ARTICLE IN PRESS

Quaternary International xxx (2016) 1–17

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Sediments, soils, and the expansion of farmers into a forager's world: A geoarchaeological study of the mid-to-late Holocene in Hwange National Park, Zimbabwe

Teresa Wriston [a, *], Gary Haynes [b]

[a] Desert Research Institute, Reno, NV 89512, USA
[b] University of Nevada, Reno, NV 89557, USA

A R T I C L E I N F O

Article history:
Received 13 December 2015
Received in revised form
5 November 2016
Accepted 9 November 2016
Available online xxx

Keywords:
Agropastoralism
Late Stone Age
Early Iron Age
Geoarchaeological land use modeling
Carbon isotopes
African archaeology

A B S T R A C T

The transition from foraging to food production in interior southern Africa is still not well understood, despite being central to hypothesized migration and diffusion routes connecting the earliest agropastoralist sites in central Africa with the southern African subcontinent. Hwange National Park (14,650 sq. km), Zimbabwe is located along these proposed routes and has both Late Stone Age and Early Iron Age sites that can address this transition.

To better understand this change in lifeways and any environmental and/or topographic factors that influenced it, geoarchaeological investigations characterized the soils, sediments, and landforms in six different areas of the park. Forty-eight stratigraphic sections varying from two to four m thick were described, six of which are detailed here. These stratigraphic sections include dated material that allows correlation between basins of different substrates and comparisons of carbon isotopic signatures to reveal whether conditions were locally favorable to grasses (hot/dry) or woodlands (cool/wet) through time.

Examined river cuts and augered samples show that some river basins have sediment textures, soil types, and topographic relief that should have been attractive to farmers. However, radiocarbon ages reveal variable potential for finding remains of any early farmers from basin-to-basin, with some bedrock-constrained valleys having no preserved deposits of appropriate age. The repeated scouring of these river basins testifies to sometimes volatile conditions that would have challenged sustained food production.

In fact, in the study area landscape instability and variable environmental conditions were commonplace during the past three millennia. Drought between ca. 2.8 and 2.6 ka may have lessened the risk of disease vectors for the earliest agropastoralists that arrived during more mesic conditions between 1.9 and 1.65 ka. At this time basins began to accumulate fill and soil development suggests landscape stability even in headland basins. Changes in soil carbon isotope values imply relatively hot/dry conditions prevailed around 0.73 ka and 0.41 ka and cool/wet conditions around 0.53 ka, but much information has been lost due to the numerous erosional events that wiped away swaths of sediments during intervening droughts. The landscape in Hwange National Park continues to change rapidly as reflected by several meters of river downcutting in response to recent man-made disturbance and/or drought. This downcutting both reveals and endangers the few remaining archaeological sites that are critical to understanding the first food producers in the region.

1. Introduction

Hwange National Park is within or near several hypothesized southward expansion routes of agropastoralists from core areas in central Africa (e.g., see Bousman, 1998; Elphick, 1977; Huffman, 2007; Mitchell, 2002; Sadr, 2008). Farming and pastoralism

* Corresponding author.
E-mail address: tawriston@gmail.com (T. Wriston).

http://dx.doi.org/10.1016/j.quaint.2016.11.010
1040-6182/

(known together as agropastoralism), are considered hallmarks of the Early Iron Age and were relatively late adaptations in southern Africa when compared to the northern extent of the continent, where they occurred as early as 10 ka (Van Zinderen Bakker, 1976). As Gifford-Gonzalez (2000) suggests, this delay was partly due to the disease vectors found in the wooded area, including tsetse fly and mosquitoes that respectively carry sleeping sickness (*nagana* in animals) and malaria. These vectors often foiled European colonists' plans for expansion (cf. Chapman and Tabler, 1971; Holub, 1975), and continue to be a threat to the health of both man and beast when, after a drought, wet conditions and woodland expansion occur (cf. Endfield et al., 2009). Therefore, the initial adoption of agropastoralism in our study area, situated near the recent boundary of tsetse fly habitat (cf. Cecchi et al., 2008), would have had to take place within an environmental window that had sufficient precipitation for crops to survive, but was sufficiently dry to minimize woodland cover and suppress the risk from disease vectors.

This study's aim was to provide baseline environmental and landscape information for northwestern Zimbabwe between ca. 3.5 and 0.5 ka, a period that encompasses the earliest agropastoralism in the region. How and why plant cultivation and/or pastoralism spread is complex and varies by locality, but minimally, the environmental conditions had to be able to support agriculture and domestic animals. Stratigraphic analyses can reveal environmental conditions through soils (Catt, 1990), which signal landscape stability during mesic conditions, and unconformities, which signal instability and drought (cf. Eze and Meadows, 2015; Heinrich and Moldenhauer, 2002). Any landscape level changes can be correlated between basins using these diagnostic strata to establish a soil chronosequence (cf. Botha and Porat, 2007). This process also reveals the areas of Hwange National Park that are most likely to contain sediments and soils that preserve the remains of early agropastoralist settlements.

2. Regional setting

2.1. Environmental background

2.1.1. Geology and soils

Hwange National Park straddles the watershed between the Zambezi Basin to the north and the Makgadikgadi pans of Botswana's Kalahari Desert to the south. The northern portion of the park has undulating topography with drainages cutting into bedrock ridges of basalt, sandstone, granite, gneisses, and various other materials (Sithole, 1994; Fig. 1). The central and southern portion of the park is covered with red Kalahari sand sheets separated by long linear dunes. These dunes were formed during the Pleistocene and have been sporadically reworked during Holocene dry periods (Stokes et al., 1998; O'Connor and Thomas, 1999).

This parent material influences the success or failure of agricultural crops. Basic volcanic rocks, such as basalt, contain the full range of the earth's crustal elements and weather to clay, allowing good soil development and high plant productivity due to the abundance of available nutrients (Bell, 1982; Limbrey, 1975); but within Hwange National Park, basalt areas have developed only thin lithosols according to Nyamapfene (1991). Conversely, granite rocks and quartz sand, comprised of relatively coarse, weather-resistant minerals, have less variety and abundance of essential minerals and nutrients required by plants (Bell, 1982; Limbrey, 1975; Norman et al., 1984), as in the regosols of the Kalahari sands (Nyamapfene, 1991). However, fersiallitic soils (Nyamapfene, 1991; a Zimbabwe-specific soil categorization similar to alfisols) have been identified in the paragneisses and granites of the northeastern study area and are good for agriculture due to their well-developed B-horizon/soil structure, high field capacity, and good drainage.

In addition to the importance of the type of bedrock from which sediment originates, erosion redistributes it and associated nutrients through the drainage system, enhancing the fertility of valley floors and river floodplains while depleting the uplands (Limbrey, 1975). Given the bedrock lithology and soil types within the Park, we expect that prehistoric farmers would be attracted to basins with fersiallitic/alfisol soils and to floodplains that drain areas with basic volcanic rocks.

2.1.2. Precipitation patterns

Northwestern Zimbabwe is near the southern extent of the Intertropical Convergence Zone (ITCZ) that impacts rainfall amount and distribution. Precipitation falls November to March while the remainder of the year is dry. Any surface waters accumulated during the wet period dwindle during the dry period, eventually leaving few, if any, sources of water until rains come again. This wet-and-dry season distribution of rainfall creates annual short term drought signatures within the geomorphic record (cf. Thomas and Burrough, 2012). Long droughts are frequent, and when drought extends over several years, significant geomorphic response, such as deflation and scour of slopes and alluvial basins, is likely. The mean annual rainfall in the park is around 620 mm/year (Rogers, 1993), but annual values and distribution are erratic and unpredictable (Nyamapfene, 1991). For instance, between 1918 and 1990, annual rainfall at Main Camp ranged from 335.6 mm to 1159.8 mm (Rogers, 1993).

The unimodal distribution of annual precipitation within southern Africa creates challenging conditions for farmers, who have learned to use sediment texture and topographic position to their advantage. For example, Scudder (1971, 1976) reports that the Gwembe Tonga people of the middle Zambezi River Basin plant wet season crops that grow during the rains in well-drained, sandy soils high on the landscape, while water-tolerant crops are planted along river ways. With the onset of the dry season, loamy soils on alluvial terraces are again planted in hopes that the water absorbed by the clay portion of the loam slowly releases to the crops, allowing their maturation under dry conditions. Gardens on alluvial terraces are therefore most valued because they could be cropped twice per year while local topographic relief that allows flexible field placement above the river is also desired. These strategies of mid-twentieth century farmers allow us to speculate that similar substrates and topographic locations were preferred by prehistoric farmers within this volatile environment. Similar patterns have also been recognized by archaeologists working in Botswana. Denbow (1984) has shown that Early Iron Age archaeological sites with small kraals are preferentially situated on boundaries of clay and sand substrates.

2.1.3. Vegetation and carbon isotopes

Trees and shrubs in Africa use the C_3 photosynthetic pathway, whereas grasses predominantly use the C_4 photosynthetic pathway (Wang et al., 2009). C_4 plants use water more efficiently than C_3 plants, particularly during the dry season in arid environments (Wang et al., 2010), and they also have higher photosynthetic rates at high temperatures and under high light conditions (Farquhar et al., 1989a,b). Thus, C_4 plants are more successful than C_3 plants when growing season temperatures are high and light levels are moderate to high (Sage et al., 1999; Still and Powell, 2010), such as in grasslands and savannas with limited tree cover (Long, 1999). Goodfriend (1999:503) and others (Ambrose and Sikes, 1991; Ambrose and DeNiro, 1989; Bird et al., 2004; Farquhar et al., 1989b; Levin et al., 2006; Wang et al., 2010; Wynn and Bird,