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Climate-conscious archaeology: contextualizing drought and history in the Chesapeake

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Abstract
This paper adopts a climate-conscious approach to archaeology, integrating environmental scientists' definitions of extended droughts and megadroughts into the analysis of historical processes in the Chesapeake region of North America. We explore the relationship between drought conditions and historical processes through three case studies: Ancestral Monacans' migration, the settlement dynamics in the Middle Potomac, and the emergence of the Powhatan chiefdom. Employing the Palmer Modified Drought Index as a paleoclimatic proxy, the research assesses how variations in rainfall and drought influenced migration, agriculture, and political formations. The findings underscore the complex interplay between Native history and environmental conditions, suggesting that the impact of climate on historical processes ranged from negligible to substantial, particularly with the adoption of maize-based agriculture. This study highlights the benefits of a climate-informed archaeological inquiry that recognizes the historically contingent ways in which climatic variability has shaped and is entangled with social change.

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Introduction

In March 2023, the United Nations Intergovernmental Panel on Climate Change (IPCC) released the Synthesis Report for the Sixth Assessment Report describing current climate change conditions and projections as it relates to international policy (IPCC 2023). The IPCC issued some of the strongest language to date declaring that human activity has unequivocally contributed to climatic warming and that climate change of this scope has adverse impacts on a global scale. The urgency of the climate problem has yielded contributions from anthropology that engage with the unique perspectives of interlocutors to critically examine research approaches to climate change and incorporate diverse notions of knowledge which can aid responses to this crisis (O'Reilly et al., 2020). In this paper, we present a novel approach to the archaeology of climate change in which we adopt rigorous definitions of extended drought and megadrought, developed by environmental scientists, to explore the intersection between climate change and historical process.

Archaeology has seen renewed interest in climate change research in recent decades (e.g., Blanton, 2004; Stahle et al., 1998), in large part because the archaeological record is an effective archive of historical ecodynamics (Sandweiss and Kelley, 2012, 372). This archive commonly incorporates proxy records of climate and the environment (e.g., Blanton, 2000; Peacock and Seltzer, 2008), often leading to collaborations between archaeology and the environmental sciences. It has become commonplace to see publications contextualizing historical processes with environmental narratives (Burke et al., 2021). Long removed from an era of deterministic thinking, the advent of new proxies for environmental histories and the looming threat of modern climate catastrophe have left archaeology in a state of *climate-consciousness*. Decades of research in the Middle Atlantic have shown that archaeologists are attuned to the role of environments and climate in shaping the history of the region (Blanton, 2003a; Hantman and Klein, 1992; Rountree, 1989). Despite this corpus of climate-conscious research, interregional syntheses have, at times, written the Middle Atlantic out of broader historical dynamics. Using three case studies of historical processes in the Chesapeake watershed, we aim to tie the Middle Atlantic into broader narratives of climate change in North America by unpacking the nuances of climate variability and how they relate to processes of drought, migration, and agriculture. Attentiveness to climate is important for contextualizing the past and identifying the entanglement of people and their environments.

Archaeological research in North America has engaged with climate questions in myriad ways. Attention to climate change and its relation to culture has a rich history throughout the continent (e.g., Binford, 1964; Griffin, 1961). Climate was a

significant factor in the historical processes of every major epoch of indigenous history. In Eastern North America, archaeologists have recognized that both gradual and sudden climate change have impacted the lives of Native people from the earliest populations (McWeeney and Kellogg, 2001), through the rise of social complexity and monumentality (Erlandson, 2013; Ritchison et al., 2021; Thompson and Worth, 2011), through European colonization (Blanton, 2003b; Kupperman, 1982), and into the modern day (Anderson, 2001). A key priority for scholars has been to take various historical patterns, sometimes comprising seemingly disparate events, to create plausible explanations including the climate and environment as forces in cultural change (Wykoff, 1988). This approach to the history of the Eastern Woodlands has yielded compelling narratives of engagement with nonhuman actors and the development of traditional ecological knowledge (e.g., Anderson et al., 1995; Benson, 2011; Cobb et al., 2023). Climate change does not emerge as *the* causative force in these human histories, but instead takes the position of an actor with which ancestral indigenous societies were entangled.

Previous studies

The present study builds from a rich body of climate research in the Eastern Woodlands (see Anderson [2001] or Sandweiss and Kelley [2012] for regional reviews). While a variety of proxy datasets have been employed, the primary environmental factor on which our study has focused is drought. Precipitation reconstructions, largely based on tree-ring series, have been a key element in understanding the climate history of North America (e.g., Blanton, 2000). Tree-ring sequences were constructed for parts of the Eastern Woodlands decades ago (Blasing and Duvick, 1984; Stahle et al., 1985), and these sequences facilitated early paleoclimate studies (e.g., Anderson et al., 1995; Stahle et al., 2000). Precipitation reconstructions have been used to estimate food productivity among ancient societies (Meeks and Anderson, 2013). Agriculture became a staple of subsistence in the centuries preceding European colonization. Estimating agricultural productivity has allowed archaeologists to test hypotheses about population dynamics and migration and explore the food production and consumption of Native societies (e.g., Scarry, 1993a, 1993b; Schroeder, 1999). This avenue of research has contributed nuance to significant historical processes such as the Vacant Quarter phenomenon (Williams, 1990). Precipitation reconstructions based on tree-ring sequences have shown that this Mississippian zone of the Southeast was likely impacted by severe droughts which altered the historical trajectories of associated Mississippian societies (Meeks and Anderson, 2013). Within the Vacant Quarter, the Middle Cumberland Region witnessed an exodus over time, the beginnings of which coincided with a pattern of severe droughts (Cobb et al., 2023).

Precipitation reconstructions are the predominant climate data addressed by North American archaeologists (e.g., Benson et al., 2007). A compelling case for the role of rainfall patterns in the success of food reserves may be found at Cahokia (Benson et al.,

2009). Researchers detected a strong correlation between better than usual rainfall and the rise of Cahokia. The city emerged and farming was reorganized around the Richland farming complex, which facilitated the rapid increase in population and expansion. Following the 50-year period during which Cahokia was at its peak the American Bottom area experienced an extensive period of drought during which population drastically declined and palisades emerged. By the middle of the 14th century, Cahokia was abandoned (Benson et al., 2007; Pompeani et al., 2021). The droughts in the American Bottom coincided with wetter periods in Mississippian peripheries, allowing for emigration of Cahokia residents to surrounding areas (Comstock and Cook, 2018). As Cahokia was abandoned, droughts subsided in more peripheral areas of the Midcontinent. This created a pull factor attracting former residents of Cahokia and the American Bottom. Mississippian maize agriculturalists migrated often in the face of climate variability during this period, and they often found different ways to adapt to unpredictability and stress, leading to contingent diversification of Mississippian lifestyles (Comstock et al., 2022).

Drought also had deep impacts across the Southeast, stretching into the Carolinas and beyond (Blanton, 2013). An examination of paleoclimate reconstructions for the South Carolina coast explored the correlation between megadrought and the depopulation of a large stretch of the South Atlantic coastline (Cable, 2020). A *megadrought* is a climatological term describing both severe droughts around the world. Definitions vary, though generally a megadrought is a prolonged dry period causing significant impacts on ecosystems, agriculture, and water supply (Cook et al., 2022). Geographic distributions of megadroughts correlated with oscillations in sea surface temperature between the Atlantic and Pacific oceans. Megadroughts in the Carolinas coincided with large-scale depopulation that was later commented on by Spanish explorers. This commentary is consistent with other European colonists remarking on extended dry periods which is further supported by paleoclimatic records as high up as the Chesapeake region (e.g., Blanton, 2000).

These prior studies demonstrate the unique relationships that exist between ancient peoples in North America and their environments. It is also important to note the extensive discussions that have been ongoing in Mississippian archaeology noted here, to improve the conversation linking the Chesapeake to these regional dynamics. The climate-influenced historical processes of the Mississippian period throughout the Eastern Woodlands are likely tied to contemporary processes in the Chesapeake (e.g., Gallivan et al., 2023). This paper is a crucial step in beginning to link the Chesapeake to a broader regional history.

Methods

Assessing the impact of drought and rainfall in our Chesapeake case studies first requires selecting a paleoclimate proxy for analyzing historical drought and rainfall. Previous studies throughout the Eastern Woodlands have utilized the Palmer Drought Severity Index (PDSI; Benson et al., 2009; Cook et al., 2007).

In recent years, the PDSI has been updated and recalibrated on a 0.5-degree national grid (Cook et al., 2010). The updated data, Palmer Modified Drought Index (PMDI), are the basis of the new Living Blended Drought Atlas for the continental United States for the past 2000 years. This drought index measures annual moisture on a relative scale where 0 represents normal soil moisture. Values between −0.50 and −1.99 represent mild drought while values below −2.00 represent moderate to extreme drought (Cobb et al., 2023; Meeks and Anderson, 2013). Positive values represent wetter than normal conditions where values between 0.5 and 1.99 represent mildly wet conditions, values between 2.0 and 3.99 represent moderately wet conditions and values of 4.0 or higher represent extremely wet conditions.

Previous studies have demonstrated the association between PDSI values and agricultural productivity, particularly of maize, among Mississippian communities in the Southeast (Anderson et al., 1995; Meeks and Anderson, 2013). These studies indicate that a minimal harvest of maize occurs when there is mild drought, and a failed harvest occurs when there is moderate or extreme drought. A normal harvest would occur when conditions are mildly wet. However, a failed harvest can also occur when conditions are extremely wet. If we assume this metric designed for the Mississippian midcontinent is transferrable to the Late Woodland Chesapeake, then a normal harvest implies the ability to provide for normal annual consumption plus one year's surplus. A minimal harvest implies the ability to provide for one year's consumption but would not suffice for additional surplus storage. A failed harvest would imply crop failure that would not support a normal year's consumption (Meeks and Anderson, 2013, 65). This measure of agricultural productivity drawn from Meeks and Anderson's (2013) study is a useful way to contextualize the experience of drought conditions as it may have impacted the subsistence economy of Late Woodland agriculturalists.

Extensive efforts have been made to define what conditions qualify as a drought. An individual year of less-than-normal rainfall conditions may not yield a long-term significant impact on agricultural communities. Various definitions have been used to define types of droughts using PDSI values. Some researchers define *droughts* as occurring after two consecutive years of negative PDSI and continuing until two consecutive years of positive PDSI (Coats et al., 2015, 127). *Megadroughts*, by contrast, have been defined as conditions where 11-year running means are negative for a period of at least 20 consecutive years (Meehl and Hu, 2006, 1607). Finally, *extended drought events* have been defined based on ten-year negative running PDSI averages that last for at least 10 consecutive years and do not begin or end with consecutive positive value years (Williams et al., 2022). This latter definition dismisses any event lasting less than 5 years and includes any string of 5 or more consecutive negative value years. In the present study, we favor Williams and colleagues' definition of extended drought events, which likely captures any lasting drought anomaly that would have meaningfully impacted economic and subsistence processes for Chesapeake communities.

Megadroughts have an equally variable definition. Most of the studies mentioned previously emphasize multi-decadal extreme drought events. However, defining megadroughts too narrowly may underestimate the severity of some drought events. We favor a definition of megadrought as "persistent, multi-year drought events that are exceptional in terms of severity, duration, or spatial extent when compared with other regional droughts" (Cook et al., 2022, 744). This flexible definition considers environmental context and local conditions for identifying the most extreme drought events in history and does not establish arbitrary limitations which may not be equally applicable across regional boundaries.

To utilize the above definitions for identifying drought events in this study, we defined three spatial extents in the Chesapeake region to take annual PMDI averages across multicentury spans in the Late Woodland period (Figure 1). For each case, we then isolated a 200-year window that captured significant historical processes in the region. We aimed to determine whether there was a notable climatic marker for each process. The first case is the transition of burial mound construction from the Great Valley to the Piedmont, a cultural shift and population movement that has been used as a signal for the origins of the Monacan Indian Nation (Dunham et al., 2003; Hantman, 2018). Our second case study centers on the migration of

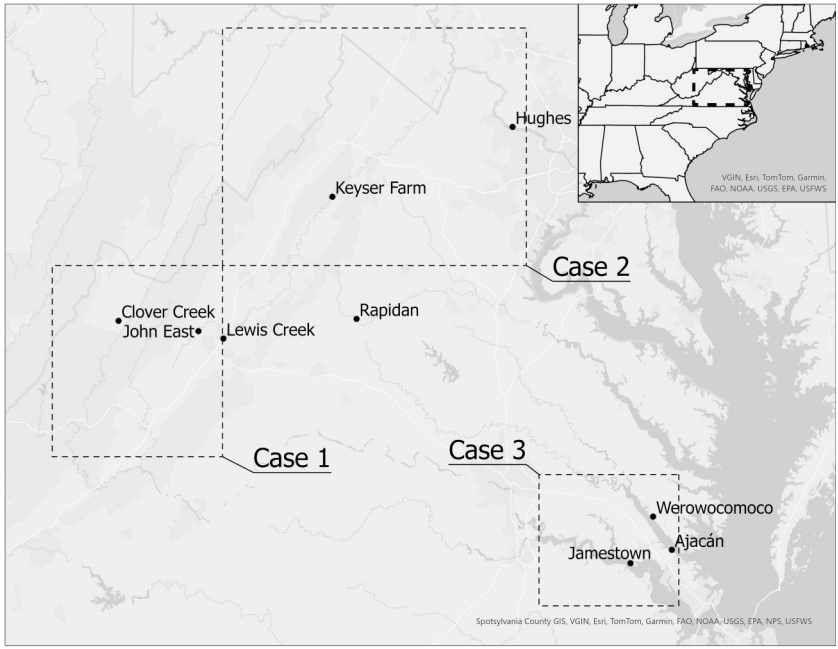

Figure 1. Map showing the geographic frame used for each case study, as well as key sites referenced throughout the paper.

agriculturalists into the Middle Potomac drainage from the west during the 15th century AD and the subsequent migration back into the Great Valley (Gallivan et al., 2023). The final case study involves the rise of the Powhatan chiefdom and the early colonial encounter during the late 16th and early 17th centuries AD in the Tidewater of Virginia (Blanton, 2000). We hypothesize that there may have been some degree of correlation between Late Woodland drought events and these three historical processes. While these histories were not *determined* by climatic variability, we consider the possibility that the Native peoples of the Chesapeake were actively engaged with climate histories and knowledge traditions about climatic variability that influenced decisions about agriculture, settlement patterning, and migration.

Case 1: The Monacans

Introduction and culture history

The first of our three case studies (Table 1) focuses on the climate context surrounding social changes in central Virginia that are linked to the origins of Ancestral Monacan Society (Hantman, 2018, 1990; Mouer, 1983). Working closely with the contemporary Monacan community, Hantman has written extensively on Monacan culture and history, and we rely on his framing of the culture history in our assessment of the climatic patterns in central Virginia's Piedmont and Ridge and Valley. Unlike the coastal Algonquian speakers, including the Powhatans whom early European colonists described in some detail, the Monacans remained on the periphery of colonial encounters. Hantman's (2018) "Monacan Millennium" defines Ancestral Monacan Society as originating circa AD 1000 with (a) a settlement reorientation toward riverine locations, (b) the adoption of maize-based agriculture, and (c) the elaboration of mortuary ritual practices centered on burial mounds. Ancestral Monacans constructed accretional mounds through complex, multistage ceremonial practices. The accretional mounds marked important places where generations of ancestors dwelled, signifying a deep and abiding connection to place. In addition to mound burial practices, Ancestral

Table 1. Summary of the three cases discussed in the text.

	Who?	When?	Historical Process
Case 1	Ancestral Monacans	AD 1101–1300	Eastward migration of people making accretional burial mounds
Case 2	Luray Complex	AD 1301–1500	Migration and coalescence in the middle and upper Potomac drainage
Case 3	Powhatan Chiefdom	AD 1407–1621	Rise of the Powhatan chiefdom and early European colonialism

Monacan society was marked by agricultural settlements along rivers and by intercommunity networks of potters who produced crushed lithic-tempered Albemarle pottery.

The geographic and temporal distribution of Albemarle pottery and accretional mounds changed over time. As detailed elsewhere (Dunham et al., 2003, 113), radiocarbon dates highlight mound construction events in the Great Valley west of the Blue Ridge Mountains from AD 900–1200, while mound usage in the Piedmont appears to be centered on the centuries from AD 1300 through the 17th century. A detailed assessment of the Rapidan Mound, which dates to this latter period, indicates that between 1000 and 2000 individuals were buried in the mound, gathered from several village communities in the area. Those buried within the mound included both sexes across all age groups, with a diet heavily reliant on maize. Evidence of skeletal injuries is rare at the Rapidan Mound, though more evidence of trauma is present within other mounds from the Ridge and Valley province (Gold, 1999).

It is possible that mound usage expanded outward from the Ridge and Valley province, spreading eastward during the Late Woodland centuries (AD 900–1600). However, the available dates suggest that accretional mound burial practices west of the Blue Ridge ended circa AD 1200, only to be continued in the Piedmont to the east. The distribution of Albemarle ceramics follows this west to east shift, pointing toward a population movement from the Great Valley into the Piedmont circa AD 1200. Given the prominent role of maize-based agriculture in Ancestral Monacan Society, climate—specifically rainfall patterns—may have been a relevant factor in what was likely a movement of people and of ideas from Virginia's Great Valley into the Piedmont.

Spatiotemporal extent

The spatial extent for this case study is based on the burial mounds identified in the Great Valley and Piedmont of Virginia. We selected the counties of Amherst, Nelson, Rockbridge, and Augusta as the geographic area across which we averaged PMDI values. These counties represent the majority of burial mounds analyzed by previous scholars. Rockbridge and Augusta counties are located on the west side of the Blue Ridge mountains and Amherst and Nelson counties are located on the east side of the mountains. These four counties encompass parts of both the Great Valley and Piedmont, which allows us to capture the conditions of the ancestral Monacans' home throughout our temporal extent. The environment is transitional between the oak-hickory and oak-pine vegetational regions, with well-drained alluvial soils in the river bottomlands that are well suited for agriculture despite the last freeze of spring occurring nearly a month later than compared to the Tidewater (Hantman and Klein, 1992). Since the proposed movement occurred at approximately AD 1200 (Dunham et al., 2003), we focused on the period of AD 1101–1300. This temporal framing allowed us to look at the century before and the century after the proposed movement to identify shifts in rainfall patterns that may have correlated with the actions of Ancestral Monacans.

Results

The PMDI data yielded complicated results for this case. Using the definitions outlined above, we identified 5 droughts between AD 1101 and 1300 (Figure 2). The first three occurred prior to AD 1200, including the longest drought lasting 21 years. In total, 36 years during the 12th century were during periods of drought. While the 12th century was not significantly dry, the 13th century was notably wetter with only two droughts totaling 21 years. However, one of these two droughts was 16 years long, only one of which was a wet year. The length and severity of this drought, lasting from AD 1245 to 1260, led us to classify it as a megadrought using the definition drawn from Cook et al. (2022, 744). This was an abnormally long period of consistent drier-than-normal conditions. This anomalous event would be the last during the target time period.

It was noteworthy that the centuries of AD 1101 to 1300 appeared to entail a shift toward wetter conditions. The duration between droughts increased drastically following the drought of AD 1147–1167. It is also of note that the only drought that occurred near the proposed time of migration (circa AD 1200) was the shortest of those identified. The proposed megadrought occurred several decades later. It is worth noting that the available radiocarbon dates make the chronology of the west to east transition difficult to place precisely, therefore, it is possible that there was some overlap with these drought events. However, the given chronology demonstrates a disconnect between dry periods and the process of moving into the Piedmont. This would suggest that drought was not a major factor in the historical migration of Ancestral Monacans, or at least the signal for this relationship is not obvious. Social factors influencing this migration are as of yet be clear. The mildly wetter conditions of the 13th century may have encouraged a movement to the floodplains of the Piedmont and the possibility of greater agricultural yields, though the connection to rainfall or drought is not abundantly clear.

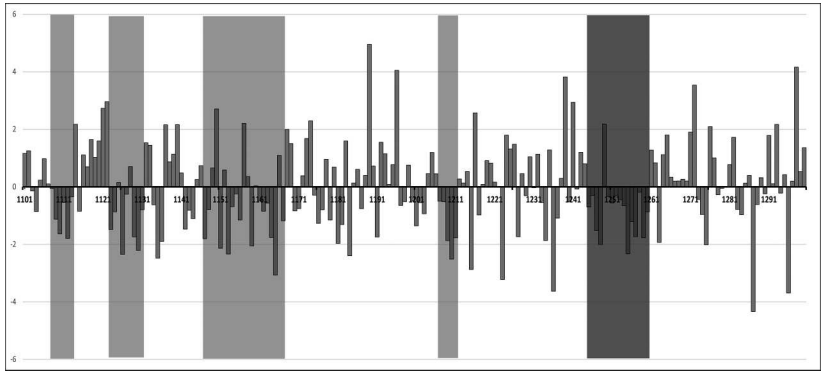

Figure 2. PMDI chart for case 1 with drought events shaded. The megadrought is shaded darker than the other extended drought events.

Case 2: The middle Potomac

Introduction and culture history

Our second case study centers on the Potomac Valley during the centuries between AD 1300 and 1500. The Potomac Valley during the Late Woodland (AD 900–1600) included a history of population movements, fortified towns, and periodic intercommunity violence (e.g., Dent, 1995, 243–284; Potter, 1993, 103–138). In particular, the Piedmont, or Middle Potomac, saw a proliferation of substantial palisaded agricultural settlements during these centuries (e.g., Blanton et al., 1999; Jirikowic, 1995; Kavanagh, 2001). Between AD 1300 and 1500, the Middle Potomac was home to communities associated with several distinct cultural traditions, including the Page, Montgomery, and Luray complexes. These groups were distinguished by different ceramic styles, mortuary practices, and village forms, though their settlements were often located quite close to one another. For brevity, we will typically use these complexes to refer to the associated communities that produced these material complexes. Building on the insights of others (e.g., Barber, 2022; Dent and Jirikowic, 2001), we suspect that the Potomac Valley during the Late Woodland represented a frontier or borderland, that is, a zone of political, cultural, and social innovation where communities from different traditions occupied the same area (Gallivan et al., 2023).

The arrival of communities associated with the Luray complex in the Potomac around AD 1400 significantly changed the valley's settlement history, and it is around the population movements of these communities that we have focused our second case study. Our assessment of Late Woodland chronology in the Potomac Valley has allowed us to place the arrival of Luray communities in the Potomac Valley within a broader historical context (Gallivan et al., 2023). Page and Montgomery communities had been present since at least AD 1150 in the Middle Potomac, moving between long-established settlements. By AD 1300, fortified villages appeared in the Potomac Valley, becoming widespread by AD 1400, a development that was likely influenced by the arrival of Luray communities from outside the valley. The introduction of people associated with the Luray complex around this time led to the abandonment of some Montgomery and Page sites and the adoption of new economic activities, notably a more intensive trade in deerskins. During the 1400s, Luray villages were typically occupied briefly, generally for less than a century. The Potomac Valley remained socially diverse throughout this sequence, with distinct cultural groups interacting regularly until at least AD 1500. Several settlements, including the Keyser Farm site in the Great Valley, show evidence of cultural blending and the creation of coalescent communities. By AD 1600, however, most of the Late Woodland era settlements in the Middle Potomac were no longer occupied, and the colonial period brought new populations and a changed social landscape to the area (Wall and Lapham, 2003).

Luray communities in the Potomac Valley stand apart from other groups in the Middle Potomac in their use of shell-tempered ceramics, reliance on intensive maize-

based agriculture, and construction of large, palisaded settlements (e.g., Manson et al., 1944). In addition to the Middle Potomac, Luray sites have been identified in the Appalachian Mountains and Shenandoah Valley, and the site distributions suggests a population movement south and east from the Ohio River Valley (Wall, 2001, 17–23; Manson et al., 1944, 375–376). Similarities in shell-tempered ceramics and palisaded settlement forms between the Luray Complex and the Monongahela cultural tradition raise the possibility that the Luray complex arrived in the upper Potomac Valley by way of the Monongahela and Youghiogheny rivers. Researchers have already demonstrated that climate change impacted the movement of populations in the Ohio Valley during the 1200s, including the movement of Mississippians from drought-stricken areas into the Ohio, settling in Fort Ancient villages during a relatively wet period (Comstock and Cook, 2018, 105). Our assessment of the Middle Potomac Valley aims to detect whether a similar climatic pattern may have played a role in the Late Woodland Potomac Valley circa AD 1400.

Spatiotemporal extent

This case study centers on the upper Piedmont and Great Valley of Virginia and parts of Maryland. To delineate the spatial extent, we included the Virginia counties of Page, Shenandoah, Warren, Frederick, Clarke, and Loudon. We also captured Frederick and Montgomery counties in Maryland. These counties contained key Luray complex communities, as well as the earliest Luray communities identified in a previous study (Gallivan et al., 2023). With this geographic frame, we aimed to capture climatic factors that may have attracted agriculturalists into the Middle Potomac. The environmental landscape in this case is very similar to the environment in the first case study. While previous climate conscious studies of the Ohio Valley may provide signals of the forces contributing to the movement out of territory to the west, we sought to understand how the Potomac climate may have facilitated the movement of communities into the region. There were local communities already living throughout the defined region, meaning that the Luray complex did not move into an abandoned or depopulated area. The Middle Potomac supported Luray communities alongside Shepard and Page communities for decades before Luray communities moved away from the main channel of the Middle Potomac. The chosen geographic scope should capture the locations they originally moved to and later ones.

Temporally, we focused on the period of AD 1301–1500. Estimates place the earliest Luray settlements beginning either in the last quarter of the 14th century or the first quarter of the 15th century. By including the entirety of the 14th century, we were able to assess the drought conditions in the century preceding Luray settlement of the Middle Potomac. This temporal scope provides important contextual information about what may have changed in climatic conditions to facilitate the timing of migration. The following century of PMDI values then characterized the situation in which Luray communities established their presence in the Potomac drainage and

what may have followed to impact subsequent migration. We hypothesized that this spatiotemporal framing would provide a sufficient window into the drought conditions that may have factored into Luray decision-making.

Results

Our analysis of the PMDI data from the Middle Potomac yielded seven identifiable droughts (Figure 3). The first three droughts in this period were longer than we expected for drought events in the Chesapeake region. The earliest identifiable drought in our selected time span began in AD 1307 and lasted for 18 years. This was followed by a more than 20-year gap before the next drought, which began in AD 1347 and lasted for 14 years. After another gap of more than 20 years, the last drought of the 14th century began in AD 1382 and lasted for 13 years. These three droughts accounted for a total of 45 years spent in drought, or nearly half of the 14th century for the middle Potomac.

The 15th century witnessed considerably fewer years of drought, despite there being one more drought than the prior century. The first of these began in AD 1408 and lasted for seven years. There was a 37-year gap before the next drought occurred which began in AD 1451 and lasted for five years. The next drought began in AD 1467 and lasted for seven years, and the final drought began in AD 1484 and lasted for eight years. These last three droughts were each separated by an approximately 12-year gap. There were 27 years spent in drought during the 15th century, according to the definitions we have applied to the data. This means that just over a quarter of the century experienced drought, with most of the drought years occurring in the latter half of the century. The longest span of time without a drought, between AD 1414 and 1451, was the period in which the people linked to the Luray complex likely

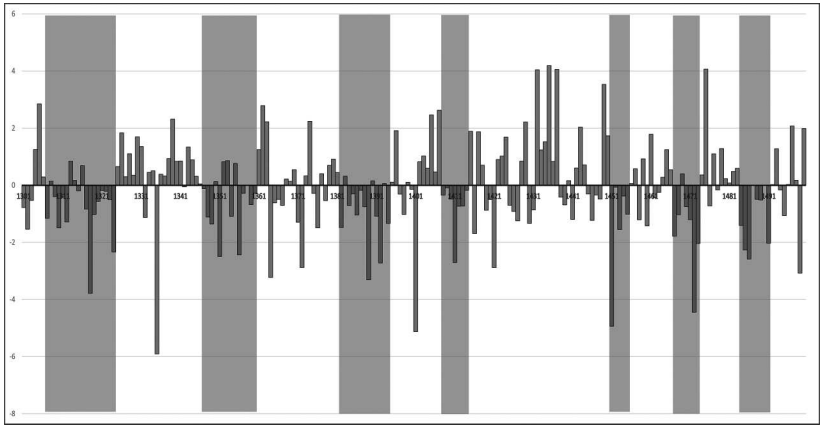

Figure 3. PMDI chart for case 2 with drought events shaded.

arrived in the Middle Potomac valley. That era was the longest period without a drought in the temporal window for this case study. While there seemed to be a shift toward more frequent drought in the last quarter of this two-century period, these droughts were shorter and were altogether preceded by a time where drought was notably absent.

Case 3: Powhatan and Tsenacomacah

Introduction and culture history

Our third case study involves the history of the Virginia Coastal Plain between AD 1407 and 1607, the year that the Jamestown colony was established. The accounts of Jamestown's English colonists frequently emphasize the power of the Powhatan polity, a paramount chiefdom that dominated much of Tidewater Virginia when the colonists arrived (Gleach, 1997; Rountree, 1989; Rountree and Turner, 2005). Comprised of about 30 districts along with the Potomac, Rappahannock, York, and James Rivers, the Powhatan chiefdom was centered on the York River village of Werowocomoco, the residence of the paramount chief (Gallivan, 2016). The Powhatan political structure included regional leaders, or weroances, who paid tribute to the paramount chief in the form of corn, deerskins, and beads. Corn was, in fact, central to the Powhatan's ceremonial practices, chiefly tribute, and landscape management. As evidence of this, colonist Spelman (1998, 493) wrote of the planting of a field for the Powhatan paramount chief. After the community sowed his field, the chief made a circuit, walking backward, and tossing beads to the gathered crowd. In addition to controlling large fields, the Powhatan paramount chief received tribute from other leaders in the form of maize, deer skins, shell beads, copper, and pearls (Smith, 1986, 174). Paramount chief Wahunsenacawh, also known as Powhatan, played a significant role in this process. Through diplomacy, marriage alliances, and military action he brought numerous communities under his sway during the final decades of the 1500s, expanding the territory and population under his direct or indirect influence. This consolidation was not merely territorial but also involved the integration of diverse groups into a more unified political and economic system.

Explanations for Powhatan chiefdom origins have relied on geographical, ecological, and historical influences (Rountree, 1989, 151–3). Paramount chief Powhatan was born near the fall line in the interior Coastal Plain, and the expansion of his political authority eastward may have been motivated by an effort to tap the rich estuarine resources in this area. Alternatively, the chiefdom may have originated near the fall line since this area provided ready access to trade relations with groups to the interior (Potter, 1993). Other explanations center on the importance of territoriality and warfare in the Powhatan chiefdom's origins (e.g., Turner, 1992, 115). A trend toward more limited ceramic distributions and the proliferation of palisades in the period before the Powhatan chiefdom arose offers evidence of this. Finally, interactions with European explorers, missionaries, and colonists in the Chesapeake region

during the enigmatic century before Jamestown may have played a role in the Powhatan Chiefdom's emergence (Barker, 1992). The Powhatan political system may, in fact, have been a response to depopulation following early interactions with Europeans. In this framing, the Powhatan chiefdom was powered by the surplus production of agricultural households, while the domestic economy operated on principles of sufficiency. The expansion and complexity of the Powhatan chiefdom may have been a strategic response to sudden depopulation caused by diseases introduced following the establishment of the Spanish mission at Ajacán in 1570. This depopulation left local leaders with insufficient producers to meet the political economy's demands while maintaining the necessary power structures. In response, Wahunsenacawh may have expanded his geographic influence and authority to fuel the chiefly political economy.

Several explanations for the Powhatan chiefdom's emergence emphasize the importance of surplus maize production during the 16th century (e.g., Blanton, 2000; Stahle et al., 1998). Blanton and colleagues' research into the climatological context for maize production in this region has identified a remarkable pattern of extreme droughts that shaped early colonial interaction. Dendrochronological evidence from the region provides evidence for extreme drought periods coinciding with the initial settlement and early years of the Jamestown and Roanoke colonies. The Roanoke Colony, established in the late 1580s in coastal North Carolina, faced extreme drought conditions shortly after its creation. These conditions exacerbated tensions with Native tribes, difficulties in securing food supplies, and the colonists' overall lack of preparedness for the realities of establishing a colony in an unfamiliar environment. Similarly, the Jamestown settlement encountered severe drought conditions during its first years. The drought would have critically impacted the colony's ability to grow crops and obtain fresh water, contributing to the hardships faced by the settlers during the "Starving Time" of 1609–1610.

Where this research centered on drought conditions linked to early colonial efforts in the Chesapeake and Albemarle Sound area, our research seeks to broaden to temporal frame to include the two centuries prior to Jamestown's settlement. A shift from historical events toward historical processes raises questions concerning whether Native communities in the area had enough experience with drought prior to the colonial period to adapt to it effectively. Blanton and colleagues' research makes it clear that extreme drought shaped early colonial era interaction, though the question remains as to whether extreme climate influenced the rise of the Powhatan chiefdom.

Spatiotemporal extent

We focused on the Virginia Peninsula for our final case study to isolate the center of the Powhatan chiefdom. We used the Fall Line of Virginia as an approximate western limit for this case. Along with the western extent of this space are the counties of Charles City, New Kent, King William, and King and Queen. Filling out the peninsula

are James City, Gloucester, York, Newport News, and Hampton counties. This space contains the heart of the Powhatan chiefdom, including the original six communities that answered to Wahunsenacawh. We defined this region to capture the communities with which he would have been directly interacting in the early days of his rise to power. Additionally, this region would capture the locations of several of the earliest attempts by Europeans to colonize Virginia, namely Ajacán and Jamestown. The ecological parameters of this area of the Chesapeake include deciduous forests and rich natural resources such as a variety of flora and fauna and a mix of riverine settings and swamps and marshes (Turner, 1992).

For our timeline, we initially chose the period of AD 1407–1607. The 15th century gave us context for the decades preceding the rise of the Powhatan Chiefdom. We sought to understand the foundation of climate knowledge on which the political developments of the 16th century would have been built. The 16th century, as well as the beginning of the 17th century, then provided the climate history in which Wahunsenacawh found himself that may have facilitated his rise to power. We extended into the beginning of the 17th century in order to capture the settlement of Jamestown. Analysis of the PMDI data led us to extend this time period to AD 1621 due to a drought previously identified for the time period (Blanton, 2000) which our data supported.

Results

We identified more droughts in this case study than in either of the previously discussed cases. There were nine total droughts between AD 1407 and 1621 (Figure 4). The 15th century was relatively wet in the Tidewater, consistent with the results we found in the Piedmont in our second case. There were 27 years of

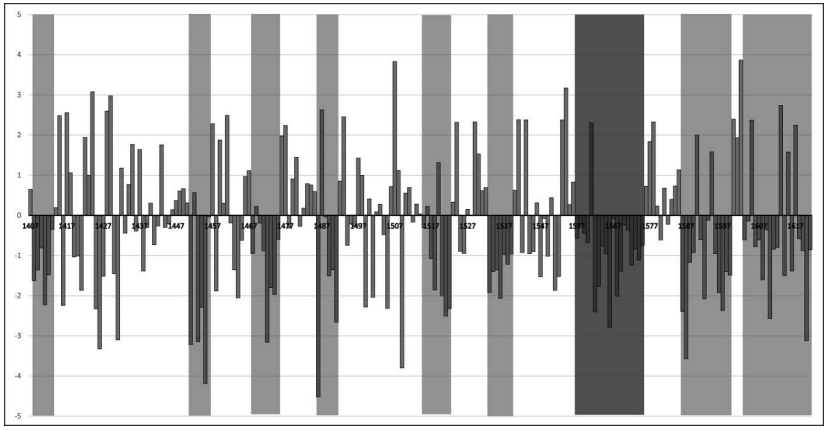

Figure 4. PMDI chart for case 3 with drought events shaded. The megadrought is shaded darker than the other extended drought events.

drought during the 15th century comprising four separate droughts. The longest of these four droughts was eight years, falling between AD 1468 and 1475. The other three droughts during the 14th century were all six years long.

Two more droughts occurred during the first half of the 16th of eight years (AD 1515–1522) and seven years (AD 1533–1539). These two droughts were consistent with the length of droughts during the 15th century. The final three droughts occurred between AD 1557 and 1621. Each of these last droughts lasted for more than a decade. One lasted for 19 years (AD 1557–1575), another for 14 years (AD 1586–1599), and the last for 19 years (AD 1603–1621). We classified the drought of AD 1557–1575 as a megadrought as it was anomalously dry during this period, witnessing only a single year with a positive PMDI average. Each of the other longer droughts was punctuated by individual wet years throughout. However, this megadrought contained a period of 14 consecutive years of drought, an unusually long string of negative PMDI averages. Overall, there were 53 years of drought between AD 1507 and 1607, followed by another 14 years of drought that extended to AD 1621. This was indicative of a shift toward significantly drier conditions from the 15th to the 16th centuries as well as notably longer droughts in the latter half of the 16th century and beyond.

Discussion

Several patterns emerged from the PMDI results that speak to the complexity of the climate history of the Chesapeake region. For Ancestral Monacan Society, we do not have clear evidence that the process of eastward migration was clearly tied to drought. The 12th century was about 1.7 times drier than the 13th century in the valley and piedmont, but neither was unusually dry. The year AD 1200 was preceded by more than three decades without an extended drought. Only one relatively short drought immediately followed the turn of the 13th century. The megadrought that we identified did not begin until AD 1245, late in the period under consideration. While this megadrought may have played an important role in Ancestral Monacan History, the chronology for the migration is somewhat imprecise, and our current understanding of this timeline does not allow us to demonstrate a clear relationship between either wet or dry periods and the Ancestral Monacan shift eastward. The increasing reliance on maize agriculture, population pressure, or some other social factor may have driven the population movement, as can be seen in the complexities of the abandonment of Cahokia (Benson et al., 2009) or in the development of the Vacant Quarter (Krus and Cobb, 2018). While extended drought events were the least common in this case study compared to the two others, one of the more important conclusions that arose from this case was the existence of a megadrought late in the 13th century. Since only two megadroughts were identified across all three case studies, these events were not common and likely had uniquely significant impacts, particularly after the advent of agriculture. While we cannot clearly link an eastward migration to these megadroughts, they may have affected changes in other aspects

of life such as subsistence (Trimble, 1989). Awareness of these climatic events can guide further investigations into historical changes.

While drought may not have played a significant role in the 12th and 13th century in Central Virginia, drought during the 14th and 15th centuries likely had a moderate impact on the Potomac drainage. The 14th century experienced drought in nearly one out of every two years, but only a quarter of the 15th century was spent in extended drought events. The droughts in the 14th century were also considerably longer than those in the 15th century. The people associated with the Luray complex arrived around the turn of the 15th century (Gallivan et al., 2023), entering the region during a period with a prolonged absence of extended droughts. This population movement likely originated from west or north of the Middle Potomac (Wall, 2001). A link between climate change and the movement of Mississippian agriculturalists has been established in the Fort Ancient region farther to the West (Comstock and Cook, 2018). Maize spread throughout southern Ohio and into West Virginia as early as AD 600, becoming a crucial framing force in Mississippian and Fort Ancient subsistence and society (Comstock and Cook, 2024). Drought and agriculture then became entangled as movers in social processes (Comstock et al., 2022).

The connection between drought and agriculture may have been key for developments in the Middle Potomac during the 15th century. Luray communities had already incorporated maize as a significant part of their subsistence strategies and economy prior to their arrival in the Potomac. The wetter conditions of the 15th century may have been a "pull" factor for these agriculturalists, making the Potomac Valley an attractive destination for settlement. The motivations for initiating migration were no doubt complex, and outside the scope of this paper, though it seems probable that the decision to choose the Middle Potomac for settlement was influenced by an understanding of local climatological conditions.

In the final case study, the importance of extended droughts is much clearer. Previous studies have already highlighted early 17th century droughts that impacted European colonies in the Chesapeake (e.g., Blanton, 2000; Stahle et al., 1998), so our results were not entirely unexpected. Early colonists reported periods where they found Virginia to be very dry (White, 2019). The Spanish colonists at Ajacán commented on the severity of drought when they arrived remarking on how the local population was unable to grow a surplus since maize and wild plants were failing (Lewis and Loomie, 1953, 89). The early years of the Jamestown colony were equally fraught with drought. Accounts from the colony document the scarcity of maize, even claiming one situation where a local Native leader asked the colonists to pray for rain (White, 2019). These historical accounts and previous archaeological studies highlight the presence of particular droughts, one in the 1570s, one beginning in 1586, and one beginning in the early 1600s. Our analysis of PMDI data has identified the droughts discussed in each of these accounts, giving us confidence in the validity of our approach. All three of these droughts were unusually long periods of dry weather. We have labeled the drought overlapping with Ajacán's a megadrought due to its length and severity.

Climate-conscious research aimed at contextualizing historical processes like those considered here has the potential to add considerably to our understanding of the pre-colonial past. Prior studies in the Chesapeake region have largely explored the relationship between drought and European colonization. However, the rise of Wahunsenacawh and the expansion of the Powhatan chiefdom can also be discussed in terms of regional climatic conditions over a longer temporal frame. Wahunsenacawh is estimated to have risen to power sometime by the AD 1580 s (Gallivan, 2007), likely becoming a paramount chief shortly after the megadrought coinciding with the Jesuit mission at Ajacán. It is difficult to discern the specific historical process that led to Wahunsenacawh's rise to power, though the timing likely falls in the longest time span without extended drought for a period of nearly 70 years. It is possible that the success of agriculture during this time may have facilitated an increase in the intensity of exchange and surplus production. Wahunsenacawh may have seized the opportunity to consolidate control over maize production and exchange and bring communities under his control during this interval. It is also possible that his rise to power occurred closer to the onset of the drought beginning in AD 1586 as in response to a period of climate stress. The uncertainty in the precise timing of the beginning of the Powhatan chiefdom makes it difficult to ascertain the exact relationship between Wahunsenacawh's rise and drought conditions, though the timing raises the possibility of a connection to the two major droughts in the latter half of the 16th century.

The three case studies reveal a spectrum of possible associations between drought and historical processes in the Chesapeake region. The approximately AD 1200 migration of Ancestral Monacan communities into the Piedmont was not obviously linked to climate. In the Middle Potomac, the arrival of people associated with the Luray Complex coincided with a transition to shorter and less frequent droughts in the 15th century. The wetter conditions may have been attractive for these Luray Complex agriculturalists moving from the West. Finally, the rise of Wahunsenacawh was situated in the interval between two significant extended droughts in the Tidewater. The shift to a far-reaching political structure under Wahunsenacawh may have coincided with favorable rainfall during the only decade of positive average PMDI, or by the need for political consolidation in the face of unusual environmental stressors. It is also clear that each attempt at European settlement of the Chesapeake region was unfavorably timed in the midst of prolonged major drought, as others have demonstrated previously (e.g., Blanton, 2000).

These case studies demonstrated the complex variation in both climate conditions and in the cultural approaches to climatic variation. The Chesapeake region was never faced with the dramatic and persistent multidecadal megadroughts that contributed to massive migrations and depopulations across much of the Eastern Woodlands (e.g., Cable, 2020). Within the Chesapeake region, there was a much more granular pattern of drought that nonetheless would have impacted cultural processes. Areas of the region were affected by different rainfall conditions at different times. Elsewhere, drought followed centuries-long patterns whereby there was either

persistently wet conditions or persistently dry conditions (Benson et al., 2009; Comstock and Cook, 2018). Within the Chesapeake, rainfall did not follow such a long-term pattern. Instead, variation occurred at the scale of decades.

The variation in climatic conditions across centuries and physiographic regions demonstrates that Native populations needed to be attuned to the local histories of rainfall patterns, particularly after the spread of maize-based agriculture. Historical processes throughout the Chesapeake were impacted by climatic factors that influenced decisions around movement and political structure. The impact of drought was variable but increased significantly after most Chesapeake communities adopted some degree of reliance on maize for meeting subsistence needs. Consciousness of these histories would have been crucial for the decisions made in the face of climatic changes. Patterns in rainfall would influence the productivity of agriculture and strategies of subsistence. The influence of drought, particularly abnormal drought, may also have weighed heavily in decisions to migrate or dissolve settlements.

The cultural variation occurred for a number of reasons, but primarily was the result of the agency of individual people and communities. Different circumstances and political structures contributed to a variety of approaches to climate change and abnormal rainfall events. Communities developed an understanding of their environments and managed the patterns that manifested over generations. It was necessary for them to learn the environment (Blanton, 2003b) which allowed for an acute awareness of any drastic annual or decadal changes.

Conclusion

We presented here an approach to archaeology that aims to be climate-conscious in our interpretation of the past. Research by environmental scientists and climatologists provides empirically driven definitions for different categories of droughts. In this paper, we adopted these definitions in a rigorous approach to studying historical climate and the human past. Following Williams and colleagues (2022), extended droughts are defined as a decade or more of negative ten-year trailing PMDI averages, trimmed to avoid consecutive positive years within the first or last ten years covered by the trailing averages. *Extended droughts* may also include any period of five or more consecutive years of negative PMDI values. *Megadroughts* are any extended drought that is significantly abnormal for the chosen context. These definitions provide a means for empirically assessing the history of rainfall patterns in a given region. This effort supports our advocacy for a *climate-conscious archaeology*. The objective to develop deep and eventful histories in archaeological research is aided when scholars consistently consider the meaningful relationship between people and climate change.

This paper develops an empirical approach to clarifying historical patterns in the Chesapeake region to better understand the human–environment interactions of ancestral Monacan peoples as well as their Iroquoian and Algonquian counterparts elsewhere in the interior and in the Tidewater prior to and shortly after the onset of European colonialism. Deploying climate proxies for the Late Woodland and early

Contact period facilitates a better understanding of the relationships that Native peoples had with their landscapes and how those relationships contributed to settlement patterning, political systems, and other culture processes.

The Chesapeake region exemplifies the variability of climate and rainfall even across small geographic spaces. We used PMDI data in conjunction with definitions of extended drought and megadrought to detail the complexities of Chesapeake regional history. Our research affirms that the effects of climate change and drought in this context could be insignificant or unclear, such as with the Ancestral Monacans, to being very impactful, such as in the Virginia Tidewater. Deploying more specific definitions of drought, developed by environmental scientists, into archaeological contexts is important for exploring localized variation and intensity of drought. This effort brings the Chesapeake area into conversation about drought and megadrought with neighboring regions. By improving our definitions and accounting for local patterns, archaeologists can broaden our understanding of the unique relationship between ancestral Native American communities and their environments. This research program facilitates an improved investigation of modern climatic changes by demonstrating historic human–environment relationships to better prepare for and estimate the impacts of modern climate on global populations.

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Kaleigh Pollak is a combat Army veteran and tribal citizen of the Monacan Indian Nation headquartered in Amherst, VA. Her involvement with the tribe consists of volunteering her time to assist in educating the tribal youth during culture classes, as well as a member of the powwow committee and most importantly the Monacan NAGPRA Committee. She participates in consultation with state and federal agencies, as well as institutions and museums, regarding the handling and repatriation of historical and culturally significant artifacts and ancestral remains. Historic preservation and community education regarding tribal history is of utmost importance for her. Having concise and scientifically accurate information pertaining to her tribal history is a key factor in better understanding her people and aids in the education of the community of Monacan tribal survivance and perseverance.