

The Conundrum of Great Zimbabwe

ABSTRACT Great Zimbabwe (AD 1100–1700) was a substantial settlement comprising elite residences and non-elite housing, largely characterized by complexes of massive stone-walled structures. Its growth had an impact on energy resources within its immediate and broader environment, with water playing a key role in the development and persistence of the settlement. The settlement layout that extends beyond the monumental structures comprises water reservoirs and perimeter walls, which for several centuries sustained a substantial population living beyond the core urban area. This article sheds light on the ‘conundrum’ of Great Zimbabwe’s massive stone-built structures. A reconsideration of the functioning of Great Zimbabwe informs the conundrum, which is relevant to contemporary discussion on urban design, architecture, energy saving, and environmental sustainability.

KEYWORDS Great Zimbabwe; sustainability; water management; urban landscapes; African urbanism.

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Introduction

Since the monumental architecture of Great Zimbabwe and sites related to it became known to Westerners in the sixteenth century, the scope and grandeur of the site have never ceased to amaze observers. From the days of the earliest Portuguese travellers’ narratives, speculation about the site has been continuous and inventive (Pikirayi 2001a; 2001b). Since serious scholarly interest started in the late nineteenth century, the debate on the origins, development, and decline of the culture once based there and later elsewhere has never stopped.

Innocent Pikirayi (innocent.pikirayi@up.ac.za) is a Professor in Archaeology at the University of Pretoria, South Africa and an honorary research associate at the McDonald Institute for Archaeological Research at the University of Cambridge, UK. His research interests include geoarchaeology, development of ancient complex societies, water and social formation, and climate change. ORCID iD: 0000-0002-9598-7631.

Federica Sulas (fs286@cam.ac.uk) is a senior research associate at the McDonald Institute for Archaeological Research, Cambridge, UK. With expertise in geoarchaeology and historical ecology, her main research interests are in landscape evolution, farming, and water. ORCID iD: 0000-0003-1825-8133.

Shadreck Chirikure (shadreck.chirikure@arch.ox.ac.uk) is formerly Professor of Archaeology at the University of Cape Town, South Africa, where he established a Materials Laboratory and specializes in the study of pyrotechnologies. He is currently Professor of Archaeological Science, University of Oxford and an honorary research associate at the McDonald Institute for Archaeological Research at the University of Cambridge, UK. ORCID iD: 0000-0002-2183-4253.

Joseph Chikumbirike (joseph.chikumbirike@spu.ac.za) is a senior lecturer at Sol Plaatje, Kimberley, Northern Cape, South Africa. His research interests are in anthracology, paleo-environments and paleo-agroecosystems. He also has a growing interest in the application of phytoliths and diatoms in archaeology. ORCID iD: 0000-0003-2716-9191.

Munyaradzi Elton Sagiya (msagiya@buse.ac.zw) is a lecturer in the Faculty of Social Sciences and Humanities at Bindura University of Science Education, Zimbabwe. From 2010 to 2021, he was a resident curator at Great Zimbabwe National Monument and World Heritage Site. His research interest includes but is not limited to dry-stone masonry, heritage of water, and the archaeology of southern Africa. ORCID iD: 0000-0001-9809-468X.

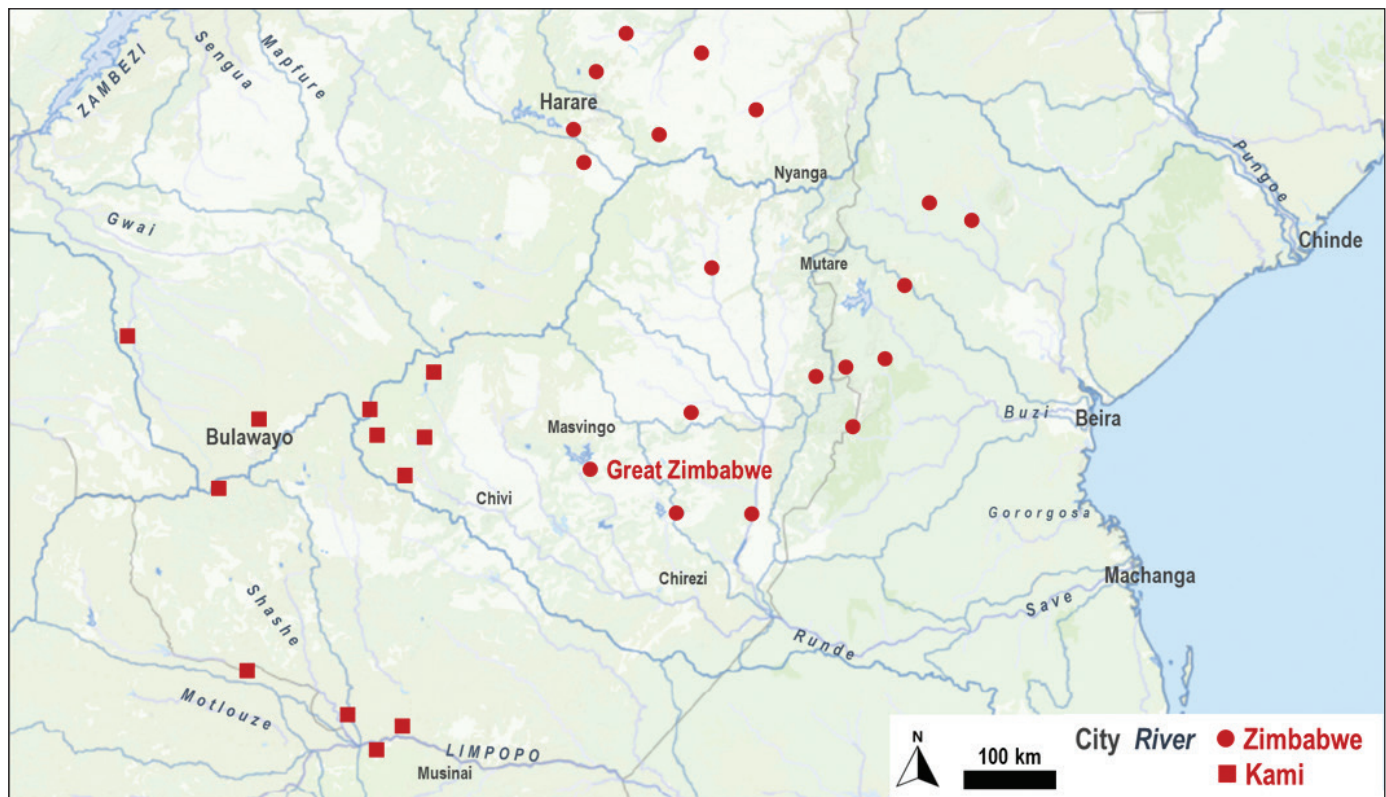


Figure 6.1. Regional map showing the approximate distribution of Zimbabwe Culture walls in southern Africa and the location of Great Zimbabwe. Basemap from FAO Aquastat; dots are free-standing walls, and squares are retaining walls of Leopard's Kopje/Khami, data from Garlake (1970). Map prepared by Federica Sulas.

With increased archaeological research throughout the twentieth century, and at the beginning of the twenty-first century, it has become even more complex. From the viewpoint of heritage, Great Zimbabwe is testimony to a major civilization that existed in southern Africa between the eleventh and seventeenth centuries AD. The settlement, whose remains cover some 720 ha, was an important production and trading centre, connected to the worlds of central and southern Africa, the northern Indian Ocean, and the Far East (Chirikure 2021). Great Zimbabwe fits into a conventional category of settlements that only exists on the Zimbabwe Plateau and adjacent regions of eastern Botswana, the middle Limpopo Valley of South Africa, the Mozambican plains, and nowhere else in the world. As such, Great Zimbabwe is the best-studied example of a settlement tradition that provides a conundrum to African urbanism(s): How we should characterize these monumental, stone-built structures that are unique to this part of southern Africa. They were certainly major settlements, far exceeding the sizes of farming villages that dominated the region before the eleventh century AD, showing considerable internal func-

tional differentiation, greater regional cooperation and integration. Their appearance further brought southern African societies into the global, commercial network of eastern Africa and Asia.

The Portuguese referred to Great Zimbabwe and hundreds of other similar stone-built structures littering the Zimbabwe escarpment as 'great stone edifices', which they thought served as palaces for the biblical King Solomon, the Queen of Sheba, and the legendary Prester John. The inhabitants of *Mukaranga*, whom the Portuguese encountered from the early sixteenth century onwards, called these *simbae* (*zimbabwe*, 'houses of stone'), meaning centres of authority and power (Diogo de Couto, *Décadas da Ásia*, ix. 25, in Theal 1898–1903, 390). The Portuguese views were reinforced by antiquarian investigators from the late nineteenth century onwards, the Hill Complex at Great Zimbabwe being thought of as a copy of the biblical Solomon's temple, while the Great Enclosure was seen as a replica of the palace the Queen of Sheba stayed in when she visited Jerusalem. The auriferous nature of southern Africa reinforced the idea of Ophir, as the source of King Solomon's gold. Theodore Bent (1896) referred to Great Zimbabwe and other monumental structures in the region as 'cities'. During much of the twentieth century, professional archaeologists have realized the monumentality associated with Great

Zimbabwe and other places, but accompanied by minimal discussion on what these represented (see e.g., Huffman 1977). These sites are currently interpreted as ancient African, urban centres (Manyanga, Pikirayi, and Chirikure 2010; Sinclair 2012; 2019; Sinclair and others 1993), which exemplify a transformation of the region from agrarian modes of production to complex socio-political forms.

Evidently these structures were local in origin (Caton-Thompson 1931; Garlake 1973) and, in terms of size, were more than just large villages. Roland Fletcher (2019) argues that they, like their counterparts in Asia, Europe, and the Americas, might be usefully considered as a class of settlement with ‘no name’, which he refers to as ‘Giants’. As undefined phenomena, they transform the global understanding of settlement growth, gain new significance in regional culture histories, and have implications for our urban future.

Focusing on Great Zimbabwe, this paper evaluates the nature and form of early anomalous settlements in southern Africa, arguing that these centres defined futuristic settlements. Their size and density had a bearing on sustainability, which is also connected to their continued existence or eventual demise.

Settlement, Sustainability, and Water

In this paper, we use ‘sustainability’ to serve two interconnected purposes: one that deals with examining the nature, working, and impact of settlement at Great Zimbabwe; and a second one that considers the relevance of this settlement sequence to debates about urban sustainability in the past, the present, and the future. In addressing the ‘urban anomaly’ presented by Great Zimbabwe, we refer to sustainability in broad terms as the ability or capacity of a settlement system to sustain human well-being and environmental integrity over time (see e.g., Redman 2014; Smith and others 2021; Tainter 2006). How long such a timeframe should be, remains a matter of discussion. Smith and colleagues (2021), for example, have recently made a compelling case that settlement persistence — the continuous use of a place through time — over the long term is critical to (urban) sustainability. Eliciting archaeological evidence of continuous occupation at a sample of ancient cities, spanning the over four thousand years-long occupation at Uruk, in ancient Mesopotamia, to the few centuries-long one of medieval Kilwa, along the East African coast, only two of the several cases considered, Smith and colleagues identify three main causes of settlement persistence:

settlement size, institutions, and geography; these are considered irrespective of the form.

When settlement forms are considered, then the question of persistence complicates even further. Examining and correlating the form and density of ancient urban settlements, Fletcher (1986; 1993; 1995) first recognized and conceptualized the development and working of ancient settlements characterized by low-density occupation extending over vast terrain, in contrast to compact, high-density ones. These gigantic, low-density settlements appear to have no connection with modern cities, whereas compact ones do and sometimes persist over thousands of years (Fletcher 2019). The latter, thus, seem sustainable over the long term, whereas gigantic settlements appear doomed to failure.

Current studies on water suggest that dispersed, low-density developments can exacerbate non-point source pollutant loadings by consuming absorbent open space and increasing impervious surface area relative to compact development (Richards, Anderson, and Santore 2003). However, low-density and dispersed settlement has enabled long-term water security in some regions such as parts of Mesoamerica. Cities and agro-urban landscapes of the ancient Maya and Aztec, for example, supported low-density settlement, often in semiarid environments, by managing water and soils at different scales, including, among others, large water reservoirs, community irrigation, watershed engineering, and urban gardens (Isendahl 2012; Isendahl and Smith 2013; Scarborough and Isendahl 2020; Scarborough and others 2012; Tainter, Scarborough, and Allen 2018). These and other practices to create and maintain water-food security were intimately linked to, embedded in, and the sources of distinctive socioecological knowledge, belief systems, ritual institutions, and governance (see e.g., Isendahl, Lucero, and Heckbert 2018; Lucero 2003). Such a physical-spiritual apparatus enabled Mayan cities like Tikal and Caracol to support low-density settlement for well over a thousand years, hosting populations of over one hundred thousand and extending to several thousands of hectares (Chase and Cesaretti 2019; Chase and Chase 2020; Smith and others 2021). While political, economic, and social changes led to the abandonment of Caracol and other cities in the late first millennium AD, people continued to live and sustain agro-urban landscapes (see e.g., Isendahl 2012; Scarborough and others 2012).

The issue of sustainability thus splits the nature of large, dispersed, and low-density settlement between one that delivers urban longevity and ones that does not. Either side of the argument, what is clear is that there is a relationship between quality of water (land,

and other natural resources) and growth patterns. These considerations inform the Great Zimbabwe conundrum and invite us to reflect upon it from different but novel standpoints.

Sustainability is important when considering the fate of Great Zimbabwe, as the natural resources around it indicate an ecosystem with some inherent fragilities, e.g., water scarcity, poor soils. These have a bearing on the settlement 'process' at Great Zimbabwe and determine the type of settlements found especially on the periphery, which might have required less aggregation, less density, and far fewer monuments. At Great Zimbabwe, we take a contextual approach and frame the temporal latitude of sustainability around biophysical conditions and changes impacting directly on the well-being of local people and natural resources. Supported by improved chronologies and survey records, while mindful of persisting data lacunae, we can interrogate Great Zimbabwe's records to ask if its settlement pattern was sustainable, in what way, for whom, and for how long. Such a quest irremediably takes us to deconstruct and reconfigure understandings of architecture, material culture, power structures, social institutions, and socioecological interactions. In doing so, we hope to add texture and fabric to the reconstruction of the development, functioning, and legacies of Great Zimbabwe settlement in the context of new global approaches to giant, anomalous places in its category, in other parts of the world. The objective is to further dialogue on Great Zimbabwe, to understand what it was.

Physiography

Great Zimbabwe is situated in the southern sections of the Zimbabwe escarpment, at about 1150–1250 m above sea level (Fig. 6.1). The physical landscape comprises whaleback grano-diorite hills. The hills define a watershed with several micro-catchments, drained by streams and small rivers towards the Mutirikwi and Tugwi Rivers. These rivers flow south-eastwards draining into the Runde River, which in turn joins the Indian Ocean-bound Save River. The vegetation is a mixed savannah woodland with *Brachystegia* and varieties of acacia vegetation found on slopes of granite hills and adjoining valleys. Some 10 km west of Great Zimbabwe are greenstone schists trending south-west and north-east, where evidence of pre-European gold workings has been recorded (Phimister 1974; 1976). The weathering of grano-diorite rock has been exploited since the early second millennium AD, as stone could easily be shaped into building materials and used in the construction of resi-

dences (*dzimba dzemabwe* or *zimbabwe*, 'houses of stone') (Pikirayi 1993; 2001a).

Compared to other regions of the escarpment, Great Zimbabwe is located in an environment with adequate, though variable, summer rainfall (800–1300 mm) and periodic winter rains (locally known as *guti*) to allow the cultivation of cereals such as maize, sorghum, and millet. Recent survey suggests the granite geology was exploited very intensely to capture underground water sources for use at the site (Pikirayi and others 2016; 2022). This practice is still carried out today around Great Zimbabwe, where farmers use water to irrigate maize and vegetables. Apart from the variable annual rainfall, extremely high summer temperatures are a constraining factor to subsistence activity. Droughts and arid conditions occur frequently (Scoones and others 1996). Significant periods of aridity during the last thousand years (Huffman 2008; 2010a; Tyson and Lindesay 1992) may have triggered large-scale abandonment of such regions. Chiefdoms and states may have arisen as collective responses to these constraints, through the control of strategic resources such as water, cattle, and grain (Kim and Kusimba 2008; Huffman 2009a; 2009b; 2010b). However, there are suggestions that communities were resilient, responding to constraints and taking advantage of opportunities, which partly accounts as to why Great Zimbabwe survived for several centuries.

Origins

Prior to the rise of Great Zimbabwe in the early to mid-thirteenth century AD (Chirikure and others 2013a), the region was inhabited by farmers, as attested at Chivowa, Gumanye, and Great Zimbabwe hills (Sinclair 1985; 1987). Their material culture shared similar cultural traits with those found in the middle Limpopo Valley and adjacent areas. In effect, southern Zimbabwe was part of mainstream developments in the region encompassing the middle Limpopo Valley and other areas of southern Africa for much of the tenth-twelfth centuries AD (Chirikure 2021). Emerging chiefdoms and possibly state-level societies competed for power and different resources including land, cattle, gold, and other trade commodities with the Indian Ocean coast (Pikirayi 2001a; 2001b; Huffman 2007). However, it is the manner in which farmers in southern Zimbabwe responded to the Indian Ocean trade that shifted the momentum in their favour. Those around Great Zimbabwe seized upon this opportunity during the twelfth century and increasingly wrestled for political and economic dominance of the southern Zimbabwe escarp-

ment from the thirteenth century onwards. At Chivowa and Great Zimbabwe, the first substantial houses appeared, the design of locally made ceramics changed, and access was gained to a greater number of imports (Sinclair 1984; 1985). During the thirteenth century, this process rapidly advanced as indicated by the building of dry masonry stone walls, using blocks of granite that screened the compounds of prominent people. By *c.* AD 1250, the foundations of an elaborate urban centre had been set. While the importance of agriculture and cattle (Garlake 1978) must not be overlooked in the rise of Great Zimbabwe, long-distance trade played a huge part, acting as a powerful catalyst transforming localized tribal organizations into regional ones. Both land and cattle were essential in developing a vital social network of associates, clients, and kinship ties, and to enfranchise management of goods and services distributed as benefits within traditional political and social institutions.

The southern Zimbabwe escarpment seems to have offered a more favourable environment and climate for the support of a large, urban complex and territorial state (Pikirayi 2001a). By AD 1250, Great Zimbabwe was clearly the more preferred destination for Indian Ocean traders; with the consequence that Mapungubwe and other polities in the middle Limpopo Valley were undercut, losing their wealth in the process (Pikirayi 2003a). The fate of floodplain agriculture in the middle Limpopo Valley is not clear during this time, but a large-scale abandonment of the region towards more favourable environments may have triggered further the region's demise. Other scholars link the rise of Great Zimbabwe to the ideology of rainmaking or control (Huffman 2009b). However, this is not practical and clearly not supported by Karanga and Rozvi histories and ethnographies (Pikirayi 2001b). These histories and ethnographies point to rainmaking centres or cults located away from centres of political power, with responsibilities for rain ceremonies entrusted to members autochthonous to particular regions, and not linked to the ruling elite or even rival dynasties.

Great Zimbabwe's location points to the possibility of a viable agriculture even under drier climatic



Figure 6.2. View of the landscape of Great Zimbabwe showing monumentality in relation to (current) environmental settings. This image shows the Great Enclosure and Valley Complexes as seen from the Hill Complex, 2018. Photograph by Innocent Pikirayi.

conditions (Holmgren and Öberg 2006). Added to this must be local water-management strategies used to capture, conserve, and use water from the surrounding granite landscape (Musindo 2019). The rise of Great Zimbabwe, ultimately, was a combination of economic opportunities driven by gold resources as well as the need to manage a variety of environmental assets and hazards, in a region where droughts and prolonged periods of aridity, high rainfall and flooding, were common.

Settlement Layout

Unfolding over a granite hilly terrain (Fig. 6.2), the layout of structures at Great Zimbabwe defines a core residential area, characterized by massive and imposing monumental architecture, and an outlying zone, with far fewer substantive settlements.

The first stone structures were built on a whaleback hill during the twelfth and thirteenth centuries (Chirikure and others 2013b). They are collectively referred to as the Hill Complex. Here two very large enclosures (the Western Enclosure and the Eastern Enclosure) and several smaller intervening ones, all constructed from and in between natural granite boulders, define living spaces, presumably for royalty (Chipunza 1993). A ritual spearhead, iron gongs, and soapstone bird effigies attest to the existence of



Figure 6.3. Aerial view of the Great Enclosure showing the Conical Tower and spatial relations to Valley Complexes. Photograph by Elton Munyaradzi Sagiya.



Figure 6.4. Excavations by Richard Hall in the Great Enclosure during the early twentieth century. Photograph courtesy of Great Zimbabwe Conservation Centre Archive.

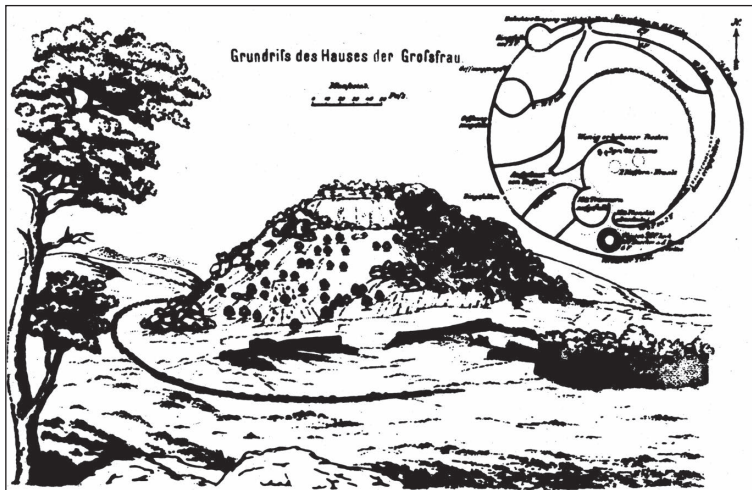


Figure 6.5. German geologist Karl Mauch's sketch plans and three-dimensional representation of both the Hill Complex and the Great Enclosure at Great Zimbabwe. After Burke 1969, reproduced in Pikirayi 2001b.

royalty (Huffman 1996, 142–45). Commoner settlements at the base of the hill were enclosed within a perimeter wall, but soon the population became too large to be retained inside it. With the expansion of the settlement, royalty shifted to the more elaborately built elliptical complex, named the Great Enclosure (Fig. 6.3). Constructed during the thirteenth and fourteenth centuries, it is the largest single, stone-built structure in southern Africa. It has a girdle wall 244 m long, 5 m wide, and 10 m high. The Great Enclosure, which is accessed via three entrances to the north and north-west, encloses a passage leading to a conical tower and a number of smaller enclosures. The destructive activities of antiquarian investigators during the late nineteenth and early twentieth centuries make it difficult to determine how this massive structure was utilized (Garlake 1973) (Fig. 6.4), but it appears the enclosures partitioned domestic and public spaces, some perhaps serving ritual functions (Huffman 1985; 1996, 147–54). Overall, the Great Enclosure represents the peak development of Great Zimbabwe both as a major settlement and as a state (Chirikure and Pikirayi 2008; Pikirayi and Chirikure 2011).

Three enclosure complexes were constructed adjacent to the Great Enclosure and extending to a nearby valley to the north-east and east (Figs 6.5–6.6). Previously referred to using names given by early European visitors, in postcolonial times these enclosures are known as the Valley Complex and include the Western Central and Eastern valley enclosures. They date from the fifteenth century onwards, and probably represent the royal palaces used in the terminal periods of the settlement. The Central valley enclosures returned one of the famous soapstone curved birds — the remaining seven have been recovered at the Hill Complex (Matenga 1998).

A second perimeter wall, which is well defined to the west of the settlement, attests to the continuous growth of Great Zimbabwe. Beyond these are 'peripheral settlements', being stone enclosures located on hills around Great Zimbabwe (Huffman 1996). Their function has not been established archaeologically. It has been suggested they housed members of the ruling family (Huffman 1996), or catered for the increased administrative functions of the metropolis (Pikirayi 2001b). Some areas between the core and the peripheral structures revealed dense mud-built structures, interpreted as commoner housing (Huffman 2007). Sulas and Pikirayi (2020) show with regards to the settlement of Chenga to the south-east of the monumental cluster that some of these sites may have served specialist functions. Overall, all this reflects an expansion of the settlement.

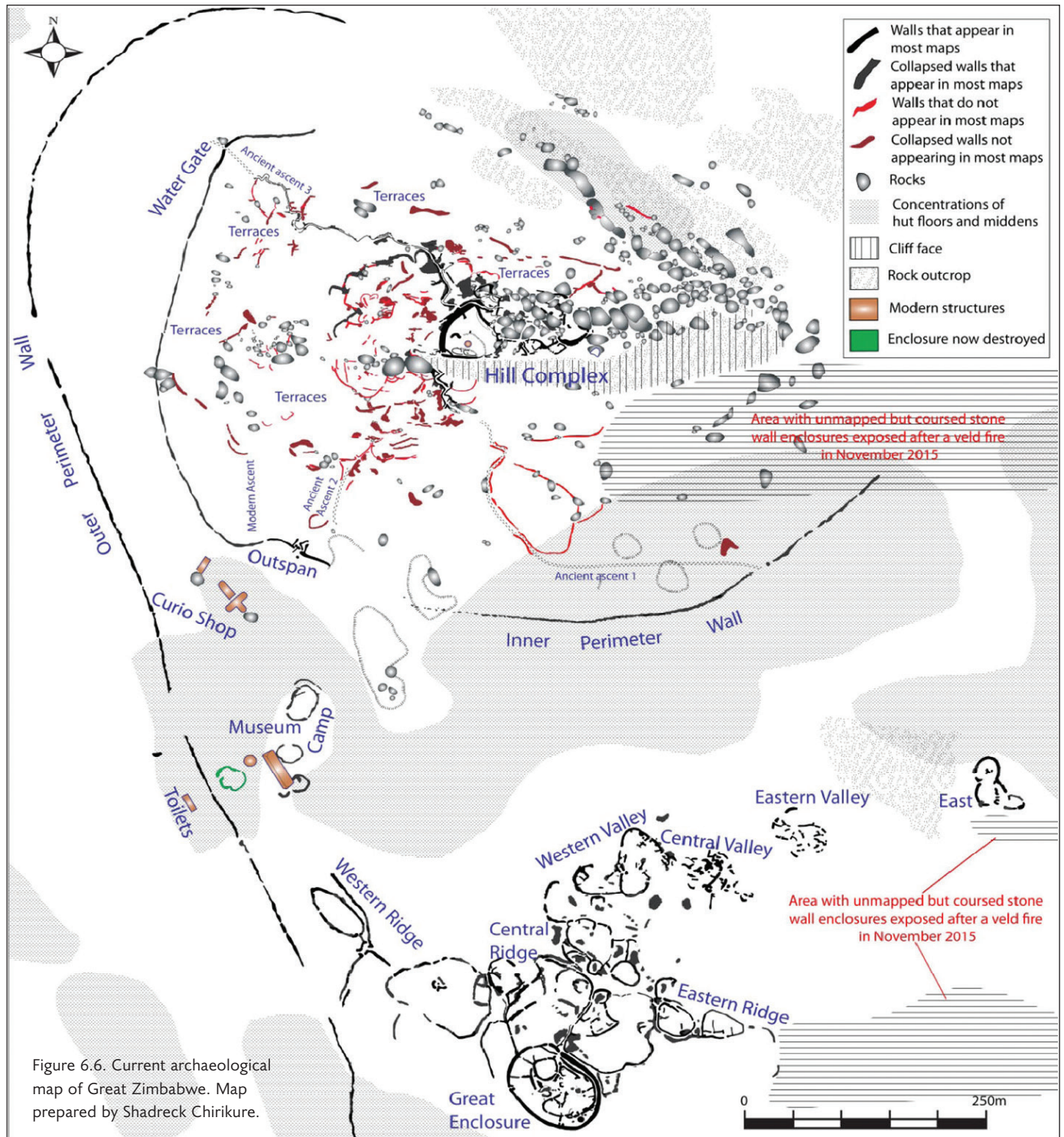


Figure 6.6. Current archaeological map of Great Zimbabwe. Map prepared by Shadreck Chirikure.

Early Portuguese descriptions seem to focus on the largest and most impressive part of Great Zimbabwe, that is the Great Enclosure (Fig. 6.3). This may have been the focus of the settlement just prior to their arrival in northern Zimbabwe: 'This edifice is almost surrounded by hills, upon which are others resembling it in the fashioning of the stone and the absence of mortar, and one of them is a tower more

than twelve fathoms high.' (De Barros, in *Décadas da Ásia*, I. 10. 1, in Theal 1898–1903) (Fig. 6.3).

Modern mapping to determine the extent of Great Zimbabwe started with Karl Mauch in the early 1870s (Burke 1969) (Fig. 6.5). Mauch attempted to clear the overgrown Great Enclosure to enhance access to the site. His rudimentary sketch plans and three-dimensional representation of both the Hill Complex

and the Great Enclosure are a first attempt in presenting the site to a European audience (Petermann 1874). Robert M. Swan, who worked together with Theodore Bent, produced the first accurate plans of the site, and interpreted it using absurd astronomical theories (Bent 1896), attracting criticism by Sir John Willoughby (1893) and Frederick Mennell (1902). Willoughby himself destroyed the stratigraphy of two stone structures, and contributed towards the disappearance of one large enclosure, a record of which only exists on Mauch's sketch plan (Burke 1969). Franklin White (1903–1904; 1905) a mining engineer, published an accurate, scientific plan of the Great Enclosure (which referred to as 'Temple or Elliptical Building') that was used by subsequent researchers until 1958, although compromised somewhat by the pillaging that took place, particularly as reflected in the work of Bent (1893a; 1893b; 1896), Hall (1905; 1909; Hall and Neal 1902), and the Public Works Department (PWD), who administered the site from 1891 to 1936.

Size and Function

David Randall-MacIver (1906, 61) observed that the stone structures of Great Zimbabwe were 'very imposing', with 'a massive grandeur all their own' when compared to others, but not as extensive as those of Nyanga, as lavishly decorated as those found in the Insiza district, in reference to Naletale, Danan'ombe, and other structures in west-central Zimbabwe. In terms of the extent of the site, he identified 'three distinct, though connected, groups of buildings, viz. the "Elliptical Temple" [Great Enclosure], the "Valley Ruins" [Valley Complex] and the "Acropolis" [Hill Complex]'. The 'Valley Ruins' are described as extending for about three-quarters of a mile in a line from east to west and occupying the southern side of the valley that separates the 'Elliptical Temple' from the 'Acropolis' (Randall-MacIver 1906, 75).

The first aerial photographs of the site were taken by Gertrude Caton-Thompson (1931, plates II, XXII, XXIII) in 1929, and these further enhanced the accuracy in the mapping of the core settlement. Using published plans, Roland Fletcher (1993) provided a broad comparative view of settlement sizes of indigenous African towns and cities, and discussed them in relation to information management and the role of external economic influences. This was useful pioneering work, which crucially pointed to the need for detailed archaeological surveys to provide more accurate detail. Noting the challenges represented by the edges of settlements, some of which are clearly not recognizable, or consistent, Fletcher (1993) provided

a useful indicator of the sizes of African towns. Great Zimbabwe is presented as a dispersed, low-density residential town (see Fletcher 1993, 738, 740; 2019). This interpretation is informed by Huffman (1977) and Sinclair and colleagues (1993) who conducted systematic archaeological surveys and detailed excavations around Great Zimbabwe, altering previous estimates about its size.

Great Zimbabwe was of comparable size to pre-industrial London (early thirteenth–mid-sixteenth century; see Fletcher 1993, fig. 44a), the only difference being settlement density, with London being more compact. A size of between 6 and 8 km² (or 600 to 800 ha) in extent would be a realistic estimation, based on current archaeological evidence. In relation to much later African cities, such as Zaria, which spread over a far larger area, the overall tendency was for such settlements to have relatively low average residential densities and comparatively small population sizes. This would make it easier to manage. A very large settlement would imply marked communication difficulties (Fletcher 1981).

According to Fletcher (1986), an assessment of the overall behavioural factors affecting settlement size has to refer to the total built area and occupation area within which the aggregate activity of the community occurred, and should be identified archaeologically from the general scatter of debris that marks a site. An open settlement should be presumed to include a periphery of open spaces, service function localities, and dumps. The peripheral zone of a settlement can be recognized as a low-density scatter of occupation debris.

From limited scientific archaeological excavations, a range of densities can be estimated for different population estimates at Great Zimbabwe. Population estimates have been proposed over the years, from early ones of about twenty thousand at peak times to recent revisions arguing that it is unlikely the population ever exceeded ten thousand (Chirikure and others 2017). A differentiation is imperative given the marked spatial differences between houses enclosed within the stone enclosures and those outside these. The latter suggested dense settlement associated with commoner housing (Huffman 2007). Use of such space remains debatable, largely based on the merits and demerits of using the ethnography (see e.g., Huffman 2011; Pikirayi and Chirikure 2011). Alternative approaches and appropriate tools are needed to describe and measure spatial layout, especially integration and connectivity (see e.g., Long and others 2007). It is the spatial configuration that affects people's spatial cognition, and human cognitive maps are developed through movement and interaction (Lynch 1981) rather than from a set of predeter-

mined rules. Great Zimbabwe grew into a large settlement, and this was achieved not only through accessibility and connectivity to certain spaces, but also through facilitating and limiting access and connection to the same spaces. This also involved reorganization of certain spaces and revisiting some of the spatial principles followed in using space previously (Pikirayi 2013c) (Fig. 6.6).

An enduring caveat of approaching the growth and population density of Great Zimbabwe concerns the spatial reach of analysis, compelled by where one draws the line between who and what should be considered part and inside of the settlement, and who and what should not. This consideration must be underpinned by the use and meaning of space in the Zimbabwe Culture, and the archaeology of both. Few studies have discussed the use and meaning of space at Great Zimbabwe and other Zimbabwe Culture sites (see e.g., Beach and others 1997; 1998; Huffman 1984; 1985; 1996; 2007). These studies, however, did not address basic questions about the minds of the inhabitants who lived inside the stone structures and the towns they defined. The connections between royalty and commoners, for example, has not been viewed in the context of how settlement design reconnected urban neighbourhoods, how space was used for food production and industrial output, and how the overall layout expressed organizational structure of the residents. Does it make sense to view the various parts of these urban centres as operating and functioning both independently and as extensions to each other? Site catchment analysis by Paul J. Sinclair (1987; 2019) focusing on Great Zimbabwe encourages us to think along these lines, and beyond.

An alternative approach to the use of space at Great Zimbabwe may be arrived at through the study of the built environment, especially the development of stone architecture (Pikirayi 2013c). At Great Zimbabwe, authority and power define space, and thus there is a connection between space and authority. The importance of residential spaces extends to non-built areas, as indicated, for example, by middens (Fig. 6.7). Understanding the development of monumental and non-monumental architecture towards a composite, integrated settlement is necessary.



Figure 6.7. Views of midden areas in the core urban zone. Photograph by Innocent Pikirayi.

Development

To understand how Great Zimbabwe grew to become a giant settlement as well as the centre of a territorial state, an evaluation of the evolution of the settlement based on available radiocarbon and other dating evidence, and monumental architecture, is imperative. The activities of antiquarian investigators as well as the Rhodesian Ancient Mining Company would result in the pillaging of Great Zimbabwe and similar structures in southern Africa between the 1890s and 1920s. This compromised the ability of professional archaeologists to establish a credible stratigraphy and chronology for the site. The activities arising from the antiquarian and scientific archaeological investigation of Great Zimbabwe would result in the Zimbabwe controversy, which dominated the historiography of the site for the entire twentieth century (Chirikure and others 2013a; Pikirayi 2001b). The dating and chronology of Great Zimbabwe were key to the controversy. Most forgotten in understanding how Great Zimbabwe grew into a large settlement is its monumental architecture (Fig. 6.8).

Scientific archaeological excavations from the various parts of Great Zimbabwe conducted since the early twentieth century provide limited stratigraphic information as well as datable imported glass beads and Asian ceramics. The advent of radiocarbon dating in the 1950s would result in the generation of absolute ages on archaeological events at Great Zimbabwe. Available radiocarbon dates have

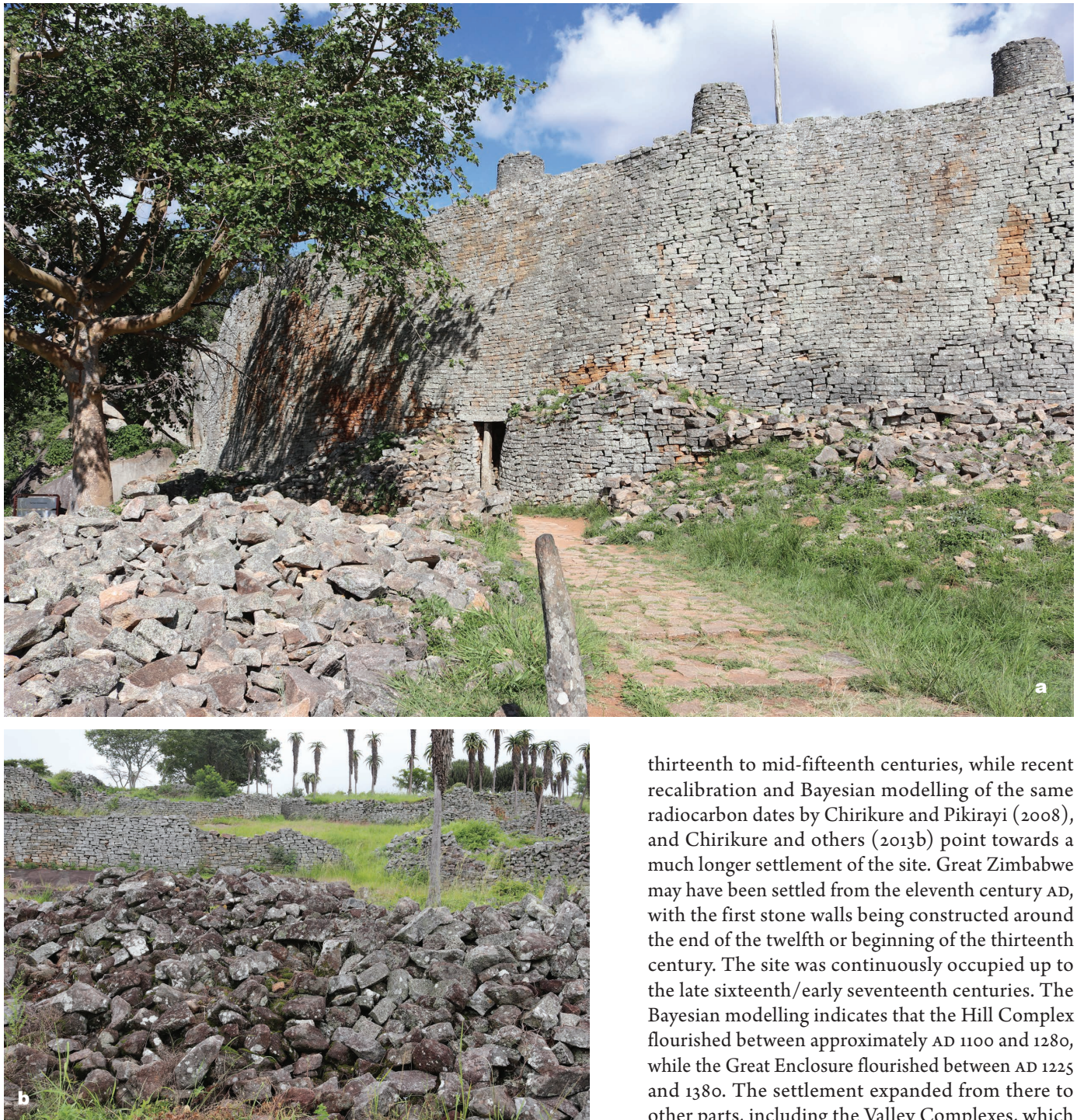


Figure 6.8. Example of monumental architecture of Great Zimbabwe from a) the Hill Complex, and b) the Valley Complexes. Photographs by Innocent Pikirayi.

been extensively discussed by Thomas Huffman and Joseph O. Vogel (1991), Shadreck Chirikure and Innocent Pikirayi (2008; Pikirayi and Chirikure 2011; Chirikure and others 2013a; Chirikure and others 2013b). Huffman and Vogel (1991) argue for a limited settlement at Great Zimbabwe, from the late

thirteenth to mid-fifteenth centuries, while recent recalibration and Bayesian modelling of the same radiocarbon dates by Chirikure and Pikirayi (2008), and Chirikure and others (2013b) point towards a much longer settlement of the site. Great Zimbabwe may have been settled from the eleventh century AD, with the first stone walls being constructed around the end of the twelfth or beginning of the thirteenth century. The site was continuously occupied up to the late sixteenth/early seventeenth centuries. The Bayesian modelling indicates that the Hill Complex flourished between approximately AD 1100 and 1280, while the Great Enclosure flourished between AD 1225 and 1380. The settlement expanded from there to other parts, including the Valley Complexes, which were settled-up to the early seventeenth century. This chronology matches that of the imports, especially glass beads, which date the site from the early tenth to the sixteenth, possibly the seventeenth centuries.

In spatial terms, the dating suggests that the earliest palace complex existed on the Hill, and later on moved to the Great Enclosure and the valley prior to abandonment (Collett, Vines, and Hughes 1992; Chirikure and Pikirayi 2008; Pikirayi and Chirikure 2011) (Fig. 6.9).

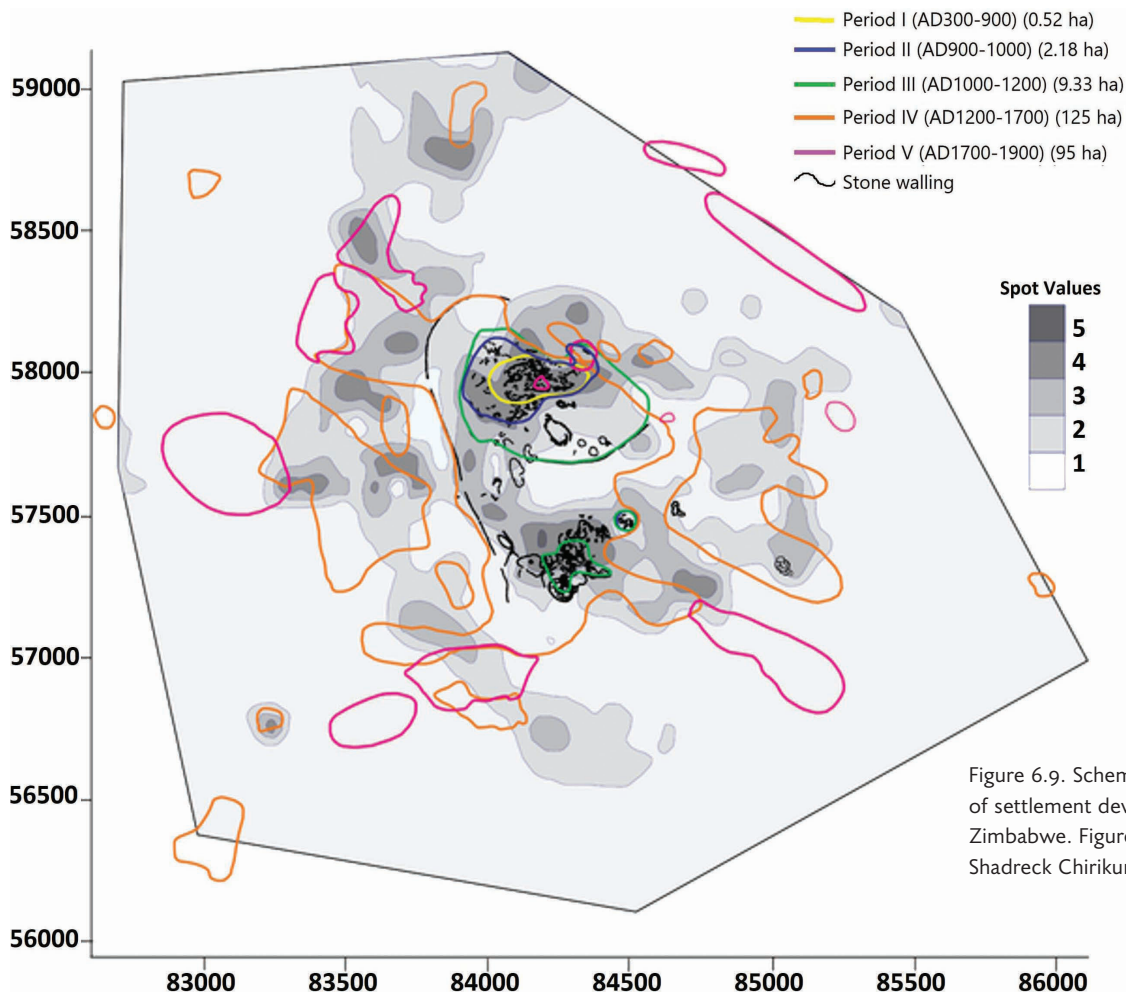


Figure 6.9. Schematic representation of settlement development at Great Zimbabwe. Figure prepared by Shadreck Chirikure.

The thirteenth century witnessed increased gold production and trade on the Zimbabwe Plateau, matched by corresponding prosperity in East African coastal cities. Great Zimbabwe itself has yielded a range of imported ceramics, including Persian tin-glazed earthenware bowls, Chinese celadon and stoneware vessels, as well as Near Eastern glass, some coral pieces, a variety of copper objects, bronze hawk bells, yellow and green glass beads, brass wire, and cowrie shells (Garlake 1973; Chirikure and others 2013a). Great Zimbabwe had extensive regional and long-distance trading networks with central Africa, the Indian Ocean coast, the Persian Gulf, India, and the Far East (Garlake 1973; Huffman 1972).

Many studies of Great Zimbabwe and related stone-walled sites have treated architecture as a backdrop to typology and dating of the structures (Figs 6.8–6.10). They have used wall types (P, PQ, Q, and R) as a basis for relative dating and chronology, as well as for tracing the development of building sequences (e.g., Garlake 1970; Whitty 1957; 1961). This observation has remained the cornerstone for understanding the development of the culture once

based at Great Zimbabwe and its spread to the northern and western regions of the Zimbabwe Plateau (Walker 1993). The emergence and development of monumental architecture bring Great Zimbabwe into the realm of regional and intercontinental trade, with the Great Enclosure becoming the largest, most influential and wealthy city in southern Africa, especially during the second half of the fourteenth century.

Demise

The decline of Great Zimbabwe as a centre of a powerful prehistoric state remains unresolved. A major factor is the unsystematic investigations of late nineteenth-/early twentieth-century European antiquarians and prospectors, who destroyed its stratigraphy and looted it in search of valuables including Near and Far Eastern artefacts and gold (Fig. 6.11). While systematic research from the 1950s onwards has resolved the chronology of the site and identity of the builders, circumstances leading to the decline or even collapse of the site remain obscure. Explanations range



Figure 6.10. The different stone-walling styles at Great Zimbabwe. Photographs by Innocent Pikirayi.





Figure 6.11. Artefacts from the Near and Far East that were recovered from Great Zimbabwe. a) Celadon from the southern terrace. Photograph by Shadreck Chirikure. b) Celadon from the Chenga enclosure. Photograph by Federica Sulas.

from the effects of long-distance trade (Huffman 1972), environmental degradation (Garlake 1978), climate change (Holmgren and Öberg 2006), to the emergence of competing polities to the north and west (Pikirayi 1993; 2013b).

It remains unclear what role climate change played in the demise of Great Zimbabwe. Although the cool-dry conditions experienced in the fifteenth century (Holmgren and others 2003; Tyson and Lindesay 1992; Tyson, Karlén, and others 2000; Tyson, Lee-Thorp, and others 2002) could have undermined its agriculture and increasing population (Holmgren and Öberg 2006), the location of Great Zimbabwe in a favourable rainfall zone would have offset this (Huffman 2007). Given the generally warmer and wetter conditions, the abandonment of Great Zimbabwe may not have been conditioned by climate. However, Hannaford and colleagues (2014) attempt a synthesis and critique of the extant hypotheses and dominant approaches regarding possible regional climate–society linkages in southern Africa for the period covering the origins and demise of Mapungubwe and Great Zimbabwe. They pay particular attention to climate causation and determinism, relating the southern African context to global issues on the same. This approach is in response to recent discussion in global climate history literature on environmental collapse, which has raised critical questions over the basis of climate as a chief causal factor in societal change. Given that Mapungubwe and Great Zimbabwe witnessed considerable socio-political complexity that may have ended due to environmental change, social disintegration, population depletion, and migration, they

discuss the potential of societal vulnerability and resilience, and attempt to incorporate diverse sources of data to help understand the role of climate in southern African history.

Beyond climate change, it is important to realize that Great Zimbabwe had to prosper as a territorial state, and had to extend its influence to maintain regional dominance. Its inhabitants needed more land for farming, while traders wanted more gold for export to the Indian Ocean coast. The demise of Great Zimbabwe after AD 1400 may be linked to general global economic depression experienced at the time (Pikirayi 2006). Europe saw a falling demand in gold. Great Zimbabwe, located close to the gold mining areas and production centres, must have felt the effects of this economic downturn. International trade began to decline from the early fifteenth century, as indicated by the paucity of Chinese porcelain at Great Zimbabwe. In response to this, the elite at Great Zimbabwe expanded regional networks of trade, leading to the rise of monumental structures in distant regions like the Makgadikgadi Pans in eastern Botswana, and northern Zimbabwe (Pikirayi 2006). By the late fifteenth century, the consequences of this decision were obvious in terms of demographic and regional shifts of some of the population from southern to northern Zimbabwe, which saw the rise of the Mutapa state (Pikirayi 1993). To the west, Great Zimbabwe was facing competition from Khami, the capital of the Torwa state, which developed an architectural canon different from the former, but which translated into far more superior and grander monumental architecture. By the sixteenth century, political and economic power had shifted to the northern and western regions of the Zimbabwe escarpment. From this explanation, Great Zimbabwe may have expanded too fast and rapidly. Written sources indicate Great Zimbabwe continued to be inhabited in the sixteenth century

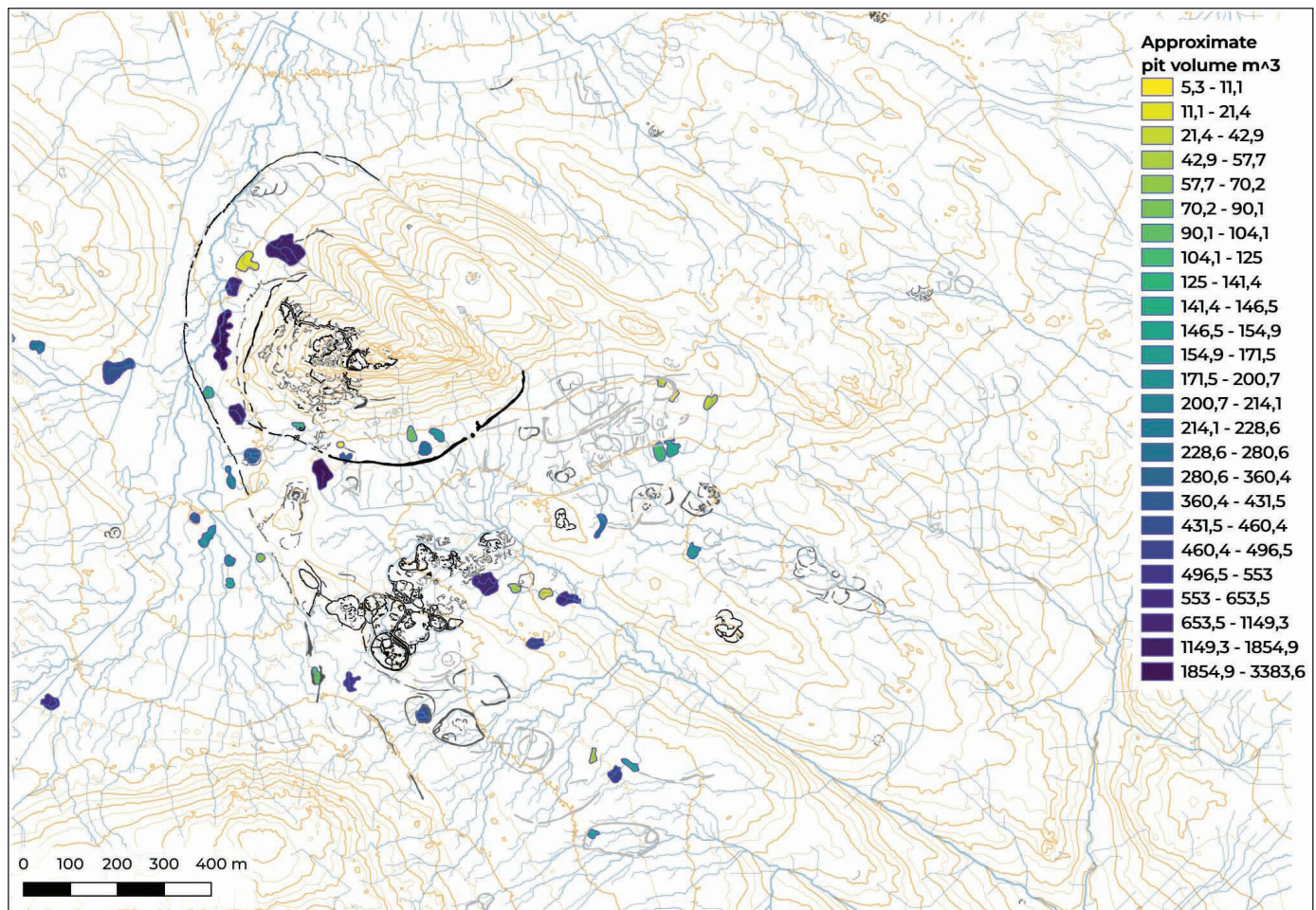


Figure 6.12. Map showing the ancient urban core in relation to local hydrology, wells, springs, dhaka pits, and modern settlement. Image courtesy of Innocent Pikirayi, Federica Sulas, and Shadreck Chirikure.

(Pikirayi 2006; 2013a; 2013b), while a Bayesian modelling of available radiocarbon dates suggests settlement until the early seventeenth century (Chirikure 2021; Chirikure and others 2013b).

What is imperative is research that addresses the responses of Great Zimbabwe residents to global as well as local environmental changes, and how they were able to manage change. Culture change is inevitable, and some of these changes have been designated as ‘decline’, ‘collapse’, etc., following experiences of significant and permanent negative impacts, and consequently, with well-established traditions being abandoned for reasons other than personal preferences. To understand what happened to Great Zimbabwe, a reconsideration of what constitutes a ‘collapsed society’ in sub-Saharan Africa is imperative.

Rethinking Low-Density Urbanism at Great Zimbabwe through Water

In considering collapse or demise, it is important to detect and document societal stresses, which develop over the long and short terms. Questions to be asked, for example, are whether Great Zimbabwe experienced over-population growth, a declining subsistence base, a deteriorating physical environment around it, and competition from neighbouring polities which undermined its regional influence and economy. These developments have a bearing on settlement growth or shrinkage. Thus, the role of environmental degradation in the demise of Great Zimbabwe requires reconsideration from the perspective of sustainability.

Current surveys around Great Zimbabwe documenting its water resources indicate that the inhabitants relied mainly on subsurface water, which was tapped or harvested from springs that occurred within the granite landscape (Pikirayi and others 2016; 2022) (Fig. 6.12). Water was carefully channelled to the core of the settlement where it was stored in reservoirs for consumption. It is evident that these

springs provided the bulk of the settlement's water requirements as some of the streams and rivers flowing to the east and south of Great Zimbabwe are fed from these sources and have running water throughout the year. This points to sustainability and resilience, which can help interrogate the demise and collapse of the settlement, and even its regeneration.

The current population, which is between five thousand and ten thousand inhabitants, relies entirely on water from the springs all situated within a 5 km radius of Great Zimbabwe. It is dispersed all over the granite landscape, the only clustering existing at two places, one a tertiary institution to the south and the other, a 'growth-point' — a term synonymous with emerging urban or rural centres in Zimbabwe. This dispersal is critical since settlement growth and expansion do impair the natural functions performed by watersheds. The growth of Great Zimbabwe must have factored this into account, since not all parts of the granite landscape are suitable for settlement. Some parts of the landscape such as streams and valleys had to be managed differently in response to increases in human-induced environmental pressure. This decoupling was necessary to ensure conservation of vital resources in the landscape and allowed for managed population growth. It remains to be demonstrated how other human activities may have offset this.

Sustainability is about living within the means of our natural systems and ensuring that human lifestyles do not harm society and culture. Sustainability at Great Zimbabwe must be viewed in human terms, encompassing the potential for long-term maintenance of well-being, with a bearing on the environment, the economy, politics, and culture. The question is whether there was anything around the site which could have caused negative impact on the resident population. Sustainability is located at the confluence of society, the physical environment, and economy. For sustainability to occur, society and economy must be equitable; the relationship between society and environment must be bearable, while economy and environment must be viable (Adams 2006). Societies must measure sustainability to determine risk, resilience, and vulnerability.

There is a link between settlements of this magnitude with a presumably large residential population and aspects of sustainability, with the general assertion that higher density settlements are more sustainable than low-density cities (Fletcher 2019). However, this remains a contested area of planning theory, and there is a need to consider the correlation between energy consumption and overall urban density of a given settlement, that is, the lower the density, the more energy is consumed (Newman

and Kenworthy 1999). Thus, can one use sustainable urbanism — the application of sustainability and resilient principles — to the design, planning, and functioning of ancient places such as Great Zimbabwe? We need to consider a number of options; the total floor area of buildings divided by land area they are built on, or, residential density, which is the number of dwelling units in any given area, or, population density (the number of people in any given area).

Despite many years of archaeological fieldwork as is the case with Great Zimbabwe, settlements with a dispersed occupation are hard to recognize. Fletcher pointed out that assessing how the community dealt with scarce resources such as salt and water becomes very difficult when a low-density occupation (400–500 ha) is being considered rather than a compact settlement (50–70 ha). According to Fletcher (1993), resource supply cannot in general be proposed as a factor directly affecting settlement area, as it is regionally specific. It is the absolute number of very large settlements in a region that is a function of resource supply. Resource constraint apparently delimits the number of large community aggregates which a region can support and therefore the probability of a very large case arising. Thus, regardless of what resources communities command, the growth of their settlements is constrained by the limits to manage the flow of information and services within the settlement. This is universal.

How could the management of Great Zimbabwe's environment have impacted on its growth as a settlement? The micro-catchments within the Great Zimbabwe landscape, and in many cases, the variable slope, also had a bearing on the low-density settlement, experienced even to this day. A rise in population may have generated impervious cover due to vegetation clearance, which in turn, impacted on water quality. Great Zimbabwe's hilly location and surroundings point to a constricted catchment and highly impaired micro-watersheds due to intense construction activity, especially towards and within the core of the settlement.¹

In the face of drought and aridity, communities are increasingly concerned about managing their watersheds to maintain hydrologic integrity and water quality. Water is the most valuable asset of any settlement. Water pollution can be ascribed either point source (e.g., industrial discharge) or non-point source (which can result, say in increased sedimentation). Great Zimbabwe's water quality was largely point source, as some of this was generated from

1 On vegetation clearance and increased imperviousness, see Butler and Davies 2000.



Figure 6.13. The productive landscape sustained by local communities today around Great Zimbabwe. Photographs by Innocent Pikirayi.

urban run-off. Water quality may have been compromised by increased nutrients, metals, hydrocarbons, bacteria, and other constituents.

How did the authorities at Great Zimbabwe manage the impacts of development on water availability and quality? How were health and sanitation managed? What waste was produced and how was it disposed? Was a low-density footprint bad for Great Zimbabwe's water availability? What was the impact of commoner housing on water quality? There are no indications that low-density development is better for watershed quality because it limits impervious cover at the site level. High-density development is better for watershed water quality because overall it disturbs less land to accommodate a similar number of people and leaves more land available to serve critical ecological functions (Richards, Anderson, and Santore 2003, 345–46).

Another important point to consider for Great Zimbabwe is water withdrawal by its increasing

population. How much did this alter water quality, and the amount contained in the aquifers, and how sustainable was this, modelled on a population of twenty thousand people? By the peak of Great Zimbabwe, what could have been the city's water demand, and how was this demand managed? Whilst answers to these questions remain open as we dig deeper in the water history of Great Zimbabwe, the available archaeological and historical record does provide insights on the sustainability or otherwise of its settlement pattern through time. In general terms, the settlement record suggests an incremental growth of the built environment starting with the Hill Complex to the establishment of complexes in the valley and other hills. Whilst one can capture the footprint of this growth in a space of about 600–800 ha, there is indication that not all structures were used at the same time, hence the question of how big Great Zimbabwe was might slide down to being redundant with reference to sustainability. Instead, it might be more productive to ask how big was the settlement when key monuments such as the Great Enclosure were in use? Putting people in these spaces remains very challenging as even low population estimates, of a few thousands living at Great Zimbabwe, are biased towards the size and nature of architectural remains — of structures built in stone and/or earthen (*dhaka*) materials, and middens in the ancient core urban area. As such these estimates overlook the possibility that potentially high numbers of people (and cattle) might have lived in the settlement more fluidly, perhaps in perishable accommodation, moving in and out of the core urban area on a daily basis, and so on.

Mindful of the enduring challenges with mapping the extent of settlement and population, the nature and distribution of management infrastructures such as the water reservoirs, spatial relations between stone-wall enclosures and micro-catchments, and possibly the perimeter walls reflect the need for supplying a substantial number of people and cattle over an urban landscape that stretched beyond the core urban area. This system supported continuous occupation for about eight hundred years, and in fact longer (Fig. 6.13). Had colonial interventions not encapsulated the site into a pile of ruins to exploit and subsequent governments enabled ancestral lifeways, one wonders if Great Zimbabwe today would be a thriving city of a few hundred thousands, the outcome of a sustainability pathway unfolding for centuries of securing water, creating wealth, and maintaining well-being — an achievement neither modern Zimbabwean cities nor most other modern African ones can claim.

Works Cited

- Adams, W. M. 2006. *The Future of Sustainability: Rethinking Environment and Development of the Twenty-First Century* (report of the IUCN Renowned Thinkers Meeting, 29–31 January 2006) <<https://portals.iucn.org/library/sites/library/files/documents/Rep-2006-002.pdf>> [accessed 6 June 2022].
- Beach, D. N., M. F. C. Bourdillon, J. Denbow, M. Hall, P. Lane, I. Pikirayi, G. Pwiti, and T. N. Huffman. 1997. 'Review Feature on *Snakes and Crocodiles: Power and Symbolism in Ancient Zimbabwe* by T. N. Huffman', *The South African Archaeological Bulletin*, 52.166: 125–43.
- Beach, D. N., M. F. C. Bourdillon, J. Denbow, G. Liesegang, J. H. N. Loubser, I. Pikirayi, D. Schoenbrun, R. Soper, and A. B. Stahl. 1998. 'Cognitive Archaeology and Imaginary History at Great Zimbabwe: Comments and Reply', *Current Anthropology*, 1: 47–72.
- Bent, J. T. 1893a. 'The Ruins in Mashonaland', *Geographical Journal*, 2: 438–41.
- . 1893b. 'On the Finds at the Great Zimbabwe Ruins (with a View to Elucidating the Origin of the Race that Built Them)', *Journal of the Royal Anthropological Institute*, 22: 124–36.
- . 1896. *The Ruined Cities of Mashonaland* (London: Spottiswoode).
- Burke, E. D. (ed.). 1969. *The Journals of Carl Mauch* (Salisbury: National Archives of Rhodesia).
- Butler, D. and J. W. Davies. 2000. *Urban Drainage* (London: Spies).
- Caton-Thompson, G. 1931. *The Zimbabwe Culture: Ruins and Reactions* (Oxford: Clarendon).
- Chase, A. S. Z. and R. Cesaretti. 2019. 'Diversity in Ancient Maya Water Management Strategies and Landscapes at Caracol, Belize and Tikal, Guatemala', *WIREs Water*, 6.2: e1332.
- Chase, A. S. Z. and D. Z. Chase. 2020. 'Monumental Landscapes of the Maya: Cogitating on a Past Built Environment', in B. A. Houk, B. Arroyo, and T. G. Powis (eds), *Approaches to Monumental Landscapes of the Ancient Maya* (Gainesville: University Press of Florida), pp. 335–48.
- Chipunza, K. T. 1993. *A Diachronic Analysis of the Standing Structures of the Hill Complex at Great Zimbabwe*, Studies in African Archaeology, 8 (Uppsala: Societa archaeologica Uppsaliensis).
- Chirikure, S. 2021. *Great Zimbabwe: Reclaiming a Confiscated Past*, Routledge Studies in African Archaeology and Cultural Heritage (Abingdon: Routledge).
- Chirikure, S., M. Manyanga, M. Pollard, and I. Pikirayi. 2013a. 'New Pathways of Sociopolitical Complexity in Southern Africa', *African Archaeological Review*, 30: 339–66.
- . 2013b. 'A Bayesian Chronology for Great Zimbabwe: Re-threading the Sequence of a Vandalised Monument', *Antiquity*, 87.337: 854–72.
- Chirikure, S., T. Moultrie, F. Bandama, C. Dandara, and M. Manyanga. 2017. 'What Was the Population of Great Zimbabwe (CE1000–1800)?', *PloS One*, 12.6: E0178335.
- Chirikure, S. and I. Pikirayi. 2008. 'Inside and Outside the Drystone Walls: Revisiting the Material Culture of Great Zimbabwe', *Antiquity*, 82: 1–18.
- Collett, D. P., A. D. Vines, and E. G. Hughes. 1992. 'The Chronology of the Valley Enclosures: Implications for the Interpretation of Great Zimbabwe', *African Archaeological Review*, 10: 139–61.
- Fletcher, R. J. 1981. 'People and Space', in I. Hodder, G. L. Isaac, and N. Hammond (eds), *Pattern of the Past* (Cambridge: Cambridge University Press), pp. 97–128.
- . 1986. 'Settlement Archaeology: Worldwide Comparisons', *World Archaeology*, 18: 59–83.
- . 1993. 'Settlement Area and Communication in African Towns and Cities', in T. Shaw, P. Sinclair, B. Andah, and A. Okpoko (eds), *The Archaeology of Africa: Food, Metals and Towns*, One World Archaeology, 20 (London: Routledge), pp. 732–49.
- . 1995. *The Limits of Settlement Growth: A Theoretical Outline* (Cambridge: Cambridge University Press).
- . 2019. 'Trajectories to Low-Density Settlements Past and Present: Paradox and Outcomes', *Frontiers in Digital Humanities*, 6.14 <<https://doi.org/10.3389/fdigh.2019.00014>>.
- Garlake, P. S. 1970. 'Rhodesian Ruins: A Preliminary Assessment of their Styles and Chronology', *Journal of African History*, 11.4: 495–513.
- . 1973. *Great Zimbabwe* (London: Thames & Hudson).
- . 1978. 'Pastoralism and Zimbabwe', *Journal of African History*, 19.4: 479–93.
- Hall, R. N. 1905. *Great Zimbabwe* (London: Methuen).
- . 1909. *Prehistoric Rhodesia* (London: Unwin).
- Hall, R. N. and W. G. Neal. 1902. *The Ancient Ruins of Rhodesia* (London: Methuen).
- Hannaford, M., G. R. Bigg, J. M. Jones, M. Staub, and I. Phimister. 2014. 'Climate Variability and Societal Dynamics in Pre-colonial Southern African History (AD 900–1840): A Synthesis and Critique', *Environment and History*, 20.3: 411–45.

- Holmgren, K. and H. Öberg. 2006. 'Climate Change in Southern and Eastern Africa during the Past Millennium and its Implications for Societal Development', *Environment, Development and Sustainability*, 8: 185–95.
- Holmgren, K., J. A. Lee-Thorp, G. R. Cooper, K. Lundblad, T. C. Partridge, L. Scott, R. Sithaldeen, A. S. Talma, and P. D. Tyson. 2003. 'Persistent Millennial-Scale Climatic Variability over the Past 25,000 Years in Southern Africa', *Quaternary Science Reviews*, 22: 2311–26.
- Huffman, T. N. 1972. 'Rise and Fall of Zimbabwe', *Journal of African History*, 13.3: 353–66.
- . 1977. 'Zimbabwe: Southern Africa's First Town', *Rhodesian Prehistory*, 7: 9–14.
- . 1984. 'Expressive Space in the Zimbabwe Culture', *Man*, 19: 593–612.
- . 1985. 'The Great Enclosure and Domba', *Man*, 20: 543–44.
- . 1996. *Snakes and Crocodiles: Power and Symbolism in Ancient Zimbabwe* (Johannesburg: Witwatersrand University Press).
- . 2007. *Handbook to the Iron Age: The Archaeology of Pre-colonial Farming Societies in Southern Africa* (Scottsville: University of KwaZulu-Natal Press).
- . 2008. 'Climate Change during the Iron Age in the Shashe-Limpopo Basin, Southern Africa', *Journal of Archaeological Science*, 35: 2032–47.
- . 2009a. 'A Cultural Proxy for Drought: Ritual Burning in the Iron Age of Southern Africa', *Journal of Archaeological Science*, 36: 991–1005.
- . 2009b. 'Mapungubwe and Great Zimbabwe: The Origin and Spread of Social Complexity in Southern Africa', *Journal of Anthropological Archaeology*, 28: 37–54.
- . 2010a. 'Intensive El Niño and the Iron Age of South-Eastern Africa', *Journal of Archaeological Science*, 27: 2572–86.
- . 2010b. 'State Formation in Southern Africa: A Reply to Kim and Kusimba', *African Archaeological Review*, 27: 1–11.
- . 2011. 'Debating Great Zimbabwe', *South African Archaeological Bulletin*, 66.193: 27–40.
- Huffman, T. N. and J. C. Vogel. 1991. 'The Chronology of Great Zimbabwe', *South African Archaeological Bulletin*, 46: 61–70.
- Isendahl, C. 2012. 'Agro-urban Landscapes: The Example of Maya Lowland Cities', *Antiquity*, 86: 1112–25.
- Isendahl, C. and M. Smith. 2013. 'Sustainable Agrarian Urbanism: The Low-Density Cities of the Mayas and Aztecs', *Cities*, 31: 132–43.
- Isendahl, C., L. J. Lucero, and S. Heckbert. 2018. 'Sustaining Freshwater Security and Community Wealth: Diversity and Change in the Pre-Columbian Maya Lowlands', in F. Sulas and I. Pikirayi (eds), *Water and Society from Ancient Times to the Present* (London: Routledge), pp. 17–39.
- Kim, N. C. and C. M. Kusimba. 2008. 'Pathways to Social Complexity and State Formation in the Southern Zambezi Region', *African Archaeological Review*, 21: 131–52.
- Long, Y., P. K. Baran, and R. Moore. 2007. 'The Role of Space Syntax in Spatial Cognition: Evidence from Urban China', in A. S. Kubat (ed.), *Proceedings of the 6th International Space Syntax Symposium* (Istanbul: ITU Faculty of Agriculture), 129, pp. 1–6.
- Lucero, L. J. 2003. 'The Politics of Ritual', *Current Anthropology*, 44.4: 523–58.
- Lynch, K. 1981. *A Theory of Good City Form* (Cambridge: MIT Press).
- Manyanga, M., I. Pikirayi, and S. Chirikure. 2010. 'Conceptualising the Urban Mind in Pre-European Southern Africa: Rethinking Mapungubwe and Great Zimbabwe', in P. J. J. Sinclair, G. Nordquist, F. Herschend, and C. Isendahl (eds), *The Urban Mind: Cultural and Environmental Dynamics*, Studies in Global Archaeology, 15 (Uppsala: Uppsala University, African and Comparative Archaeology, Department of Archaeology and Ancient History), pp. 573–90.
- Matenga, E. 1998. *The Soapstone Birds of Great Zimbabwe: Symbols of a Nation* (Harare: African Publishing Group).
- Mennell, F. P. 1902. 'The Zimbabwe Ruins, near Victoria, Southern Rhodesia', *Proceedings of the Rhodesia Scientific Association*, 3: 69–70.
- Musindo, T. T. 2019. *Modelling Water Use at Great Zimbabwe: An Ethnohistoric, Ethnoarchaeological, and GIS Landscape Analysis at an Ancient African City* (Oxford: BAR).
- Newman, P. and J. Kenworthy. 1999. *Cities and Sustainability: Overcoming Automobile Dependence* (Washington, DC: Island).
- Petermann, A. (ed.). 1874. 'Karl Mauch's Reisen im Inneren von Sud-Africa', *Petermann's Mitteilungen, Ergantung*, 8.37: 1873–74.
- Phimister, I. R. 1974. 'Ancient Mining near Great Zimbabwe', *Journal of the South African Institute of Mining and Metallurgy*, 74: 233–37.
- . 1976. 'Precolonial Gold Mining in Southern Zambesia: A Reassessment', *African Social Research*, 21: 1–30.
- Pikirayi, I. 1993. *The Archaeological Identity of the Mutapa State: Towards an Historical Archaeology of Northern Zimbabwe* (Uppsala: Societas Archaeologica Upsaliensis).
- . 2001a. 'The Physical Environment and the Landscapes of Great Zimbabwe Culture States', in F. Chami, G. Pwiti, and C. Radimilahy (eds), *People, Contacts and the Environments in the African Past*, Studies in the African Past, 1 (Dar es Salaam: Dar es Salaam University Press), pp. 129–50.

- . 2001b. *The Zimbabwe Culture: Origins and Decline of Southern Zambebian States* (Walnut Creek: Altamira).
- . 2003a. 'Shifting Patterns of Trade in the Western Indian Ocean Zone: Northern Zimbabwe, 1500–1750 AD', in F. Chami, G. Pwiti, and C. Radimilahy (eds), *Climate Change, Trade and Modes of Production in Sub-Saharan Africa*, Studies in the African Past, 3 (Dar es Salaam: Dar es Salaam University Press), pp. 129–54.
- . 2003b. 'Environmental Data and Historical Process: Historical Climate Reconstruction and the Mutapa State, 1450–1862', in W. Beinart and J. McGregor (eds), *Social History and African Environments* (Oxford: James Currey), pp. 60–71.
- . 2006. 'The Demise of Great Zimbabwe, AD 1420–1550: An Environmental Re-appraisal', in A. Green and R. Leech (eds), *Cities in the World, 1500–2000*, The Society for Post-Medieval Archaeology Monograph, 3 (Leeds: Maney), pp. 31–47.
- . 2013a. 'Great Zimbabwe in Historical Archaeology: Reconceptualising Decline, Abandonment, and Reoccupation of an Ancient Polity, AD 1450–1900', *Historical Archaeology*, 47.1: 26–37.
- . 2013b. 'The Zimbabwe Culture and its Neighbours: Origins, Development, and Consequences of Social Complexity in Southern Africa', in P. Mitchell and P. Lane (eds), *The Oxford Handbook of African Archaeology* (Oxford: Oxford University Press), pp. 915–27.
- . 2013c. 'Stone Architecture and the Development of Power in the Zimbabwe Tradition AD 1270–1830', *Azania*, 48.2: 282–300.
- Pikirayi, I. and S. Chirikure. 2011. 'Debating Great Zimbabwe', *Azania*, 46.2: 221–30.
- Pikirayi, I., F. Sulas, T. Musindo, A. Chimwanda, J. Chikumbirike, J. Mtetwa, E. M. Sagiya, and B. Nxumalo. 2016. 'Great Zimbabwe's Water', *WIREs Water*, 3.2: 195–210.
- Pikirayi, I., F. Sulas, B. Nxumalo, M. E. Sagiya, D. Stott, S. M. Kristiansen, S. Chirikure, and T. Musindo. 2022. 'Climate-Smart Harvesting and Storing of Water: The Legacy of Dhaka Pits at Great Zimbabwe', *Anthropocene*, 40: 100357.
- Randall-MacIver, D. 1906. *Medieval Rhodesia* (London: Macmillan).
- Redman, C. L. 2014. 'Should Sustainability and Resilience Be Combined or Remain Distinct Pursuits?', *Ecology and Society*, 19.2: 37.
- Richards, L., G. Anderson, and M. K. Santore. 2003. 'Protecting Water Resources with Higher Density Developments', in *National Conference on Urban Storm Water: Enhancing Programs at the Local Level, Proceedings, Chicago, IL, February 17–20, 2003* (Cincinnati: U. S. Environmental Protection Agency), pp. 340–68.
- Scarborough, V. L. and C. Isendahl. 2020. 'Distributed Urban Network Systems in the Tropical Archaeological Record: Toward a Model for Urban Sustainability in the Era of Climate Change', *The Anthropocene*, 7.3: 208–30.
- Scarborough, V. L., N. P. Dunning, K. B. Tankersley, C. Carr, E. Weaver, L. Grazioso, B. Lane, J. G. Jones, F. Valdez, and D. L. Lentz. 2012. 'Water and Sustainable Land Use at the Ancient Tropical City of Tikal, Guatemala', *Proceedings of the National Academy of Sciences of the USA*, 109.31: 12408–13.
- Scoones, I. L., C. Chibudu, S. Chikura, P. Jeranyama, D. Machaka, W. Machanja, B. Mavedzenge, B. Mombeshora, M. Mudhara, C. Mudziwo, F. Murimbarimba, and B. Zirereza. 1996. *Hazards and Opportunities: Farming Livelihoods in Dryland Africa; Lessons from Zimbabwe* (London: ZED Books).
- Sinclair, P. J. J. 1984. 'Some Aspects of the Economic Level of the Zimbabwe State', *Zimbabwea*, 1: 48–53.
- . 1985. *Excavations at Chivowa Hill, South Central Zimbabwe*, Working Papers in African Studies, 9 (Uppsala: Uppsala University, Department of Cultural Anthropology).
- . 1987. *Space, Time and Social Formation: A Territorial Approach to the Archaeology and Anthropology of Zimbabwe and Mozambique, c. 0–1700 AD* (Uppsala: Societas Archaeologica Upsaliensis).
- . 2012. 'Towards an Archaeology of the Future: The Urban Mind, Energy Regimes and Long-Term Settlement System Dynamics on the Zimbabwe Plateau', in P. J. J. Sinclair, G. Nordquist, F. Herschend, and C. Isendahl (eds), *The Urban Mind* (Uppsala: African and Comparative Archaeology, Department of Archaeology and Ancient History, Uppsala University), pp. 591–616.
- . 2019. 'Towards an Understanding of Spatiotemporal Dynamics at Great Zimbabwe: Contributions of the Urban Origins in Eastern and Southern Africa Programme', *Acta archaeologica*, 90.1: 123–34.
- Sinclair, P. J. J., I. Pikirayi, G. Pwiti, and R. Soper. 1993. 'Urban Trajectories on the Zimbabwe Plateau', in T. Shaw, P. Sinclair, B. Andah, and A. Okpoko (eds), *The Archaeology of Africa: Food, Metals and Towns*, One World Archaeology, 20 (London: Routledge), pp. 705–31.
- Smith, M. E., J. Lobo, M. A. Peeples, A. M. York, B. W. Stanley, K. A. Crawford, N. Gauthier, and A. N. Huster. 2021. 'The Persistence of Ancient Settlements and Urban Sustainability', *Proceedings of the National Academy of Science of the USA*, 118.20: e201815118.
- Sulas, F. and I. Pikirayi. 2020. 'From Centre-Periphery Models to Textured Urban Landscapes: Comparative Perspectives from Sub-Saharan Africa', *Journal of Urban Archaeology*, 1: 67–83.
- Tainter, J. A. 2006. 'Social Complexity and Sustainability', *Ecological Complexity*, 3: 91–103.

- Tainter, J. A., V. L. Scarborough, and T. Allen. 2018. 'Resource Gain and Complexity: Water Past and Future', in F. Sulas and I. Pikirayi (eds), *Water and Societies from Ancient Times to the Present* (London: Routledge), pp. 328–47.
- Theal, G. M. 1898–1903. *Records of South Eastern Africa*, 9 vols (Cape Town: Government of the Cape Colony).
- Tyson, P. D. and J. A. Lindesay. 1992. 'The Climate of the Last 2000 Years in Southern Africa', *The Holocene*, 2: 271–78.
- Tyson, P. D., W. Karlén, K. Holmgren, and G. A. Heiss. 2000. 'The Little Ice Age and Medieval Warming in South Africa', *South African Journal of Science*, 96: 121–26.
- Tyson, P. D., J. Lee-Thorp, K. Holmgren, and J. F. Thackeray. 2002. 'Changing Gradients of Climate Change in Southern Africa during the Past Millennium: Implications for Population Movements', *Climatic Change*, 52: 129–35.
- Walker, P. J. 1993. 'The Architectural Development of Great Zimbabwe', *Azania*, 28: 87–102.
- White, F. 1903–1904. 'Observations on Recent Discoveries at Ancient Ruins', *Proceedings of the Rhodesia Scientific Association*, 4: 14–20.
- . 1905. 'The Large Elliptical Ruin at Great Zimbabwe', *Proceedings of the Rhodesia Scientific Association*, 5: 11–20.
- Whitty, A. 1957. 'The Origins of the Stone Architecture of Zimbabwe', in J. D. Clark and S. Cole (eds), *Third Pan-African Congress on Prehistory* (London: Chatto and Windus), pp. 366–77.
- Whitty, A. 1961. 'Architectural Style at Zimbabwe', *Occasional Papers of the National Museums of Southern Rhodesia*, Series A. Human Sciences, 3.23A: 289–305.
- Willoughby, W. C. 1893. *A Narrative of Further Excavations at Zimbabwe* (London: George Philip and Son).