Historical Drought Events of the Great Plains Recorded by Native Americans

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ABSTRACT—We identified prolonged dry (or drought) events during the 1777 to 1869 interval that were depicted in Native American annual pictographic records (winter counts) from several documents for a retrospective analysis with supplementary data and information. Based on available information related to the keeper (author) of the winter count, we approximated the locations of the drought episodes. Based on the locational information, we retrieved and reviewed historical temperature and precipitation data observed at US Army forts during the time interval of the winter count–documented drought episodes. Additionally, we examined Palmer Drought Severity Index data from the *North American Drought Atlas*, which includes annual drought estimates reconstructed from tree-ring chronologies, for the years and location of the documented droughts. We spatially and temporally compared the Native American drought-related winter counts to the available weather, drought information, and other ancillary information in an effort to cross-validate these relatively sparse and disparate historical climate records. Generally, we found the Native American observations of prolonged dry intervals were in agreement with other observations or available documentation. Thus, winter count observations of other climate-related events may provide an additional source of information for other historic climate analyses.

Key Words: climate, drought, Great Plains, Native Americans, weather observations, winter counts

Introduction

The sparse availability of historic instrument-based observations limits the identification and characterization of historic drought events (Woodhouse and Overpeck 1998). The "modern" observations of weather and climate in the Great Plains began in the early 1800s and were made at forts established by the US Army (e.g., Lawson 1974; Grice 2005). The majority of the observations, however, began in the mid- to late 1800s (Midwest Regional Climate Center 2014a). Boustead (2014) demonstrated the potential usefulness of ancillary documentation of weather events to provide contextual and locational information about historical weather events. An analysis of the winter of 1880–81 in the northern Great Plains and upper Midwest of the United States, as described in Laura Ingalls Wilder's novel *The Long Winter*, generally agreed with and provided contextual information not available from the recorded weather observations. As suggested by Boustead (2014), "disparate data sets and qualitative information must be combined in a meaningful way to create an accurate description of the weather and climate events while also retaining their unique historical perspectives."

Native Americans of the Great Plains began annual documentation of significant events as early as the late 1600s (e.g., Howard 1976). These annual records of events, while often including significant deaths of tribal members, encounters with other tribes, and in later years, their encounters with early settlers of the Great Plains, would occasionally include weather and climate events (Therrell and Trotter 2011) such as prolonged dry intervals.

While originally thought to have begun as oral histories (Burke 2007), these records evolved into drawings or pictographic records of the significant events of each year (e.g., Figure 1). The pictographic records were called "winter counts" because they documented

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Figure 1. Native American paints a winter count on a buffalo skin (National Anthropological Archives 2014a). Each individual drawing or pictograph represents a significant event that occurred in the past year.

the major event of the year that occurred generally between the first snowfalls of each successive year. Thus, due to the span of a winter count year, a recorded event could have occurred in one of two years of our current calendar system. The winter counts were thought to have been documented by a tribal historian (winter count keeper) who would consult with a council of elder men to choose the single event of the past year to add to the winter count (Burke 2007; Sahley 1969). Several of the winter counts were maintained beyond the lifetime of one keeper, and the winter count maintenance was frequently passed down to male relatives of the original keeper (Burke 2007).

Within this study we reviewed the US Army weather and climate records and Native American winter counts, and we also reviewed historical drought information derived from tree-ring chronologies (Cook and Krusic 2004). In addition, we examined previous studies of historical drought or precipitation in the Great Plains (e.g., Lawson 1974; Mock 1991) for overlap of the timelines or spatial locations with the winter counts included in this study. We also reviewed available documents from the Commissioner of Indian Affairs (e.g., Office of Commissioner of Indian Affairs 1856) that have been found useful in historical drought analyses (Thomas 2014). We reviewed these documents for comments that were occasionally made on the past year's weather experienced within jurisdictional territories.

While there are several definitions of drought (NOAA 2012), due to the nature of this study and available data, the term "drought" is used herein to broadly represent prolonged dry events observed by Native Americans. Thus, within this study we examined the documented drought events included in several Native American winter counts, and to the extent possible, compared the spatial and temporal characteristics of these drought events to other available documentation of these events. Our overall objective of this study was to review potential resources for cross-validation of these disparate sources of historical climate information in an effort to provide a more thorough understanding of these historical climate events.

Methods

We initially reviewed winter counts for documented events of prolonged dry weather or drought from the 1700 through 1880 time interval. We reviewed over 20 winter counts that were included in five printed or online documents. This interval included the timespan of two of the winter counts of greatest duration: the John K. Bear (Howard 1976) and the Battiste Good (National Anthropological Archives 2014b) winter counts. We used several key words to identify prolonged dry weather or drought conditions within the interpretive text that accompanied the winter counts. These key words included "drought," "dry," and "famine," or additional statements or references to generally prolonged dry conditions. Documentation often included both a pictograph and a textual interpretation of the pictograph (e.g., National Anthropological Archives 2014b). In some instances only a textual statement as was available, as for the John K. Bear winter count (Howard 1976).

We based the timing of observed events on reported years associated with the winter counts. The years of the events associated with the winter counts are "calibrated" based on common observations among the winter counts of the Leonid meteor shower in 1833 (Therrell and Trotter 2011). It is possible, however, that there were years during which a winter count was not recorded. Thus, there may be errors in the estimation of years associated with specific events.

In addition to the timing of winter count events, we approximated the location of the events as needed. We based the location of the observed winter count on specific references to landmarks or locations within the winter count or accompanying text. We also consulted, as available, ancillary documentation, including maps, that described tribal locations over time (e.g., Mooney 1898; DeMallie 2001). Winter counts that were related to prolonged dry (or drought) conditions are included in Table 1 (in chronological order), with references to the source document that mentioned the event and its approximate location.

We evaluated the locational information of the winter count keeper(s) during the year of the recorded drought events (Table 1) for availability of ancillary information related to the observed climate conditions for that location and time interval. We retrieved US Army fort weather observations, *North American Drought Atlas* data (Cook and Krusic 2004), and available comments included in the reports to the Commissioner of Indian Affairs (e.g., Office of Commissioner of Indian Affairs 1856) as available for comparison with the winter counts that depicted or reported prolonged dry or drought conditions.

While the *North American Drought Atlas* data and graphics (e.g., Figure 2), for 2.5° × 2.5° regions, were available for each of the drought events included in Table 1, weather observations or additional ancillary infor-

TABLE 1. Year(s) of prolonged dry or drought events, according to winter counts.

Event year	Winter count keeper	Winter count interpretive statement	Reference	Location	PDSI value (Cook and Krusic 2004)
1777–78	John K. Bear	"Severe famine this year"	Howard 1976	Northeast South Dakota	–1.350
1787–88	Cloud Shield	"They lived on roots."	National Anthropological Archives 2014b	Southwest South Dakota	–5.425
1799–1801	High Dog, Swift Dog, Blue Thunder, Long Soldier	"Time people were on prairie. No water."	Howard 1960, Praus 1962, National Anthropological Archives 2014b	Southwest North Dakota	–3.079
1808–9	Long Soldier	"Hunting buffalo during famine while Indians were starving"	National Anthropological Archives 2014b	Southwest North Dakota	–4.384
1813–14	Cloud Shield	"Food was very scarce and they had to live on acorns."	National Anthropological Archives 2014b	Southwest South Dakota	–2.446
1818–19	Long Soldier	"Called sand blowing year"	National Anthropological Archives 2014b	Southwest North Dakota	–4.382
1829–30	John K. Bear	"There was a severe famine."	Howard 1976	Northeast South Dakota	0.452
1848–49	Blue Thunder and others, Long Soldier	"No good hay this year"	Howard 1960, National Anthropological Archives 2014b	Southwest North Dakota to Northeast South Dakota	–4.529
1854–55	Little Bear	"Summer of sitting"	Mooney 1898	Western to Central Kansas and Oklahoma	–5.843
1868–69	American Horse, Cloud Shield	"People were starving and had to sell many mules and horses."	National Anthropological Archives 2014b	Southwest South Dakota	–0.797

Note: PDSI = Palmer Drought Severity Index

mation were not as readily available. Weather data were only available for the 1854–55 and 1868–69 events at US Army forts located in the general vicinity (within 150 km) of the regions of documented dry weather conditions for those events. Similarly, we found that reports to the Commissioner of Indian Affairs were only available for the Great Plains for the 1854–55 and 1868–69 events. Thus, we evaluated the events prior to 1850 (Table 1) using only the available tree-ring chronology data, while the two events following 1850 were analyzed with the tree-ring data and other available information.

Results and Discussion

Events of 1777 through 1849

We compared each of these prolonged dry condition or/drought events to the tree-ring reconstructed summer Palmer Drought Severity Index (PDSI) data (Cook and Krusic 2004) for cross verification of the event's occurrence. The PDSI is a hydrological accounting method to assess drought that utilizes temperature and precipitation observations to derive antecedent precipitation, as well as moisture supplies and demands, to estimate drought severity (Palmer 1965; Heim 2002). The PDSI values for the gridded region(s) located within or nearest the estimated location of the documented winter counts for each event are included in Table 1. We considered the potential inaccuracy in the estimated year of the reported drought events through selection of the largest negative PDSI value within the interval of one year before the reported starting year of an event through one year after the ending year (Table 1). A region is considered to be experiencing *mild* drought when a PDSI value of –1.00 to 1.99 is observed, *moderate*

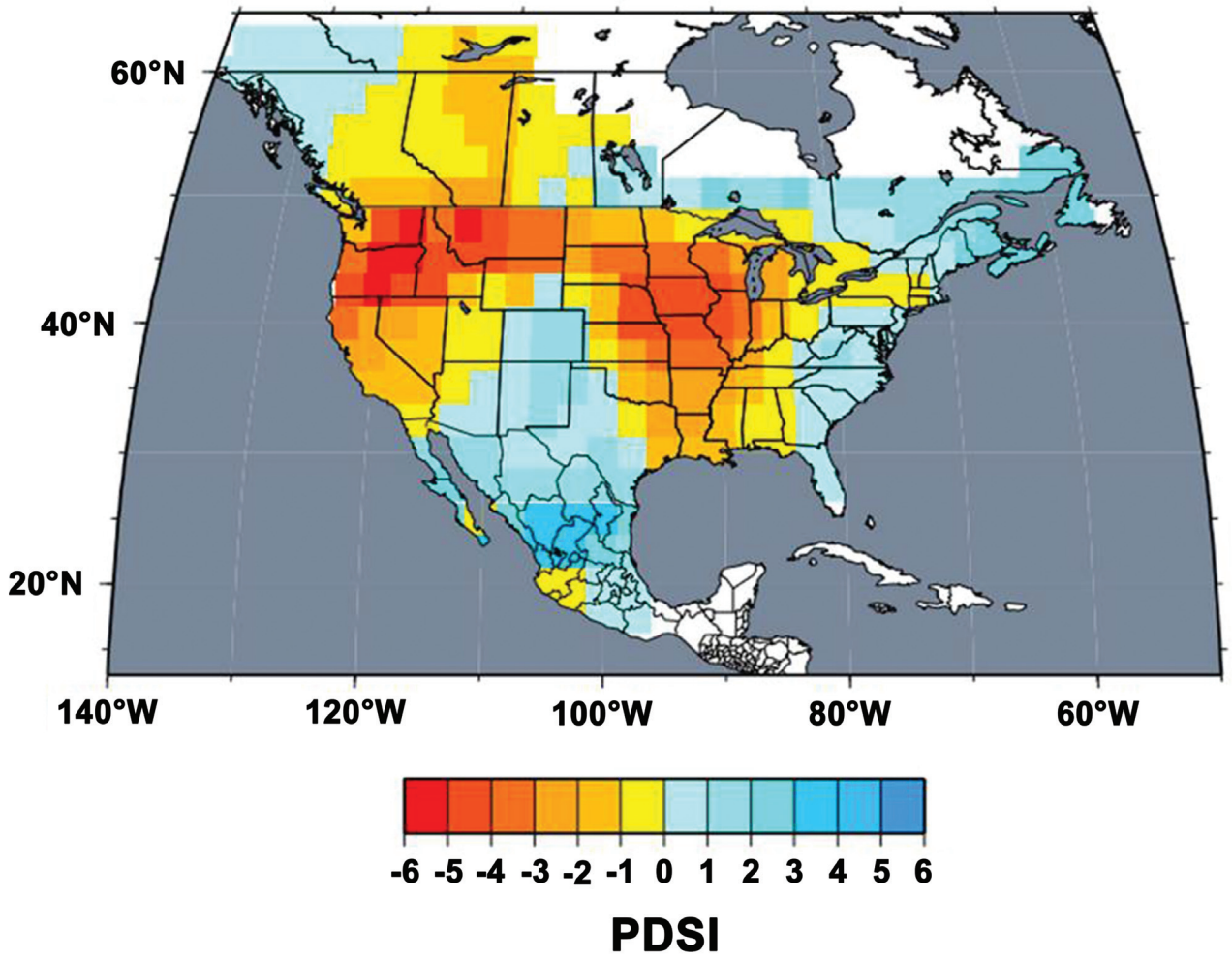

Figure 2. Palmer Drought Severity Index (PDSI) map for 1800 (Cook and Krusic 2004). Negative numbers and associated colors indicate drought conditions.

drought for PDSI values of –2.00 to –2.99, *severe* drought for PDSI values of –3.00 to –3.99, and *extreme* drought for PDSI values of –4.00 or less (Palmer 1965).

Seven of the eight events through 1850 displayed negative PDSI values, and each of the seven with negative PDSI values exhibited values indicating a mild (or more intense) drought (Table 1). We classified the 1799–1801 (Figure 2) event as a severe drought and we classified the 1787–88, 1808–9, 1818–19, and 1848–49 events as extreme droughts. The 1829–30 event, which did not meet the PDSI threshold of –1.00 for mild drought, was selected for study (as were other events) under the assumption that the interpretive statement related to scarcity of food or famine was indicative of a drought. While drought would certainly be a plausible explanation for scarcity of food, there may have been other factors that contributed to the lack of food (e.g., pest or disease infestations).

Event of 1854–55

This event, as recorded by Little Bear (Mooney 1898), occurred during the summer of 1855. Based on documentation provided by Mooney (1898), it is believed that the Kiowa were located in the region of Southern Kansas and Western Oklahoma at this time. This event was associated with a PDSI value of –5.843, which would indicate an extreme drought. The documentation associated with the pictograph of this event (Figure 3) included the translation of original text to "Summer of sitting with legs crossed and extended" (Mooney 1898). Additional statements included that "There was no sun dance this summer. The weather was extremely hot and the grass dried up, in consequence of which the horses became so weak that when traveling the Kiowa were frequently obliged to halt and sit down to allow the animals to rest" (Mooney 1898).

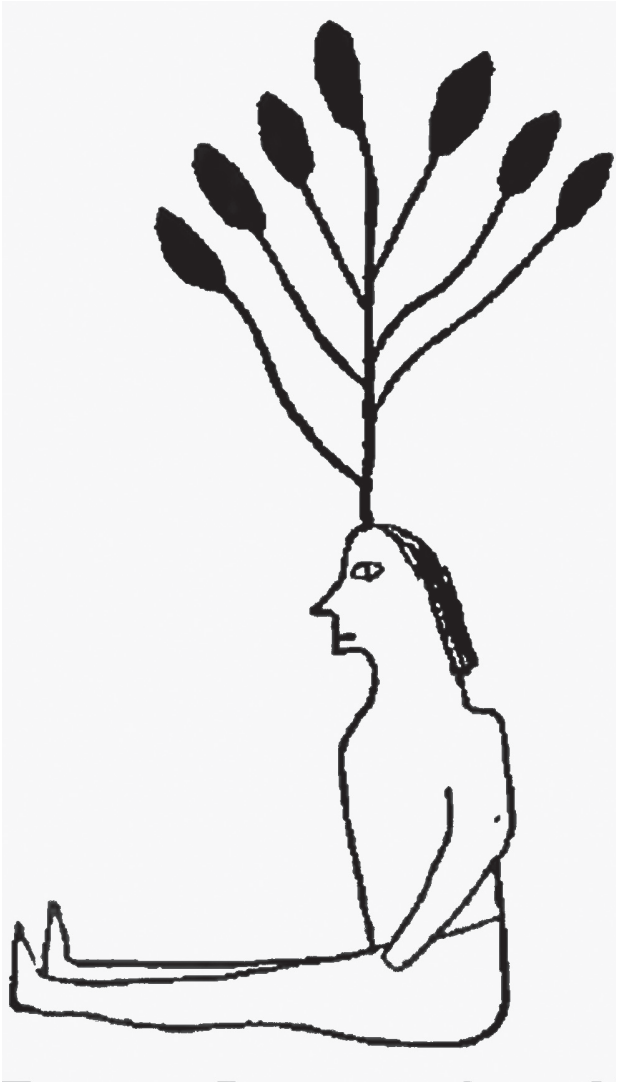

Figure 3. A winter count pictograph for the 1854–55 interval attributed to Set-tan "Little Bear" of the Kiowa tribe (from Mooney 1898). The winter count title was translated as "Summer of sitting with legs crossed and extended."

Mock (1991) found evidence of drought conditions nearby, within eastern Kansas, during the fall and winter of 1854. Daily temperature and precipitation data obtained from Fort Gibson, Oklahoma (Midwest Regional Climate Center 2014b), indicate that of the three years centered on 1855, the greatest mean daily temperature (recorded at approximately 9 pm) between May 1 through September 30 was observed in 1856 (Table 2). Our analysis of precipitation data recorded between May 1 and September 30 indicated that 1856 was the driest of the three years (26.7 cm), followed by 1854 (29.7 cm) and 1855 (52.6 cm, Table 2). We estimated that the normal precipitation for the May 1 through September 30 interval in this region is 57.6 cm. This value was computed from currently available monthly data of the 1981–2010 interval for Oktaha, Oklahoma, which is located within 30 km of the location of Fort Gibson (NOAA 2014). This value, however, may differ from the normal precipitation values of the mid-1800s. The PDSI data for the individual years indicate that the greatest severity of the drought was in the summer of 1855.

The apparent contradiction in results for this event between the PDSI and historic precipitation data, while not expected, could not be dismissed as an error within the observations. Although the climate data for Fort Gibson indicates this was the year with the greatest precipitation, summer precipitation events can be associated with individual storm cells that are often focused on small spatial areas. Thus, while Fort Gibson may have experienced one or more major rainfall events that year, these might have been very isolated heavy rainfall events.

Additional documentation on the climate of 1855 in this region is provided within a report to the Commissioner of Indian Affairs (Office of Commissioner of Indian Affairs 1856). While a report for the Kiowa tribe does not appear to be available, a report for a neighboring tribe (the Osage) documents the drought conditions of 1855. The report states that "The drought has been to an extent unknown by the oldest inhabitants, for the past fifteen months, throughout this whole section of the country."

Event of 1868–69

This event was recorded on the winter counts of several keepers including American Horse and Cloud Shield as documented within the online Smithsonian Institution exhibit (National Anthropological Archives 2014b). The winter count of Cloud Shield was interpreted as follows: "They had to sell many mules and horses to get food, as they were starving." The winter count for American Horse similarly mentioned sale of horse and mules due to "people starving." Only intermittent climate data for this event were available (Midwest Regional Climate Center 2014b) from Fort Randall, South Dakota. Precipitation data were missing for August and September during 1869; thus, the precipitation analysis for 1868 through 1870 was confined to May 1 through July 31 each year. While 1868 and 1869 experienced 18 cm or more during this interval, less than half this amount (7.62 cm) was observed in 1870 (Table 3). The normal precipitation for Pickstown, South Dakota, located within 10 km of the location of Fort Randall, is 24.6 cm for the May

TABLE 2. Climate data for Fort Gibson, Oklahoma, from May 1 through September 30 for years indicated.

Year	Temperature (°C)	Rainfall (cm)	Palmer Drought Severity Index
1854	24.6	29.7	−0.285
1855	24.4	52.6	−5.843
1856	26.2	26.7	−4.930

Note: Temperature data are mean daily temperatures observed at approximately 9 p.m. local time during the interval indicated. Precipitation data are cumulated daily precipitation during the interval indicated.

TABLE 3. Climate data for Fort Randall, South Dakota, from May 1 through July 31 for years indicated.

Year	Temperature (°C)	Rainfall (cm)	Palmer Drought Severity Index
1868	26.33	18.80	−0.529
1869	n/a	18.03	1.908
1870	21.89	7.62	−0.797

Note: Temperature data are mean daily temperatures observed at approximately 2 p.m. local time in 1868 and from estimates of daily minimum and maximum temperature during 1870. Precipitation data are cumulated daily precipitation during the interval indicated.

through July interval (NOAA 2014). Similar to the normal data for Fort Gibson, this precipitation value was computed from the currently available monthly data of the 1981–2010 interval, and may differ from the normal values of the mid-1800s. The PDSI associated with this event was –0.797 which is near the level that would indicate a mild drought (–1.00).

A report from the Dakota Territory in October 1869 (Office of Commissioner of Indian Affairs 1869) stated: "These Indians entirely failed in their farming operations during the season of 1867 and 1868, their crops having been blighted by drought and eaten by grasshoppers." J. M. Goodhue of the US Army, who arrived in the Yankton region of the Dakota Territory in September 1870 (Office of Commissioner of Indian Affairs 1871), stated: "When I arrived here the crops looked well and promised a bountiful harvest, but owing to the fact that there has been no rain of any consequence since the last week in May, the crops on this reservation will prove almost an entire failure." Thus, prolonged dry conditions apparently existed in this region at this time.

Historical Events in Context of Current Drought Events

Winter count observations of the prolonged dry (drought) events, due to their nature, are difficult to compare with current drought events. Several of the events included in this study, based on the summer reconstructed PDSI values (Table 1), would be considered "extreme drought" events and would thus be similar to the current conditions within the western United States (Swain et al. 2014). Unlike the information available for the current drought conditions in the western United States, the duration and spatial extent of the historical events are more difficult to confirm. While the reconstructed PDSI values offer some consistency of documentation of the year-to-year duration and spatial extent of the events, we found that the instrument data from the US Army forts, the reports to the Commissioner of Indian Affairs, and winter counts were less consistent.

Conclusions

We compared Native American drought-related winter counts, spatially and temporally, to the available weather, reconstructed drought information, and other ancillary information in an effort to cross-validate these relatively sparse and disparate historical climate records. Generally, we found that the Native American observations of prolonged dry intervals were in agreement with other observations or available information. Thus, the winter count observations may provide an additional source of information for other historic climate events (e.g., flooding or severe winter weather events). Seven of the 10 winter count events identified as prolonged dry or drought events exhibited PDSI values indicative of moderate, or greater, intensity of drought. Of those events not meeting the PDSI threshold for mild drought was an event (1868–69) that was substantiated as a drought event based on other information that was available for this event. We suggest that research efforts that could provide additional information to identify or verify the year of the winter count events, or tribal locations during the year of the observed winter count events, would be most helpful for future analyses. We also suggest that future studies on this topic might include assessment of the availability of individual tree-ring data for the examined events and evaluation of this data as compared to the winter count events.

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