The Role of Climate in Early Spanish–Native American Interactions in the US Southwest

Carla R. Van West, Thomas C. Windes, Frances Levine, Henri D. Grissino-Mayer, and Matthew W. Salzer

Archaeologists describe and reconstruct past environments for two reasons. First, we describe the physical setting, climate, and environmental resources of a particular area and time period because they convey a mental image to our readers and form the background for subsequent narratives and interpretations. Second and more importantly, we reconstruct past environmental conditions because we know that factors such as the length of a growing season or access to dependable water often establish the limits within which a given set of human behaviors can occur. After environmental reconstructions are developed, we attempt to identify the economic opportunities, constraints, options, and risks present to various human groups, given their economic organization, technological capabilities, and population characteristics.

We describe in this chapter how we reconstructed past climate in the Middle Rio Grande basin of north-central New Mexico during the sixteenth and seventeenth centuries. We then describe how climate variation likely influenced natural resource productivity and food production in the Middle Rio Grande basin, which, in turn, influenced living conditions for its Indigenous populations and non-Native explorers. Although we understand that climate was but one of a number of important factors that influenced the events of the Spanish entrada (A.D. 1539–1598) and Early Colonial periods (A.D. 1598–1680), we contend that extremes in climate played a decisive role in permitting or inhibiting sustainable settlement for both Natives and newcomers.

Background: Why the Middle Rio Grande Basin?

Following orders issued by Captain General Francisco Vázquez de Coronado to explore lands to the east of the Cibola province, Captain
Hernando de Alvarado and a party of twenty-three men-at-arms, an unknown number of Indian allies, and at least one Catholic priest were led from Hawikku by Pecos Pueblo emissaries to the Tiguex province along the Middle Rio Grande valley in early September 1540 (Flint 2008:130). What these explorers found was the largest concentration of settlements anywhere in Tierra Nueva—some twelve closely spaced pueblos stretching from what is now Albuquerque north to Bernalillo along both sides of the Rio Grande, housing many thousands of people. Within months, the remainder of Vázquez de Coronado’s large expeditionary force at Hawikku had moved to the Tiguex province. There, they took up residence in and around at least one of the province’s largest villages, Coofor (Flint 2008:141–144), after displacing its Native inhabitants and forcibly appropriating its stores of food, clothing, and fuel. These actions, as others in this volume discuss (Flint and Flint, this volume; Mathers, this volume), initiated the process of population dispersal, settlement abandonment, and demographic collapse in the Middle Rio Grande Valley from which these pueblo populations never fully recovered. This chapter, then, focuses its efforts on the reconstruction of climate in that portion of the Middle Rio Grande basin that was home to the Southern Tiwa-speaking peoples of Tiguex province.

The Study Area: The Middle Rio Grande Basin

Setting

The Rio Grande flows 1,887 miles from southwestern Colorado to the Gulf of Mexico and drains a basin of approximately 637,137 square kilometers. In its course, it traverses four geomorphic provinces of the United States and Mexico. Within central New Mexico, the lands bordering the river are assigned to the Mexican Highland or Basin and Range geomorphic province. This reach of the Rio Grande is referred to as the Middle Rio Grande Basin (MRGB), and it extends from the area near present-day Cochiti Lake and Cochiti Pueblo on the north to present-day Elephant Butte Reservoir near Truth or Consequences on the south. Within the MRGB are contained two subbasins—the Santo Domingo basin to the north, and the Albuquerque–Belen basin to
the south—and numerous north–south oriented mountain ranges. Elevations range from about 1,524 m along the river to 3,255 m at Sandia Crest. The Tiguex pueblos occupied the northern portion of the Albuquerque–Belen basin.

Climate

The climate of the MRGB is arid overall and characterized by a summer dominant precipitation pattern. Elevation strongly controls the amount of moisture received. Whereas the lowland basins of the MRGB typically receive between about 230 to 300 mm of total precipitation per year, the upland ranges receive an average annual total of between 380 and 560 mm. Precipitation is delivered unevenly throughout the year, with more than half of the annual total delivered during the period between July and October as brief, heavy, and spatially patchy thunderstorms. These summer and early autumn monsoonal storms develop as moist air over the Gulf of Mexico is brought inland from the southeast in response to the shifting position of the Bermuda High Pressure Zone. In contrast, late fall, winter, and spring storms derive from moisture over the eastern Pacific Ocean, and these are greatly influenced by the periodic occurrence of the El Niño/Southern Oscillation (ENSO) phenomena. Under average, non-ENSO conditions, winter storms are prolonged, light, and widespread, due to the fact that they drop most of their moisture over more western regions before they reach the MRGB. However, when the ENSO is in its warm phase (El Niño), considerable amounts of moisture can be delivered to central New Mexico during the normally cool season as snow and in the warm season as heavy monsoons. In contrast, when the ENSO is in its cold phase (La Niña), areas that normally receive winter and/or summer moisture can experience extended periods of little to no moisture.

Monthly and annual temperature trends in the MRGB are similar to monthly and annual temperature trends elsewhere in the US Southwest. Average monthly temperatures are lowest in January (mean minimum ranging from −7 to −5°C) and highest in July (mean maximum ranging from 33 to 34°C). The length of the average frost/freeze period ranges from about 204 days near Bernalillo (April 17 to October 22) to 220 days near Albuquerque (April 1 to Nov 19), with each station having
a sufficient number of Corn Growing Degree Days (CGDD)\textsuperscript{1} to bring corn plants to maturity. The average May 1 through September 30 “growing season” for corn in the northern portion of the Albuquerque—Belen basin ranges from 2,939 CGDD units in Bernalillo to 3,241 CGDD units farther south in Albuquerque—well above the minimum threshold of 2,500 CGDD units needed for successful corn harvests (Adams et al. 2006). North of the Albuquerque—Belen basin, growing-season moisture increases but CGDDs decrease, whereas south of the basin, growing-season moisture decreases but CGDDs increase.

**Pre-Contact Farming Practices**

Not long after arriving in the Tiguex province, Captain Alvarado sent a message to General Vázquez de Coronado, describing the valley as, “wide, level, and fertile, planted with cornfields,” and its inhabitants as “excellent, more like farmers than warriors” and having “much food: corn, beans, melons, and turkey in great abundance” (Flint and Flint 2005:305–306). The message was the signal that the general needed to hear; there was a good land not far away where he and his large expedition could come and survive the winter (Flint and Flint 2005:303). Alvarado clearly was describing the Middle Rio Grande Valley in a successful year when the various Native crops were beginning to ripen. But what foods other than corn, beans, and melons (probably pumpkin-type squash) were being grown, where, and by what methods? We simply do not know from this earliest eyewitness account.

Archaeological evidence from late prehistoric and early historic sites in Albuquerque suggests that the inhabitants of the Tiguex region were subsistence farmers whose agricultural way of life revolved around the intensive cultivation of corn, beans, squash, and cotton. These basic items were supplemented by the procurement of numerous weedy annuals (e.g., goosefoot, pigweed, purslane) and a variety of seasonally and locally available grass seeds, piñon nuts, fruits, and succulents (Toll 1992).

Researchers have not found reliable evidence that the Tiguex communities and other northern Rio Grande Pueblo peoples constructed large-scale, Iberian-type irrigation systems prior to sustained Spanish settlement (Anschuetz 1998; Biella and Chapman 1977a; Wozniak 1987).
Researchers currently working in the MRGB, however, increasingly suspect that many small-scale and rather ephemeral irrigation systems once existed along the Rio Grande (Kurt Anschuetz, Eileen Camilli, and Scott Worman, personal communication 2010). Anschuetz and Worman both draw on Espejo’s 1582 observations that Piro communities near present-day Socorro planted corn, beans, calabashes, and other crops dependent on seasonal rainfall or irrigation from ditches, and that sandy stretches along both sides of the Rio Grande were cultivated (Hammond and Rey 1966:220–221). Based on his research near the MRGB site of Alameda Pueblo, Worman (2009) hypothesizes that these small, expediently constructed canals diverted water from the braided channels of the Rio Grande and irrigated fields at the floodplain margins. He also suggests that these systems were highly productive, sustained large MRGB populations, and were critical for food production during periods of drought.

In landscape positions above the floodplains, researchers suggest that many ingenious farming techniques were used to grow crops in diverse settings where stored soil moisture and harvested floodwater could be used to augment the patchy and often unreliable summer rains. Fields made productive by means of agricultural features (e.g., terraces, grids, gravel mulch) and strategic positioning (e.g., at arroyo mouths, at the base of gentle slopes, oriented toward or away from strong sunlight) were located in both upland and lowland settings. These strategies can be classified as forms of dryland, runoff, floodwater, and water-table agriculture, as well as hand-water “kitchen gardens” (Doolittle 2000; Doolittle and Mabry 2006). Locating fields in this way helped to reduce the risk of significant food shortfalls in any year resulting from the often unpredictable occurrence of droughts, floods, midseason frosts, and short growing seasons.

**Methods: Reconstructing Climate in the Middle Rio Grande Basin**

Two existing and independent tree-ring chronologies were used to reconstruct annual precipitation and temperature patterns in the MRGB. The precipitation reconstruction (MRGB, A.D. 622–1992) was prepared
by Grissino-Mayer et al. (2002) using a tree-ring chronology constructed from several species of long-lived conifer trees from the Sandia Mountains east of Albuquerque, the Magdalena Mountains west of Socorro, and the lava fields of El Malpais National Monument south of Grants. The San Francisco Peaks temperature reconstruction (SFP, 663 B.C. to A.D. 1992) was developed by Salzer (2000a) based on an upper-elevation tree-ring chronology comprised solely of bristlecone pine growing on the San Francisco Peaks near Flagstaff, Arizona.

For each tree-ring chronology, Grissino-Mayer et al. (2002), Salzer (2000a), and Salzer and Kipfmüller (2005) used standard methods to create or update their chronology (Fritts 1976; Stokes and Smiley 1996). This involved sample collection and preparation, cross-dating, measurement, as well as statistical verification for accuracy of measurement and cross-dating procedures. In addition, standardization of each ring-width series was accomplished through a curve-fitting process that removed age- and size-related variability and retained climate-related variability in the resulting tree-ring indices. Finally, all of the tree-ring series were combined using a mean value function to create an overall mean site chronology. Thereafter, statistical tests of modern climate and tree-growth studies were conducted with the goal of producing mathematical equations that would allow them to estimate the climate variable they wished to retrodict. The interested reader is urged to consult the dissertation research of Grissino-Mayer (1995, 1996) and Salzer (2000a), the articles by Salzer (2000b) and by Salzer and Kipfmüller (2005), and the report issued by Grissino-Mayer et al. (2002) for the MRGB reconstruction for a complete description of methods used to build each chronology and to develop their respective dendroclimatic reconstructions. Underlying both of these dendroclimatic reconstructions is the statistically demonstrated relationship that tree growth is strongly associated with climate (Fritts 1976; Fritts et al. 1965). It is this basic principle that allows dendrochronologists to transform the trends in tree-ring chronologies into reconstructions of given climate variables once tested and verified.

We use the MRGB chronology to represent local precipitation trends within the MRGB and the SFP chronology to represent regional temperature trends. As a first step, we converted the annual MRGB precipitation values expressed as Palmer Drought Severity Indexes (PDSI)
and the SFP temperature values expressed as mean maximum annual temperature values to standard deviation units (Z-scores) so as to make these two datasets comparable (Appendix A). Second, we plotted these reconstructed values against the actual annual values recorded for the longest and most reliable weather station in the northern portion of the Albuquerque-Belen basin—the Albuquerque WSFO Airport (Station 29024). This was done to evaluate whether or not we were justified in using these two chronologies as proxies of past climate in the Middle Rio Grande Valley. Satisfied that the MRGB and SFP chronologies were reasonable proxies of past climate trends, we then plotted the annual values and trends displayed in these two chronologies to help us understand in what ways the sixteenth and seventeenth centuries may have differed from other centuries in the last millennium. Finally, we paired and plotted these two climate records and annotated these graphs with significant historic events as they are currently known for the sixteenth and seventeenth centuries. With these data we are able not only to characterize climate during these two centuries relative to preceding or subsequent centuries but also to identify specific years and intervals when climate conditions were unusual in their magnitude or duration. For example, periods of either extreme or persistent warmth or coolness, coupled with either drought or relative wetness, have likely consequences for crop growth, food supply, human health, and sustainable settlement. Observations recorded in dated historic documents are used to support or refute the overall accuracy of these reconstructions.

Results: Correlating Climate and Human History in North-Central New Mexico Moisture Variation

The first half of the sixteenth century was moderately moist, fairly predictable from year to year, and favorable for crop production (see Figure 5.1a). Immediately after the single wettest multiyear interval during the last millennium (1533–1557), however, climate conditions rapidly and dramatically deteriorated in the MRGB. What resulted was the most severe and persistent multidecadal drought in the entire reconstruction (1571–1593, although it started earlier and continued later). The most pronounced period of this long drought has been referred to as
**Figure 5.1a.** Reconstructed PDSIs (reexpressed as Z-scores) for the Middle Rio Grande Basin, New Mexico, for the period between a.d. 1000 and 1992. PDSIs are proxy values for precipitation. Needles are reconstructed annual values; trend line is a twenty-year, standard, weighted, running mean. The five most extreme wet and dry intervals in the millennium are identified (Grissino-Mayer et al. 2002:1, Table 4, Table 5).

the "megadrought" of the last one thousand years, and it appears in many North American tree-ring chronologies (e.g., Blanton, this volume; D'Arrigo and Jacoby 1991; Hughes and Brown 1992; Stahle et al. 2000; Woodhouse and Overpeck 1998). Historians, anthropologists, geographers, and medical researchers, among others, have associated the effects of the sixteenth-century megadrought with numerous cases of famine, disease, significant environment change, and dramatic population declines across the United States and Mexico (e.g., Acuna-Soto et al. 2002; Marr and Kiracofe 2000; Stahle et al. 1998).

In contrast, the seventeenth century was unusually wet. Beginning in 1606 and lasting until 1713, the MRGB was favorably moist, with one pronounced period of extreme wetness between 1627 and 1653. Only one interval of prolonged drought, from 1664 through 1674, punctuates the record of moisture. Nevertheless, year-to-year predictability in precipitation was quite low in the first half of the century, despite the increase
**Figure 5.1B.** Reconstructed mean maximum annual temperature (re-expressed as Z-scores) on the San Francisco Peaks, Arizona, for the time period between A.D. 1000 and 1992. Needles are reconstructed annual values; trend line is a twenty-year, standard, weighted, running mean. The five most extreme warm and cool intervals in the millennium are identified (Salzer 2000:Table 7).

in moisture over the previous century. Year-to-year predictability returned in the second half of the century.

**Temperature Variation**

The sixteenth century was moderately cool overall. Two brief intervals of extended warmth occurred, however, the first dating from 1529 to 1543 and a second dating from 1586 to 1593 (see Figure 5.1b). The longest and coldest interval of the sixteenth century took place between 1512 and 1527. This sixteen-year-long interval of cool growing seasons, however, was minor in comparison to the severe cool-to-cold conditions that persisted for most of the seventeenth century.

The seventeenth century began cool (1599–1612), then warmed for fifteen years, and thereafter plunged into the most extreme cold interval for the entire one-thousand-year period. An extended interval of coolness persisted from 1636 to 1683, with very few individual warm
years. Annual mean maximum temperature only began to approach normal and warmer-than-normal after 1684. This cold period’s most extreme expression took place between 1636 and 1653, which Salzer (2000:187) identified as the single coldest interval during the last millennium. Salzer (106–126) suggests that numerous and strong volcanic eruptions occurring between 1599 and 1683 released gases and ash of a sufficient quantity to significantly reduce sunlight and contribute to global cooling. Although he does not suggest that volcanism caused the seventeenth-century cool period, he does suggest that large volcanic events at least enhanced the persistent temperature effect. Other researchers (e.g., Eddy 1981) have suggested that this intense cool period is a response to a long period of sunspot minima known as the Maunder Minimum (A.D. 1645–1715). Whatever the atmospheric and terrestrial causes, there is no question that the mid-seventeenth century cold period was severe and widespread.

A Combined Record of Precipitation and Temperature

When we overlay these two tree-ring reconstructions, we are able to examine the paleoclimatic record in yet a different, and perhaps more interpretable, manner. Figures 5.2a–5.2d represent the combined records of reconstructed precipitation and temperature for the MRGB. Each annotated graph portrays the annual trends for a fifty-year period of time.

Figure 5.2a depicts the first half of the sixteenth century. The fairly persistent coolness of the early 1500–1530 period gave way to two decades of unusual warmth between 1530 and 1550. It was during this period that Fray Marcos de Niza and Francisco Vázquez de Coronado ventured north to Tierra Nueva. Perhaps not coincidentally, Vázquez de Coronado’s large expedition made its way north during one of the few exceptionally warm and wet intervals of the sixteenth century. Such conditions likely encouraged the warm-season growth of grass and browse that supported the many thousands of animals that accompanied the expedition. Similarly, the unusual combination of warm and wet climate probably encouraged the growth of corn and other crops for the Native peoples of the region. Nevertheless, the unusual wetness
FIGURE 5.2A. Middle Rio Grande Basin climate, a.d. 1500–1550. Long-term mean is 0.00; each unit above and below the mean is equivalent to one standard deviation unit. Positive values represent increasing wetness and greater warmth. Negative values represent increasing drought and cold.

FIGURE 5.2B. Middle Rio Grande Basin climate, a.d. 1550–1600. Long-term mean is 0.00; each unit above and below the mean is equivalent to one standard deviation unit. Positive values represent increasing wetness and greater warmth. Negative values represent increasing drought and cold.
**Figure 5.2C.** Middle Rio Grande Basin climate, A.D. 1600–1650. Long-term mean is 0.00; each unit above and below the mean is equivalent to one standard deviation unit. Positive values represent increasing wetness and greater warmth. Negative values represent increasing drought and cold.

**Figure 5.2D.** Middle Rio Grande Basin climate, A.D. 1650–1700. Long-term mean is 0.00; each unit above and below the mean is equivalent to one standard deviation unit. Positive values represent increasing wetness and greater warmth. Negative values represent increasing drought and cold.
had its drawbacks; snowfall was probably greater, and summer monsoons may have been more intense, with the possibility of frequent floods and high water in normally low-flowing streams. Corroborative evidence from other paleoclimate records suggests this may have been so. For example, Quinn (1992, 1993) has reconstructed a record of strong El Niño events for the 1525–1987 period. His data suggest that years 1539, 1540, and 1541 experienced especially strong El Niños, which likely reached eastward to the MRGB. In addition, Richey and his colleagues (2007) have created a decadal-scale record of sea surface temperatures in the Gulf of Mexico using deep-sea cores and radiocarbon-dated foraminifera. The similarity of this foraminifera-based data set to the El Malpais tree-ring precipitation reconstruction (Grissino-Mayer 1995, 1996) suggests that both are proxy records for the history and strength of the summer monsoon (Poore et al. 2005).

Historic documents tell us that Vázquez de Coronado and his remaining party departed from the MRGB in April of 1542. With many of their villages greatly damaged by the large group of intruders, we can imagine that the remaining inhabitants of Tiguex vigorously attempted to cultivate the land and restock their once-large stores of corn, beans, squash, and cotton. Unfortunately for the Native peoples of this region, 1542 appears to have been warm and rather dry, and this moderate drought persisted for two decades.

Figure 5.2b depicts the second half of the sixteenth century. The deterioration in climate observed by both Grissino-Mayer et al. (2002) and Salzer (2000) is visible first as a cool and intensely wet interval between 1553 and 1557, followed by a dramatic trend toward arid conditions, often accompanied by cool weather. The sixteenth-century megadrought was near its maximum expression when Spanish explorers returned in 1581–1582 with the Chamuscado-Rodríguez and 1582–1583 Espejo parties. In those particular years, it was not only extraordinarily dry but also frequently cold—a climate condition that worked against raising successful crops in almost all landscape settings, high and low. When the Sosa, Morlete, and Leyva de Bonilla-Humafía expeditions of the 1590–1593 period arrived, they experienced the final warm and dry phase of the megadrought. That these expeditions were not particularly well received seems no surprise from an examination of the paleoclimate record. Native populations probably struggled to bring in a harvest,
which was increasingly subject to raids from and theft by Plains Indian populations. Demands by outsiders, no matter how few, surely must have been unwelcome, although there are reports (cited by Schroeder and Matson 1965:145–160) that Sosa’s party did receive food from various pueblos. Climate alone cannot explain why Oñate y Salazar and his colonists were able to establish a settlement near Ohkay Owingeh (San Juan Pueblo) in the Northern Rio Grande valley, but climate conditions likely contributed to the failure of the colony when colder conditions set in after 1598 (see below). Nonetheless, it is interesting to note that he and his party arrived after the only warm and wet interval of the late sixteenth century. Both this paleoenvironmental reconstruction and historic documents show that the Northern and Middle Rio Grande valley was cold and dry by the time they arrived, and these conditions continued for the next four years.

Figure 5.2c depicts the first half of the seventeenth century. The few years of occupation near the Pueblo of Ohkay Owingeh were years of great hardship for Oñate y Salazar and his colonists. Barrett (2002:17, citing Hammond and Rey 1953:696) describes a letter written to the viceroy by Fray Juan Escalona for supplies. Escalona tells the viceroy that frost had scorched the corn fields that year, and in recent years, drought had caused the fields to dry up. As a result, he writes that in the three years the Spaniards had been in New Mexico, they had consumed all the maize that the Pueblo Indians had stored during the previous six years. Although the colonists did experience relief from the extreme cold drought by 1603, the climate of the early 1600s was often cool and wet. A brief warm and wet interval from 1626 to 1631 permitted the successful cultivation of wine grapes in at least the southern MRGB pueblo of Senecú in 1629. By 1635, though, conditions took a turn for the worse, and a long interval of extremely cold and wet conditions set in. Numerous reports of epidemic disease and death are recorded by midcentury; the total census of Pueblo population was only a fraction of what Alvarado saw in 1540.

Figure 5.2d depicts the second half of the seventeenth century. Midcentury wet and cold conditions were broken by a decade or so of relatively benign conditions that alternated between warm-wet and warm-dry climate (A.D. 1654–1663). But in 1664 the MRGB apparently experienced one of the most severe and persistent cold droughts in the
entire millennium. These harsh conditions initiated around 1664 and continued, almost unbroken, through 1678. As with the cold drought of 1598–1603, this extremely cold and dry interval resulted in much suffering for the inhabitants of central and northern New Mexico. Hackett (1923–1937:17) cited historical documents describing the famine that beset the Pueblo Indians and the Spaniards, who only escaped starvation by eating hides and the straps of carts that they prepared as food, boiling them with what little corn, herbs, and roots they could find. Hackett also cited reports that a great “pestilence” had killed many people and cattle by 1671. It was during this period of environmental strife that Governor Treviño tried forty-seven Pueblo men in 1675 and hanged three for practicing religious rituals that Spanish colonists believed were witchcraft and sorcery (Hackett and Shelby 1942:xxii). By the end of the 1670s, total Pueblo population in New Mexico had diminished markedly and many pueblos were abandoned, including all in the Estancia basin and most in the Albuquerque–Belen basin (Barrett 2002:67–70; but see Ramenofsky and Kulisheck, this volume).

The Pueblo Revolt of August 10, 1680, took place after nearly two decades of unimaginable hardship. Adverse climatic conditions that negatively impacted agricultural endeavors; devastating epidemics; massive population decline; constant raiding; Spanish policies related to population aggregation, tribute, and Native religious practices; and growing intolerance on the part of Native populations coalesced in the successful routing of the colonists and Spanish sympathizers from New Mexico (Barrett 2002). Although there was sufficient cause for staging such a coup well before the late summer of 1680, we suspect that a particularly destructive freeze took place that summer and may have contributed to the timing of the revolt. The evidence for this crop-damaging freeze takes the form of a “frost ring” that appears not only in the SFP temperature chronology but also in other high-elevation tree-ring series in western North America. According to Salzer (2000:91), frost-damaged rings displaying cellular damage from ice formation develop during the growing season of a tree when at least two nights of subfreezing temperatures occur. If this happens early in the growing season, then the earlywood (large, thin-walled cells) of the tree is affected. In contrast, if a hard freeze occurs later in the tree’s growing season, the damage will take place in the latewood (smaller, thick-walled cells that
show up at the outer margin of the tree's annual ring). Thereafter, with improved weather conditions, the tree continues to grow and produce new wood. Given that bristlecone pines in the Rocky Mountain region put on new growth from late June to late August or early September (Salzer 2000:92), we suspect that this destructive frost took place at a point in the corn-growing season when it was too late to replant at lower elevations. The frost-damaged section of the SFP ring of 1680 is located within or near the latewood rather than in the earlywood. It is likely that this destructive freeze took place in early August during a year and a multiyear interval of exceptional cold. Our guess is that this “event” was a contributing factor to the timing of the revolt.

Concluding Remarks: The Role of Climate in Early Spanish–Native American Interactions in North-Central New Mexico

Our review of this paleoclimatic record suggests that different types of multiyear periods described as either “warm and wet,” “cold and wet,” “warm and dry,” and “cold and dry” often have outcomes that can be anticipated. Multiyear intervals that were both relatively warm and wet are rare in this reconstruction. Of all combinations of temperature and precipitation trends, these last are the most favorable for aboriginal Pueblo subsistence. In the MRGB, farming both on the Rio Grande floodplain and adjacent valley slopes would have been possible. Although the typical spring runoff may have been larger than usual, warmer-than-normal conditions may have lessened the limiting effects of cool air drainage in the floodplain and encouraged the use of small-scale irrigation systems. In upland settings, such as Albuquerque’s West Mesa, enhanced precipitation would have allowed recharge of soil moisture and facilitated summer runoff irrigation. We suspect that when warm and wet conditions prevailed, successful crop production was possible in many settings using a variety of agricultural water-harvesting techniques, surplus could be generated and stored, and long journeys to Tierra Nueva with many participants and livestock were possible. These were the climate conditions surrounding the Vázquez de Coronado expedition of 1539–1542, the initial arrival of Oñate y Salazar and his colonists in 1598, and even the “reconquest” by Vargas in 1692.
Multiyear intervals characterized by moderate to extreme cold accompanied by wetness are far more frequent in this paleoclimate record. Successful harvests would have been possible only from well-chosen locations with good drainage protected from the adverse effects of cold air flowing down from the Sandia Mountains into the fertile river valley. Cool and wet conditions would favor crop production in upland settings where direct precipitation supplemented by runoff irrigation was possible but would thwart successful agricultural production in the floodplain. Planting in the floodplain would have been delayed until after the spring floods diminished and temperatures rose sufficiently to support seed germination. Furthermore, the total acreage of arable settings and the possibility of producing significant crop surpluses likely would have been reduced. We also suspect that the intensity and duration of these two conditions influenced health as well as economic conditions for all inhabitants of the region. For example, when persistently wet and intensely cold conditions prevailed, disease, illness, and crop failures were not uncommon. Such was the case of the long cold and wet period of 1635–1639, when Father Juan de Prada reported in 1635 that New Mexico was a land of extremes in cold and heat (Hackett 1923–1937:108), and that Pueblo people were dying of smallpox and cocoliztli; Acuna-Soto et al. (2002) interpret this disease to be hemorrhagic viral fever.

We also note that multiyear droughts were common during these two centuries. Prolonged warm-dry periods, as well as cold-dry periods, were particularly frequent in the sixteenth century. During these two centuries, droughts usually lasted from six to eleven years, but a few were longer. Depending on their magnitude and duration, the effects of these droughts varied considerably. Although warm droughts could be very severe, harvests usually could have been secured from fields in the Rio Grande floodplain using small-scale irrigation techniques. It is likely, however, that the quantity of floodplain fields was diminished, given the reduced number and altered distribution of braided channels within the Rio Grande. These same warm-dry conditions would have extensively limited production in arable upland settings due to low soil moisture and fewer runoff events.

In contrast, cold droughts added more constraints associated with short growing seasons, growing-season frosts, and problems associated
with cold-air drainage in lowland settings. Cold and dry conditions impeded successful aboriginal crop production in all landscape positions. Although floodplain settings had access to irrigation water, low temperatures, shortened growing seasons, and the ever-present danger of crop-killing frosts were significant hindrances. Arable settings in the uplands probably suffered from a lack of winter-moisture recharge needed for seed germination and early growth, as well as summer moisture, which was required for tasseling, silking, and continuous growth. Historical documents written during drought periods suggest that suffering was greatest during the cold droughts. The best example of a prolonged cold drought was the one that occurred in the 1664–1678 interval, when open display of traditional ceremonies to rebalance the world and bring warmth and moisture resulted in the trial and hanging of Pueblo leaders in 1675.

By pairing two independent, statistically verified tree-ring chronologies (see Appendix A) and comparing them to historic reports, we have been able to reconstruct a paleoclimate record for the sixteenth and seventeenth centuries in the MRGB. As students of human behavior, we readily acknowledge that the relationship between culture and environment is complex. We do not propose that climatic conditions determined any particular outcome. Instead, we suggest that complicated interactions among environmental, behavioral, and demographic factors (Dean 1988, 1996) operating in the 1500s and 1600s in what is now New Mexico resulted in the events recorded in the historical documents of the period. Weather conditions that influenced the abundance or dearth of food resources and other critical economic resources most certainly should be considered in the mix of factors that help historians and anthropologists explain cultural events.

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