maldonado et al. 2013](#)), risk (e.g., [Lazrus 2015](#)), and signature ways of being in the world (e.g., [Sakakibara 2011](#)), this paper focuses on the agriculturalists’ and traditionalists’ observations and thoughts about climate variability. [Turner and Clifton \(2009, p. 185\)](#) were told by salmon and shellfish fishers in British Columbia, “Everything is different now with the warmer weather; harvesting times are way, way different.” Indeed, the impacts of a changing climate on Indigenous peoples and recognition of the value of Indigenous knowledge systems for conceptualizing it were recently highlighted at a high level in chapter 12 of the Third (2014) U.S. National Climate Assessment ([Bennett et al. 2014](#); also see [Maldonado et al. 2016](#)). [Maldonado et al. \(2016, p. 122\)](#) boldly state, “Future climate assessments and scientific studies should reference traditional knowledges as well as Western science. . . .” The consideration of different ways of knowing about a changing climate is said to have the ability to positively inform the discourse ([Alexander et al. 2011](#)).

2. Geography and climate of southwestern Oklahoma

Information is provided here on the geography, nature of farming, and climate variability for the southwestern Oklahoma region. It is important to note here that scientific data serve only as context for the Native

observations and are not meant for verification. Rather, the Indigenous voices in this research report local nuance, detail, and cultural meaning about changes that may represent information others have missed. Theirs should be data that stand independently.

Southwestern Oklahoma consists mostly of grassland and gently rolling prairie topography (e.g., [Oklahoma Atlas Institute 2005](#)) but includes some weathered mountain ranges such as the Wichita Mountains at the south edge of the research area ([Fig. 1](#)). Cattle ranching and winter wheat and hay farming dominate agricultural activities (representing the interests of this study’s agricultural collaborators); in addition, some sheep, lamb, hogs, and sorghum are raised (e.g., [Oklahoma Board of Agriculture 2016](#)).

Warmer than normal temperatures, sometimes significantly warmer, have been recorded in southwestern Oklahoma since the mid-1990s, which followed a prolonged period of slightly below temperatures that commenced in the late 1950s [information for this temperature and precipitation discussion comes from the [South Central Climate Science Center \(2013\)](#), the Southern Climate Impacts and Planning Program ([Lodangco et al. 2015](#)), and the [Oklahoma Climatological Survey \(2016a,b\)](#)]. Although drought is a recurring condition in southwestern Oklahoma, there was an extended wet period from the early 1980s up to the late 2000s. This was followed by a very dry period, which was ameliorated in May 2015. Based on South Central Climate Science Center analysis, the Palmer Drought Severity Index and a 2-yr standardized precipitation index both indicated severe drought in southwestern Oklahoma during this latter dry period, with the U.S. Drought Monitor for 18 October 2011 showing “exceptional” drought with significant impacts on agriculture and water supply in the region. According to [Lodangco et al. \(2015\)](#), the August 2010–December 2014 period (53 months) was the longest duration drought event recorded in Oklahoma Climate Division 7 (encompassing the study area) for data going back to 1895. Interviews and participant-observation experiences (described next) took place during the onset and height of that drought period, which also was a period of above normal temperatures. As will be seen, the local perceptions and observations of the agriculturalists and traditionalists track closely with what was taking place at the time and likely were affected by them.

3. Interview research and participant-observation experiences

[Davis \(2008, p. 51\)](#), in reflecting upon years of fieldwork with Indigenous people, called it “. . . an adventure, a voyage into the unknown. How will the

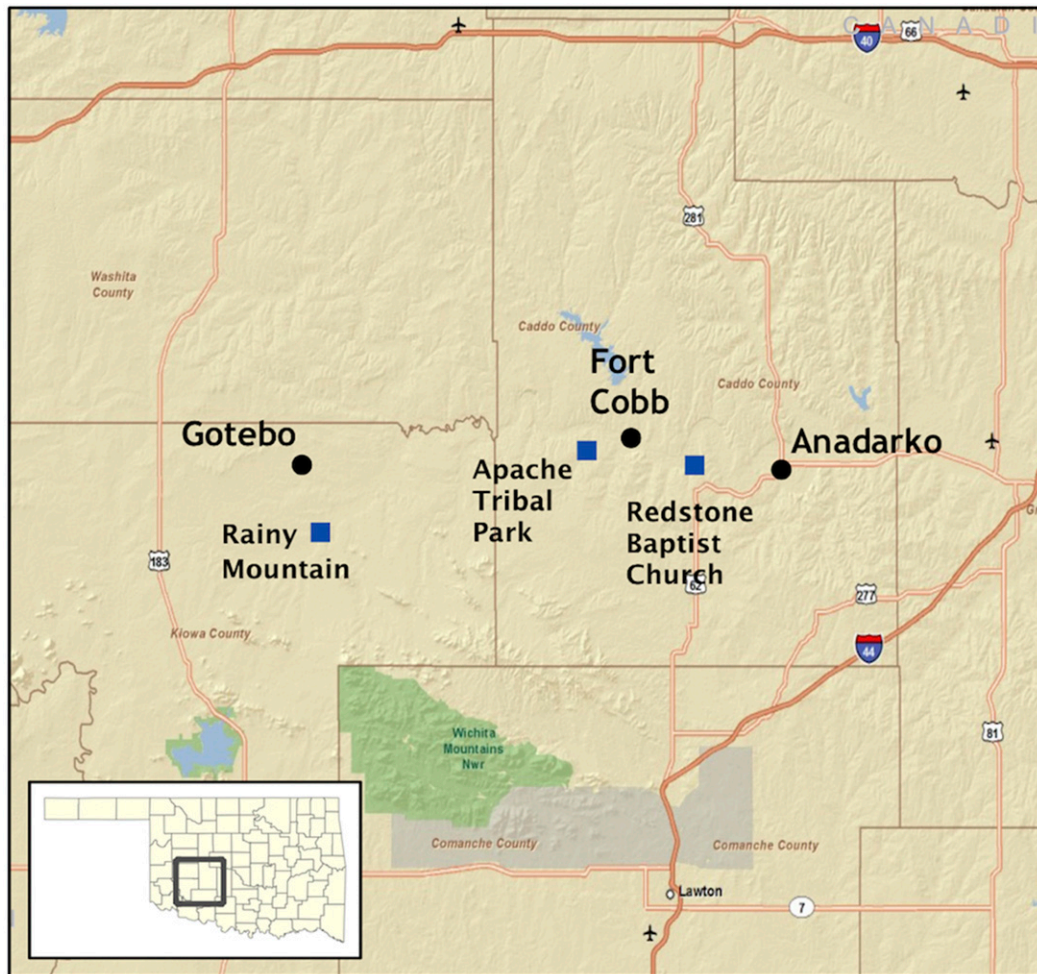


FIG. 1. Key sites of interviews and participant-observation experiences (from Pepler 2012).

local Indigenous people receive me? What will I say I am doing? What will I say is my purpose? How will I introduce myself?” Those embarking on such endeavors must plan it well, conduct it thoughtfully, and record it in detail so that it may stand the test of time. Nakamura (2010) suggested that researchers approach Indigenous communities from a learning perspective as a way to encourage open-mindedness and sensitivity. Researchers should be prepared and willing to refine their research questions based on their interactions; such strategies help limit misinterpretation and exploitation of Indigenous peoples. Coombes et al. (2014) recently reviewed approaches to participatory research with Indigenous peoples.

Sixteen semistructured interviews and related follow-ups were conducted and transcribed during 2009–11 as a primary form of data collection (e.g., Spradley 1979; Bernard 2006). Conversations lasted from 30 to 100 minutes. They were voice recorded with a digital device.

Extensive hand notes were taken during interviews to provide contextual nuance during interviews and typed as field notes. While interview guides can be rigid, they often are loosely followed, as was the case here as those interviewed were allowed to carry the discussion’s flow; when people wanted to talk, they did. “Chewing the fat” before, during, and after interviews sometimes elicited additional interesting information and allowed for unanticipated insights and issues to manifest (e.g., Crane et al. 2010). Interviews were transcribed by the author rather than contracted out in order to capture not only the words spoken but also those not spoken by remembering body language, facial expressions, and tones of voice. Johnson (2008) suggests that freeing oneself from the convention of disembodied researcher helps recognize and identify each person’s positionality so that all voices and ideas can be heard. This path provides space for all perspectives and voices to be heard, including in part through heavy use of direct quotation

(e.g., Crane et al. 2010). Transcript analysis involved coding, or applying labels to, each quotation (e.g., Patton 2002) to organize and sort ideas into common or emerging strains of thought [i.e., thematic analysis; Boyatzis 1998; see also Rowles (1978) for an example].

Eighteen participant-observation experiences took place during roughly the same period, including at meetings, conferences, agricultural workshops and training sessions, and tribal fairs and youth camps. Jackson (1983, p. 43) described the notion of participant-observation research as providing a method of inquiry to “transcend the epistemological gulf between ‘insider’ and ‘outsider’ status,” allowing the researcher a way of obtaining his or her data in ways that has meaning for everyone (see also Vidich 1955). A researcher can assume roles of “participant as observer” and “observer as participant” (e.g., Gold 1958). Many research-enriching conversations took place at these activities, providing additional material beyond what was heard during interviews. These activities helped allow me to establish a community acceptance, and extended my network of acquaintances. Data collection in these cases consisted of extensive field notes taken during and after each event, and photography when allowed. Various sites of interviews and participant-observation experiences are shown in Fig. 1.

Before fieldwork was allowed to commence, I was interviewed by four Kiowa agriculturalists in February 2009 as part of my entry into Indian Country, to discuss the motives and goals of the research project and how it might be beneficial to the people and communities who would be interacted with. Researchers should not impose themselves on Native peoples; as stated by Mihesuah (1998, p. 4), “Sensitive researchers know that if tribes are not willing to aid them they should abandon the project.” In September 2007, the United Nations adopted the Declaration on the Rights of Indigenous Peoples (United Nations 2008) that codifies language regarding the Indigenous right to maintain, control, protect, and develop traditional knowledge (Article 31, p. 11). Respect and ethical conduct are part of an Indigenous research methodology (Louis 2007) that holds that the research 1) must be accepting and advocating of the Indigenous knowledge systems uncovered; 2) must position the Indigenous community members and the researcher within the research (by making them collaborators, in effect); 3) must give regard to the needs of the community when devising the research agenda (i.e., research should not be conducted simply because someone receives a funding grant); and 4) must share the written results of the research directly with the community (and even allow the Indigenous collaborators to see and comment on drafts).

Nearly all interviewed allowed use of their names and quotation of their own words during the process of informed consent: the knowledge conveyed is theirs and should be attributed to them (e.g., Svalastog and Eriksson 2010). First names are used here. For those wishing to remain anonymous, anonymity was (and can be) protected by using pseudonyms. This study’s collaborators (as they are referred to henceforth) did not consider themselves “objects of study” or, as Institutional Review Boards refer to them, “human subjects.” Accurate attribution is important because Native Americans often have not been satisfied with the manner in which researchers have portrayed them (e.g., Mihesuah 1998; Svalastog and Eriksson 2010), either through cultural misrepresentation or intellectual theft; viable works with Native peoples must include their own voices and own versions of events, and not just history or culture as interpreted by others (e.g., Wilson 1998; Mihesuah 1998). Scholars who do not seek or listen to the stories are self-limiting their forms of evidence, analysis, and understanding (e.g., Fixico 1998). Mihesuah (2005) went so far as to suggest that it is racist to purposely omit using direct Native voices in such research. Following Watson and Huntington’s (2008) example, “we all produced this narrative” (p. 277).

4. Observations of change

The observations of change told here are categorized as referring to animals, plants, expected weather and seasons, and water resources. Additional weather and seasonal climate indicators described by the collaborators can be found in Pepler (2012) and all are documented fully in the author’s dissertation (Pepler 2011). Among such indicators are the building activity of beavers, the size of squirrel nests, the thickness of horse, cattle, and deer coats, and the gathering habits of squirrels and mice, all in relation to the upcoming winter; the behavior of horses and cattle and the gathering activity of ants before storms; the movement of turtles before rains; the blooming of mesquite as an indicator of the end of winter; the thickness of pecan shells and the size of walnuts in relation to drought; and observations of clouds and of sun and moon visibility as general indicators of upcoming weather.

a. Animals

Garrett, a Kiowa farmer, said he has noticed more armadillos on his properties, which he attributed to “heat down south,” causing them to move farther north. Milton, a Comanche rancher, said, “And the little horny toads—I haven’t seen many of them, I haven’t seen one in five years. Yeah, it worries me, and I don’t know what

the cause is.” Randall, a Kiowa farmer and extension educator, added, “And just like turtles in the pond year round without even hibernating, I’ve seen that going on out there. Our animals are confused.”

Some related how birds are remaining year-round. Milton said, “I have seen geese and ducks staying here year around where they used to migrate.” Ricky, a Kiowa farmer and conservationist, agreed, saying, “Even the birds—you used to could tell when the geese were coming how the weather was gonna be for the winter months. But even that has changed. You got birds staying here now that should have left. Even the animals don’t know what to do anymore. Our climate’s so much changed over the last 10 years.” Bob, a Chehalis and Chickasaw soil conservationist, said that he has noted more crickets and ants.

Rudy Jr., an award-winning Kiowa farmer and minister, commented on how his fishing has been affected. “You know what, I cannot really find any earthworms. A few years ago when you wanted to go fishing, you could go out almost any place in the area to dig up worms to go fishing. Now, where do you go to find these things? Do you need an earthworm farm or something?” He said that he now instead goes to the convenience store when he needs bait. He also said that crawdads are harder to find: “I used to go down to the creek to find those things and go fishing. You don’t see those things around here anymore. It’s just drier.”

Randall said that he can foretell drought by the beaver—if beavers are building a lot of dams, you can be confident there will be drought because they are pooling whatever water there is. Garrett said he had been observing dams on his property and found at least three of them, which portended drought. He said the beavers were chewing up his pecan trees for material for their dams. He said, based on this observation, “We are in a dry period!”

b. Plants

Rudy Jr. talked about the effects of change on pecan trees and plums. He said, “We have a pecan grove along the creek—hundreds of trees—and they make every other year. Right now this is the third year they didn’t make—the plums, this is their third year. We don’t understand.” About the causes, he said, “We don’t know if it’s the (lack of) rain or if it’s the land or if it’s the fertilizers—they’re nature and they come up by themselves. The plums never did come this year—no fruit. Kind of makes me wonder what’s going on, you know.”

Ricky also watches pecans and plums. He said recent drought in the past few years has meant fewer or no pecan and plum crops. On pecans, he said, “You could

look at the pecan shell—if that shell was thick you knew there was plenty of water and everything was going to be fine. But if you look at that shell now and how thin it is, that would tell you that weather conditions weren’t going to be good at all because of that.” For plums, Ricky indicated, “If that plum bush was going to be healthy our weather conditions were going to be good, we’re going to have plenty of water. But the leaves are small and don’t have that dark green color to them.” Ricky also described how walnuts used to grow to 3 inches in diameter (he gestured with his hand) but now they are lucky to reach half that size.

Dorothy, a Kiowa elder and traditionalist, provided some interesting remembrances of how things were related to plant abundance when she was young, in the 1930s and 1940s. She said, “Last year we got the big idea to hunt for choke cherries. They’re orange and they used to be mixed with a corn mixture that was like our dried meat patties that they carried—well, these were cakes. We had the hardest time finding those, and in my day they used to have bushes all over. And finally we found some up on the side of the road up by Fort Cobb.” She also related a story about what used to grow along the Washita River:

We’d go down to swim in the Washita River, as red and muddy as it is, and we’d have a muddy slide. On our way down you could always find something—they’d have a melon field and we thought nothing of pulling that out and breaking it in two, and they had those grapes that were little, not like the big winery grapes, there were little bitty wild grapes and everyone remembers them from my age group. (Dorothy called these areas “rich gardens.”) Even my mother used to make grape jelly with that. But you could pull a whole vine of them down and eat them. And there were a lot of wild plums. You just always knew where things were growing all over. And all of a sudden, I do not know what era, the weather just started not doing like it’s supposed to.

Conversations at a vegetable judging contest and other discussions about traditional foods revealed concerns about how climate variability is affecting the availability of culturally important plants used for food, medicinal, and ceremonial purposes, a concern shared by Indigenous peoples everywhere (e.g., Lynn et al. 2013; Bennett et al. 2014). Randall discussed efforts to save and mark culturally important seeds as one way to preserve tradition against change, which represents a form of food sovereignty. Garrett described community gardens that were to be planted in the spring, indicating it was important to be accountable to the people by way of providing for them and doing it in the most natural way possible. Randall stated, “We care about people and hungry families.” He mentioned the “Hobart Kiowa,”

who were growing organic vegetables and others who grew important herbs organically.

c. *Expected weather and seasons*

Ricky described how expected seasonal changes are not happening. He said, “The winter months—I remember snow this deep (gesture) but now you’re lucky to get an inch. Or even if it snows at all. You used to depend on that, and the sleet, the snow. But it’s no more.” He also mentioned rain patterns: “Even the rain patterns have changed—they used to say April rain brings May flowers or something like that—but even that has changed. We don’t even know anymore—the weather patterns have changed.” He also quipped about El Niño, “Who ever heard of that 20 years ago?” Larry, an aspiring Delaware farmer and businessman, said that he remembered more snow in the 1960s (with drifts in feet) and more ice storms now, with this trend beginning in the 1970s, though the last couple of years have been snowier. Maya, a Kiowa, Comanche, and Wichita traditionalist, told me about the increasing frequency of ice storms. She said, “I have noticed the ice storms getting worse. They are so much worse. Out here on the plains it’s not the blizzard that’s the problem but it’s the ice that forms. I’ve noticed those in the past four years. We used to have like one every five or six years, now it’s two a year. That’s what I’ve noticed.”

Sandy, a Muscogee (Creek) farming program administrator, talked about hailstorms coming out of season. She said, “Back in February 2009 there was this hailstorm, and that’s considered winter. We heard this noise almost like a train that loud in the basement. After that was over it got real quiet and we all came up—the ground was covered with hail, just like snow. We had hail damage on our cars and so forth but that was really unusual to have a hailstorm in February.”

Alan, a Kiowa rancher and instructor, described increased variability: “In the past ten years it’s been bad, it’s been odd, it’s not the same. Ever since they talked about the ozone layer, it’s showing. Sometimes we get more rain than we need and then we get less, it’s not balancing out like it should be. Then our heat—it’s getting warmer. And sometime it gets cold, it’s odd.” He added, “It’s a little bit more unpredictable because the way the climate is changing.” Maya also talked about increasing summer heat: “The heat, I don’t ever remember it being this hot. We used to spend summers out at Fort Cobb Lake, and I don’t ever remember it being this hot, being so hot for so long.”

Dixon, a young Kiowa farmer, remarked generally on changes in expected patterns. “Last year is totally different from this year. It’s all changing. It used to be winter would get cold and you’d have a snow, springtime it would be wet, summertime would be summertime.

Now they’re having tornadoes in the fall, everything is starting to mix up, the weather is changing, the atmosphere is changing. And it’s hard to deal with stuff like that anymore. It isn’t like it used to be.” He talked about the previous winter: “Last year we had that blizzard and all that ice—we hadn’t seen anything like that in years. And the year before that it was completely dry—no snow, just cold and dry. Drought in the wintertime!” On unpredictable summers he said, “Then it will be a wet summer—we got like 16 inches when we had that last hurricane come through (summer 2010). And that other summer (2007) we had two months of nonstop rain—I lost 400 or 500 acres of hay and that about put me about of business, most of that was custom work—I didn’t work for two months. You talk about hard. But, once it dried up we had the best hay season we ever had.” Richard Jr., a Kiowa traditionalist, also commented on tornadoes, saying “Years ago there was like a set pattern—tornado season was from March to May. But now it’s just anytime. It just doesn’t give you time to react anymore.”

Dorothy provided an interesting observation about rain from her childhood days, saying, “My earliest recollection—we always had so much rain, but it wasn’t this nasty kind (like we have now). It was the kind that it would rain real pretty and I remember even swimming in the road ditches, the water was abundant. We had abundant rain, sometimes it would feel so good because the drops were big and there would be no thunder and lightning.” She also said there were more rainbows when she was young.

d. *Water resources*

The effects of climate variability on water resources available to Indigenous populations have been documented (e.g., [Cozzetto et al. 2013](#); [Bennett et al. 2014](#)). This study’s collaborators have observed impacts as well. Randall has noticed changes in water resources. He said, “Our water table is being affected by this climate change. Our creeks are drying up. It’s because our water table is low—they say because the farmers irrigated coming out of our aquifer, but it’s not, it’s from the change in the weather.” He said that farmers in the area do not irrigate as much as they used to since there are fewer peanut farms. Alan said rivers have fallen so low that “you can walk through them.” He also said some springs have dried up. He mentioned how fishing has gotten worse because the water temperature is higher than it used to be. Wallace, an Apache rancher, farmer, and retired schoolteacher, also mentioned a loss of water resources.

5. Effects of change on observational methods

An important consideration here, which the collaborators echoed, is how climate change is rendering some

of their observational indicators less reliable. As told, this is manifested mostly as confusion in animal behavior and in unreliability of once-assumed weather patterns and seasonal changes. Anecdotal evidence from other places in the world suggests this as well (e.g., [Turner and Clifton 2009](#); [Majoros 2010](#)). Some remarked about the increasing unreliability of animal signs. Randall summed it up, “You know what, I see that even the animals are confused because of our change. Our world is sick.” Ricky added, “All the signs that told the conditions about the weather that people relied on are no more. But even the animals don’t know anymore. I don’t even know if they could tell anymore.” He described how the animal signs that his father used, like the gathering habits of beavers, the thickness of the fur on a deer’s chest, and the nest building characteristics of squirrels and birds for determining the severity of the upcoming winter, and observations of horse behavior before an impending storm seemed less reliable than in the past. He closed, “The animal knew.”

Wallace remarked that although he “wouldn’t put money on it” (watching the animals), he thought animal signs are being lost due to change. He said, “My grandfather used to tell us how about the birthing of wild animals—if they are birthing early or late, it will have an effect on the early winter.” He went on, “Some animals like squirrels will get a growth of hair, but it’s been hard for me to detect. The animals that were in his era are not in my era. It’s changed. There’s not as many squirrels here as there used to be to look at, to study. I suspect that my grandfather studied that, whatever he could see or looked at.” Regarding his own farm animals, he said, “I’ve watched my cattle to see how they act, but I can’t detect if there’s changes.”

Ricky commented, “You really can’t go and look at the nuts or the pecans or the walnuts and see how the shell was, to tell what was going to take place or what was going to happen because it’s all messed up.”

During opening remarks at the International Summit on Indigenous Environmental Philosophy (2010) at the Redstone Baptist Church, the then chairman of the Kiowa Tribe described that weather and climate patterns have changed. While his people (in particular, his grandparents) used to be able to predict the weather, they cannot now, as change has already taken place ([Indigenous Environmental Philosophy 2010](#)).

6. Agricultural adaptations to change

Some offered insights on how they have adapted to the changes observed. Garrett has made changes in his wheat farming based on his perception of first freezes not happening until later in the fall. He said, “We’ll

plant our crops (wheat) later in the fall, close to November, because we learned that if we planted too early we got failed crops. The late freezes hit the early crops and killed them, and we lost those. The ones that were planted late hadn’t come out yet, so after the cold spell went by they started sprouting out.” Rudy Jr. corroborated, saying, “That’s how we saved our wheat—we planted 30 days later—the frost didn’t get to our seeds.” Dixon described his strategies to combat recent later spring freezes: “We always plant in early spring, and usually we try to get in after a freeze. Last year we had planted some crops already and it was April, and then we got a late frost. A late frost, that will put you out—it sets everything back, it will kill everything. So this year we were scared to plant anything until at least May 1.” He added, “The cold winter set everything back—we didn’t get our first cut of Bermuda grass until June 1, and we’re supposed to have it in the middle of May.”

Ricky talked extensively about how increased climate variability is making it harder to plan. He said, “Weather plays a vital role in what you’re going to do. All the farmers would plant if they would know what the future was going to hold—are we going to have a drought this year or floods? It’s too unpredictable—we really don’t know—we can have an idea of what might take place, but it’s just a gamble.” He admitted that he may have to rely more on television weather to forecast. He added an interesting thought on taking control of nature: “It’s about taking chances anymore and going on your best intuition—we can’t rely on nature anymore because nature doesn’t know what to do anymore. We’re going to have to rely on man-made abilities for our crops—because we’re going to have to rely on irrigation systems to put water out. We’ll have to make our own change of weather ourselves.”

7. Relevance of change

The contemporary relevance of the impacts of climate change on Indigenous peoples is manifesting itself in various ways, including in public discourse and awareness. In *Facing the Storm: Indian Tribes, Climate-Induced Weather Extremes and the Future for Indian Country*, the [National Wildlife Federation \(2011, p. 2\)](#) reported, “The high dependence of Tribes upon their lands and natural resources to sustain their economic, cultural, and spiritual practices, the relatively poor state of their infrastructure, and the great need for financial and technical resources to recover from such events all contribute to the disproportionate impact on Tribes.” *Conversations with the Earth: Indigenous Voices on Climate Change (CWE 2009)*, viewed by the author during summer 2011 at the Smithsonian Institution

National Museum of the American Indian, is a multimedia exhibition exploring the impacts of global climate change from the perspective of many tribal communities across the world using photography and community-created participatory video and audio recordings. It was said to be the first exhibit of its kind to highlight Indigenous science and examine how Indigenous communities are disproportionately affected by climate change. The Native film series *Injunuity* suggests that we should look to Native wisdom for guidance on environmental issues, including a changing climate, as shown in particular in its short film *Turtle Island* (Injunuity 2013).

According to most in this study, climate change is a real phenomenon perceived at the local scale that is impacting their ability to observe relied-upon indicators, and has caused them to make changes in their agricultural endeavors. Generally, it was conveyed that weather and climate have become less reliable or predictable with respect to occurrences such as normal seasonal changes or expected rains, with perceptions of more drought and heat, and less snow but more ice—a general feeling that the climate and its weather have become more variable overall. It is interesting to note here that they, much like Ingold and Kurttila's (2000) reindeer herders, perceive seasonality mostly as a phenomenon of experienced weather (the recurrent rhythms of plant growth and animal movement and their effects on everyday life) rather than as a phenomenon of recorded climatology (the record of averages and fluctuations of atmospheric attributes without particular regard to effects on the lives of plants, animals, and humans). To the agriculturalists, fall begins or is close when the indicators tell them so.

The previously described perceived unreliability of once-trusted observational signs, seen as a concern, is forcing the agriculturalists to adjust their insights about them in light of changes and variability that has been perceived—a form of adaptation. This, however, is causing them to consult or value scientific weather and climate information more than they may desire, as most expressed some level of distrust of climate change science and particularly a few of its messengers (see later). Crane et al. (2010) described how farmers' attitudes toward climate predictions, including beliefs and feelings, are as important as comprehension when it comes to believing or using climate information (e.g., McCrea et al. 2005) or relating culturally or socially to the messengers of information (e.g., Arbuckle et al. 2015). Jennings' (2002) study of northern plains farmers concluded that cultural meanings about climate change are derived from the everyday experiences in which peoples' values and beliefs about themselves and others are formulated, with climate conceptualized as a context or

filter for ecological experiences and perceptions that can influence decision-making. Ingold and Kurttila (2000) found that the cognitive disconnect between the climate understandings of Sami reindeer herders and climate scientists rendered useless efforts by those scientists to convert climate change predictions into information relevant at the local level. Pennesi (2011, 2013) found similar disconnects between rain prophets and government predictions in Brazil. The point here is that most of the collaborators experience a similar disconnect between their own experiential relationship with climate variability and scientific conceptualizations of climate change.

Reasons expressed for a changing climate ranged from man-made causes to natural cycles to God's will. Among man-made causes were air pollution (ozone was cited several times), general human overconsumption, a thirst for fossil fuel energy, and even the planting of trees to act as shelter belts to the winds in the area in the 1930s, which Larry thought might be responsible for some of the changes noticed. Others described change as being part of a natural cycle or rhythm, while one said it is simply "what you believe." On changes in general, Ricky said they "are not made by nature's problems, but all man-made stuff. Our nature wants to change (compensate) but we're not allowing it." Stuart, a Wichita traditional gardener, agreed, believing it is obvious: "Everything is human influence. We're supposedly the thinkers and the smartest ones able to do anything, and yet we're the ones destroying the trees and straightening creeks and all that kind of stuff." Garrett blamed air pollution, echoed by Milton and Rudy Jr., "All these chemicals that's been put into the atmosphere, this ozone and all this—the man-made chemicals sent up into the air have been destroying the atmosphere. All this stuff going up there is deteriorating the ozone layer and getting into the weather systems." On overconsumption, Maya said, "Everybody in this society—it's 'We want it and we want it now'—it's that take-out and to-go drive-through culture. If you don't have your energy, if you don't have your electricity right here and right now, people will be mad." Sandy described the nuance between climate change and global warming: "The reason I referred to it as climate change rather than global warming is because we've been having excessive cold times that may even out the warm times. So for that reason I don't know it's truly a warming—it may average out to close to what it's been but yet it's at extreme rates right now." But, Dixon remarked, "It's just what you believe. We don't know what this world's going to do. You look at a book—the geologists say this happened before we even started. Well, how do you know? Just because you find some dinosaur bones, or an asteroid hit the earth. There are always certain people

who think we're all producing global warming—I think it's all just happened." Milton is not sure what is happening, either, but believes we can reverse the trend by getting away from fossil fuels: "We do need to develop other green energy and protect our planet more. I think that's a good solution (wind turbines)—I think the geothermal is good—anything that is renewable, whether it's for electricity or biodiesel or fuels—as long as it's a green product that is renewable then I don't see anything wrong with that."

Some indicated that before they can form an opinion on the public discourse, they need more information. Milton said, "I listen to them (climate scientists) but my opinion is still out, because I need to see more. But I'm afraid of what I'm going to see." Rudy Jr. indicated, "(The debate) gets my attention and I listen to it but other than that I don't really care." Stuart said similarly, "I listen to them (climate scientists), probably not as much as I should. I read things in the paper and listen to a lot of what they talk about." Others, like Sandy and Maya, are surer that the scientists are right. Sandy said, "I've watched CNN to keep up—I think they (the climate scientists) may have something there. I don't think they are just cuckoo or have their own agenda. I think they are studying and trying to tell us, just trying to relate information to us." Maya added, "I only know as much as I hear and read. You hear people in our state say there is no global warming. And that to me is just ridiculous because there is scientific evidence that, yes, there is. I do believe it is man-made, because if my grandma was still around she would probably agree with me that it was never this hot—that would be going off of her information." Maya provided a telling anecdote on the disconnects in conceptualizing climate change: "There is a lady that we call Grandma Dorothy (this study's collaborator Dorothy), and she says the same thing—she doesn't remember it being this hot running around in this area when she was a little girl. But then if we asked her about global warming she'd be like, 'What do you mean?' She wouldn't understand that part." Others, like Wallace, do not like some of the messengers of climate change. He said, "As far as climate change, that guy Al Gore, he's been made a millionaire off of that. I don't believe him—he used a lot of words that were new to people, new to me, too, about weather and changes, about polar caps and how they are melting, how it's going to do this or that. Shoot, I'm not going to waste my time to follow him."

8. Summary and conclusions: Indigenous knowledge formation

The knowledge professed by this study's collaborators [some of which was documented in [Pepler \(2012\)](#)] can

be placed within the larger context of Indigenous environmental knowledge formation studies, as this knowledge follows closely that discovered through archival research for this study ([Pepler 2010, 2017](#)) and that described by other research efforts that have taken place around the world. It suggests and augments a cultural model of knowledge formation developed by [Paolisso \(2007\)](#) from his study of Chesapeake Bay watermen's reasoning about blue crab management and applied by [Lazrus \(2009\)](#) in her study of the perceived vulnerabilities of people living on the Pacific atoll of Tuvalu as the risk of sea level rise caused by global warming increases. These models help describe the tacit understandings people have about the world around them, and provide insight on how people perceive, remember, and describe natural features and how they understand, utilize, and manage natural resources and their surroundings. From a research perspective, these models can serve as a heuristic tool to enable explanation of a knowledge system. A compilation of Indigenous knowledge characteristics can be found in [Bonny and Berkes \(2008\)](#).

Knowledge expressed by this study's collaborators has deep intergenerational origins involving family members as conveyed through story telling or actual demonstration [e.g., [Suzuki and Knudtson 1992](#); [Grenier 1998](#); [Berkes 1999](#) (Canada); [Menzies and Butler 2006](#) (Canada); [Lauer and Aswani 2009](#); [Lauer and Matera 2016](#) (Solomon Islands); [Lefale 2010](#) (Samoa); [Green et al. 2010](#) (Australia)]. It possesses a social memory that values and preserves insights from the past as a way to remember and maintain traditional ways (e.g., [Mistry 2009](#)). While many told me of knowledge passed down, many lamented not asking more questions of elders now passed.

Knowledge expressed represents culturally valued and situated ways of knowing. It is the result of its embedding within a particular cultural situation or context [e.g., [Antweiler 1998, 2004](#) (Indonesia); [Cruikshank 2001](#) (Canada); [Mercurieff 2002](#) (Alaska); [Henshaw 2003](#) (Canada); [Menzies and Butler 2006](#); [Ford et al. 2006a,b](#) (Canada)] that often is part of a received understanding of how the world works (e.g., [Grenier 1998](#)). These ways of knowing hold special relevance to the people who have taken ownership of them as unique to their situation.

Similarly, there is a localness to the knowledge expressed—place-based, long-term, experiential, repeated and therefore regenerative, based on recognized patterns and cycles observed by virtue of inhabiting a place [e.g., [Steward 1955](#); [Nietschmann 1972](#) (Nicaragua); [Huber and Pedersen 1997](#) (Tibet); [Antweiler 1998, 2004](#); [Grenier 1998](#); [Berkes 1999](#); [Maurial 1999](#); [Nazarea 1999](#); [Ingold and Kurttila 2000](#) (Finland); [Orlove et al. 2002](#) (Peru/Bolivia); [Roncoli et al. 2002, 2003](#) (Burkina Faso); [UNESCO 2003](#); [Pennesi 2011, 2013](#)]

(Brazil); Lauer and Aswani 2009, Lauer and Matera 2016; Orlove et al. 2010 (Uganda); Ifejika Speranza et al. 2010 (Kenya); Lefale 2010]. It is knowledge that can be difficult to separate from the places that give it meaning [e.g., Basso 1996 (Arizona); Cajete 2000; Preston 2009]. This component of knowledge provides a situational awareness about a place, producing an intuition or wisdom needed for recognizing what to look for and how to react to it that might not be obtainable from other sources of weather and climate information. Continued observation makes it dynamic and therefore adaptive (e.g., Turnbull 1993; Grenier 1998; Huber and Pedersen 1997; Berkes 1999; Ingold and Kurttila 2000; Menzies and Butler 2006; Lauer and Aswani 2009; Lauer and Matera 2016; Turner and Clifton 2009).

Knowledge in this instance is nested within a belief system that suggests humans should possess a closeness and intimacy with the nonhuman world and should exercise respect and reciprocity when engaging with it; there is no separation between the human and nonhuman world. This component has been described as holistic and sacred (e.g., Suzuki and Knudtson 1992; Lake-Thom 1997; Maurial 1999; Semali and Kinchloe 1999; Kidwell 2002; Menzies and Butler 2006; Deloria 2006) and recognizes natural cycles and patterns in terms of relationships involving humans and nonhumans. Cruikshank (2012, p. 245) describes this as “animals, humans and even features of landscape [e.g., glaciers] have points of view, exhibit agency, and engage in reciprocal responses.” This philosophy plays strongly into desires to maintain ways of the ancestors such as notions of weather and climate.

Finally, the knowledge revealed is socially mediated. As described by others, the culturally situated and place-based contexts of Indigenous knowledge are best understood as products of both the social relations among humans and between the human and nonhuman worlds [e.g., Rundstrom 1995 (Arctic); Antweiler 1998, 2004; Cruikshank 2001; Jennings 2002; Ford et al. 2006a,b; Crane et al. 2010]. The agriculturalists described typical days in which information was sought from official sources, then socialized at morning coffee gatherings. It was then modified by personal weather observations while out in the fields, and observations of what other farmers were doing, forming a situational awareness or insight that might lead to modification of the day's plans and activities—an actionable knowledge [e.g., Toledo 1992 (Mexico); Berkes 1999] put into daily practice that adjusts as time passes to reflect changes in climate conditions, new information, and new practices.

In the end, the observations described in this paper could serve as guidance for future research on climate variability. In such research there is focus on seasonal,

annual, and multiyear trends. Perhaps focus could instead be on extremes and significant thresholds such as first onset fall frost, which seem to be the main types of concern of the collaborators in this study. Such occurrences affect their decisions on the land, perhaps more so than what might be noted as trends.

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