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Rural Settlement Dynamics in a Rapidly Urbanizing Landscape: Insights from Satellite Remote Sensing and Archaeological Field Surveys in Zanzibar, Tanzania

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ABSTRACT

In Africa, rapid urbanization covers archaeological sites and limits the utility of traditional archaeological field survey methods. This is not only a crisis for archaeological heritage conservation, but it also distinctly impacts anthropological understandings of African urban trajectories since much evidence for precolonial urbanism lies within areas of rapid expansion. However, high-resolution multitemporal satellite data may facilitate reconstructions of urban growth in African cities, enabling archaeological surveys to target undeveloped areas for prospection within the interstices of modern urban development. This paper describes an application of satellite remote sensing for archaeological prospection within the rapidly urbanizing hinterland of Zanzibar Stone Town, a UNESCO World Heritage site. Survey results reveal settlement trajectories around the city over the last millennium, drawing attention to the role of rural agricultural land as a factor in the emergence of precolonial urbanism and the continued significance of rural places as urbanization progressed into the Colonial era.

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Introduction

The future of the world is urban. From 2018–2050, the global urban population is expected to increase from 55–68%, up from just 30% in 1950 (United Nations, Department of Economic and Social Affairs, Population Division 2018). African cities are the fastest growing urban areas in the world and are expected to triple in size from 2018–2050, surpassing the urban growth rate of Asia, which is currently the highest in the world (United Nations, Department of Economic and Social Affairs, Population Division 2018, 24–25). By 2100, some of the largest cities on Earth will be African and include African metropolises like Kinshasa, Dar es Salaam, and Lagos (Cobbinah, Erdiaw-Kwasie, and Amoateng 2015). Concurrently, the number of “micro-urban” African cities of less than 500,000 people will also increase significantly in the coming decades (Chai and Seto 2019). The causes of rapid urbanization include population growth, but urbanization is also occurring even in places where populations have locally declined, due to increased migration from rural areas as a result of socioeconomic transformations (Sumari et al. 2020). Rapid urbanization in Africa constitutes a pressing issue in sustainable development, where challenges consist of ensuring access to infrastructure, medicine, food, education, and opportunities for growing urban populations. It also, however, will have significant impacts on archaeology on the continent, affecting heritage management and archaeological research, especially in terms of long-term urban transformations. Archaeologists of the present and future will need to increasingly contend with the challenges of survey and research in rapidly urbanizing environments. This paper presents a case study and methodology for addressing these challenges around Zanzibar City,¹ a rapidly urbanizing place on the island of Unguja in Zanzibar, Tanzania, in eastern Africa.

The impact of rapid urbanization on archaeological research and heritage conservation is understudied. In contrast to high-profile case studies of cultural heritage loss in war zones and through looting, urban expansion is rarely considered as a contemporary archaeological crisis, especially in Africa (although see Lane 2011). Yet, urbanization is an urgent problem for archaeologists and heritage managers, since it threatens to significantly impact the preservation and accessibility of archaeological sites. This is a concern for archaeologists interested in urban transformations on the African continent, since so much archaeological data related to the emergence and growth of Africa’s first cities lie in and around some of the fastest rapidly urbanizing regions.

Globally, remote sensing technologies have revolutionized archaeological approaches to prospection, regional analysis, and the use of space (Casana 2021; McCoy 2021; Opitz and Hermann 2018). In the field of urban studies, satellite remote sensing is a key dataset for understanding modern urban land use changes in Africa (Knauer et al. 2017; Xu et al. 2019; Yao et al. 2019). Satellite remote sensing and raster imagery classification may also enable the creation of high-resolution models of historical and archaeological landscapes within modern African cities. These models can facilitate targeted archaeological prospections to systematically investigate the archaeology of modern African cities, many for the first time.

The case study here explores a composite methodology combining satellite remote sensing and archaeological field surveys. The aim was an exploration of the archaeological landscapes around Zanzibar City, which contains a UNESCO World Heritage urban landscape built around a precolonial urban center, Zanzibar Stone Town. Zanzibar City is a rapidly urbanizing African city in the 21st century

A.D. (Kukkonen et al. 2018). Historical maps, LandSat imagery, and PlanetScope imagery enabled a time-series comparison of urban growth. Using an object-based classification of multispectral Planet imagery in Trimble Ecognition (10.3 Trimble Germany GmbH 2022), this project produced a stratified model for systematic survey in the interstices of Zanzibar City's modern development. Surveys shed light on settlement trends in the hinterland of a large African urban center over the last millennium and inform an understanding of urban transformations and rural adaptations to sociopolitical change. The methodology developed here may inform emergent archaeological approaches for tackling rapidly urbanizing environments in Africa and globally. Through field surveys informed by these techniques, this study has recorded evidence of a rural archaeological landscape that may soon be swallowed up by urban expansion. From analysis of this data, the study reveals the sociopolitical and economic rural landscapes that emerged as Zanzibar Stone Town grew and changed, the spatiotemporal characteristics of urban-rural connectivity, and the significance of rural agricultural land as the island's urban elites initiated and participated in long-distance exchanges across the Indian Ocean and globally.

Rapid Urbanization in Africa

At the time of writing, over a decade has passed since Lane (2011) argued that archaeologists in Africa have been guilty of turning a blind eye to urban and peri-urban settings, since these places tend to be more difficult to investigate through traditional archaeological field methods. Since then, rapid urban expansion has become a key feature of African societies in the 21st century A.D., in eastern Africa especially (Burton 2017). Urban, suburban, and low-density peri-urban spaces are already, and will continue to be, loci for the destruction of archaeological heritage on the African continent. Some studies have attempted to address and stem the impacts of urbanization on famous archaeological sites, for instance around Carthage (Altekamp and Khechen 2013; Ennabli 1998) and in Cairo (Blasco, Verstraeten, and Hansen 2017; Elfadaly and Lasaponara 2019). Outside of these locations, though, most rapidly urbanizing places on the continent tend to be at high risk for the destruction of heritage while simultaneously being poorly understood archaeologically.

Many Africanist archaeologists are used to thinking about and working in rural landscapes, an orientation that may relate to the relatively low profile of African urban expansion as a modern archaeological crisis, compared to case studies involving the destruction of cultural heritage through looting in war zones in the Middle East (e.g., Kersel and Hill 2020; Meskell 2020; Tapete and Cigna 2019). However, the challenge of rapid urbanization for Africanist archaeologists and heritage managers is severe, since African cities are expanding at the fastest rate of anywhere on Earth and often through unregulated and informal settlements (Quaye et al. 2022). Already-underfunded conservation facilities are tasked with balancing archaeological research and conservation goals with broader societal priorities around providing education, healthcare, clean water, employment, and sustainable infrastructure to future generations.

Rapid urbanization entails the sudden expansion of urban land use, which covers previously rural areas with houses, paved roads, and developed public space. In Africa, Xu and colleagues (2019) characterized rapid urban development in Africa across 25 different cities and noted that African urban patterns in the 21st century A.D. generally produce more dispersed, less compact urban forms than in Europe, China, or India, potentially further increasing the impact of urbanization on rural archaeological landscapes. Urbanization in Africa also significantly intensifies extractive industries for sand, gravel, stone, clay, and timber, impacting land use and archaeological sites in remaining rural areas (Lane 2011). Research elsewhere in the tropics has described low-density, dispersed, peri-urban, and agro-urban forms as an alternative urban pathway in comparison to compact urbanism (e.g., Hawken and Fletcher 2021; Mortoja, Yigitcanlar, and Mayere 2020). These models may apply to rapid urbanization in tropical African cities. In eastern Africa, rapid dispersed urbanization is and will continue to be a key challenge for policy makers, as well as for archaeologists attempting to investigate settlement systems and urban landscapes.

The Archaeology of Eastern African Urbanism

On the Swahili coast of eastern Africa, archaeologists have investigated urban trajectories for more than a half century, focusing on the ruins of abandoned villages, "stone-towns," and trading entrepôts of the late 1st to early 2nd millennium A.D. (e.g., Abungu and Mutoro 1993; Chittick 1974, 1984; Horton 1996; Horton et al. 2022; Kirkman 1954; LaViolette and Fleisher 2009, 2018; Pawlowicz, Fleisher, and Wynne-Jones 2021; Rødland 2021; Wilson and Omar 1997; Wynne-Jones and Fleisher 2016). These studies have revealed the breadth and complexity of the precolonial Swahili world, especially calling attention to the diversity of non-elite site types beyond stone-built monumental centers (e.g., LaViolette and Fleisher 2018). These investigations of urbanism have been spatially oriented to avoid modern urban areas of the eastern African coast, where modern development impedes site visibility, survey, and excavation. Nearly all the studies addressed sites that now lie amid rural agricultural villages and fields and represent abandoned contexts where urban occupations ended sometime between the 14th and 17th centuries A.D.

Far less common are investigations of urban processes in the largest cities on the eastern African coast: places like Mogadishu, Lamu, Malindi, Mombasa, Tanga, Dar Es Salaam, and Zanzibar City (although see Kiriama 2018; Power et al. 2020; Qin and Ding 2018; Sassoon 1980). Except for Dar Es Salaam, these cities began as precolonial Swahili towns in the late 1st or early 2nd millennium A.D. and grew through the Colonial and post-Colonial periods to become modern cities. As such, most likely hold some of the longest records of continuous sedentary occupation in the region. For instance, Power and colleagues' (2020) recent excavations in Zanzibar Stone Town confirmed a 900 year sequence of habitation in the Old Fort, as the settlement grew from a fishing village to a Swahili stone-town to a colonial entrepôt and urban center.

These deep-time records of urban growth, change, and decline make modern cities in coastal eastern Africa ideal places to investigate long-term urban trajectories, but modern cities are also the most poorly understood from an

archaeological perspective. As a result of this gap, broad understandings of eastern African urbanism are likely skewed, since current models draw on research conducted at urban settlements that grew rapidly in the 11th–15th centuries A.D. and then were abandoned prior to or during Portuguese colonial incursions. Furthermore, research on the Colonial period has largely investigated rural settlements, considering the impacts of colonial settlements, the caravan trade, and plantation systems on rural societies (Alders 2023a; Biginagwa and Lane 2021; Croucher 2014; LaViolette and Norman 2023). The absence of multi-scalar, long-term understandings of urban trajectories from the largest cities on the coast currently limits anthropological understandings of eastern African urbanism, as well as the dynamics of colonial contact. This gap also curtails the potential for the Swahili coast to contribute to comparative understandings of urban and rural trajectories globally (*sensu* Fletcher 2020; Smith 2020). The cause for this gap is the material fact that field research in urban environments can be prohibitively more difficult and expensive than research in rural places. Rural sites in eastern Africa are simply easier to access, visualize, and sample, since archaeological deposits are far less likely to be trapped under modern houses and paved roads.

Zanzibar City

Zanzibar City is the main modern city on the island of Unguja, the large (ca. 1700 km²) southern island of Zanzibar, a semi-autonomous island archipelago approximately 30 km east of the Tanzanian coast (Figure 1). The settlement lies on a peninsula jutting west and is one of the largest modern ports in eastern Africa. On the edge of the peninsula is Shangani, where most of the oldest standing architecture of the old town, or Zanzibar Stone Town (*Mji Kongwe* in Swahili), remains. The French traveler Guillain produced the first detailed map of this town in A.D. 1856, recording an urban form that likely developed directly out of an earlier precolonial stone-town. Figure 2 shows this map alongside a modern image of the old town from drone imagery taken by the Zanzibar Mapping Initiative, a collaboration between the Zanzibar government and the World Bank, in 2016.

The original settlement of Zanzibar Stone Town figures prominently in historical research on colonial eastern Africa (Bishara 2017; Cooper 1977; Glassman 1995, 2011; Hopper 2015; Prestholdt 2008; Sheriff 2010, 2018; Vernet 2017). Archaeologically, however, the town has seen little systematic archaeological work apart from documenting architectural features and gazetted sites (Cooper and Ghidoni 2022; Horton and Clark 1985; Rhodes, Breen, and Forsythe 2015) and an underwater archaeological survey of the town's harbor, which brought up relatively little due to deep sedimentation and other post-depositional processes (Breen, Forsythe, and Rhodes 2016). Recently, however, the first extensive excavations in the Old Fort have revealed a 900 year sequence of occupation (Power et al. 2020). These excavations attest to ceramic deposits on a natural beach from the 11th–12th centuries A.D. and then multiple phases of Swahili house construction and the possible remnants of a stone mosque from the 12th–15th centuries A.D. Following this, the Portuguese built a factory in the late 16th century A.D. and a church in A.D. 1612. The Yarubid Omanis destroyed this initial structure during a raid in A.D. 1651, but it was rebuilt in a smaller style before the Portuguese

were finally expelled from the coast north of Mozambique in A.D. 1699. After this, authority briefly passed into the hands of a Swahili queen, Fatuma, whose palace was supposedly located somewhere on the eastern side of the current fort (Power et al. 2020, 284). Subsequently, Omanis built a fort around the ruins of the Portuguese church and maintained it until it passed into the hands of the British (in A.D. 1890) and subsequent postcolonial government.

Power and colleagues' (2020) research showed that Zanzibar Stone Town is the site of a precolonial Swahili settlement with stone architecture and imported Indian Ocean trade wares, similar in size and scale to other trading centers with elite, stone-built architectural features from the 11th–15th centuries A.D. in the Zanzibar archipelago like those at Tumbatu (Rødland 2021) or Chwaka in Pemba (LaViolette, Fleisher, and Horton 2023). Unlike these other settlements, however, Zanzibar Stone Town was not abandoned prior to or at the start of the Colonial period, and local elite Swahili authority seems to have continued alongside foreign rulers from at least the early Portuguese period onward in the form of the Mwinyi Mkuu. This was the hereditary Swahili ruler, whose residence likely lies east of the Old Fort and who relocated inland to Dunga in the 19th century A.D. when the Busaid Omanis made Zanzibar Stone Town their capital.

Unique urban and socio-ecological factors may relate to the continued persistence of Zanzibar Stone Town as a central place over the last millennium. These factors might be revealed by investigating rural settlement trajectories in the immediate countryside of the town. Research elsewhere in coastal eastern Africa has investigated urban and rural settlement dynamics through survey (e.g., Fleisher 2003, 2010; LaViolette and Fleisher 2018; Pawlowicz, Fleisher, and Wynne-Jones 2021; Wynne-Jones 2007), but these studies have focused on urban landscapes that were abandoned prior to the Colonial period. Understandings of Swahili social transformation may be incomplete without consideration of some of the most paramount urban centers of the coast that went on to develop into modern cities. These “apex” urban centers include Zanzibar Stone Town but also Lamu, Malindi, and Mombasa. Compared to research at ruined Swahili stone-towns where archaeological deposits are easily accessible, very little archaeological work has occurred to understand urban and rural interactions around the old archaeological sites of these larger cities (though see Qin and Ding 2018). This situation may obscure a complete understanding of the social dynamics of Swahili urbanism and sociopolitical development, since there may have been dynamics unique to places like Zanzibar Stone Town and Mombasa that enabled these settlements to develop into large modern cities as their counterparts were abandoned at the start of the Colonial era.

Modeling Zanzibar City's Urban Growth

Archaeologists have long recognized the potential of multi-temporal spatial datasets for recovering past landscape histories and settlement trends, from historical maps (Green et al. 2019; Petrie et al. 2019) to declassified satellite imagery (Casana 2020; Menze and Ur 2012) to LandSat and other long-running multispectral, multitemporal sensors (Abate et al. 2020; Agapiou 2020). This section presents a time-series comparison of historical maps, historical imagery, and

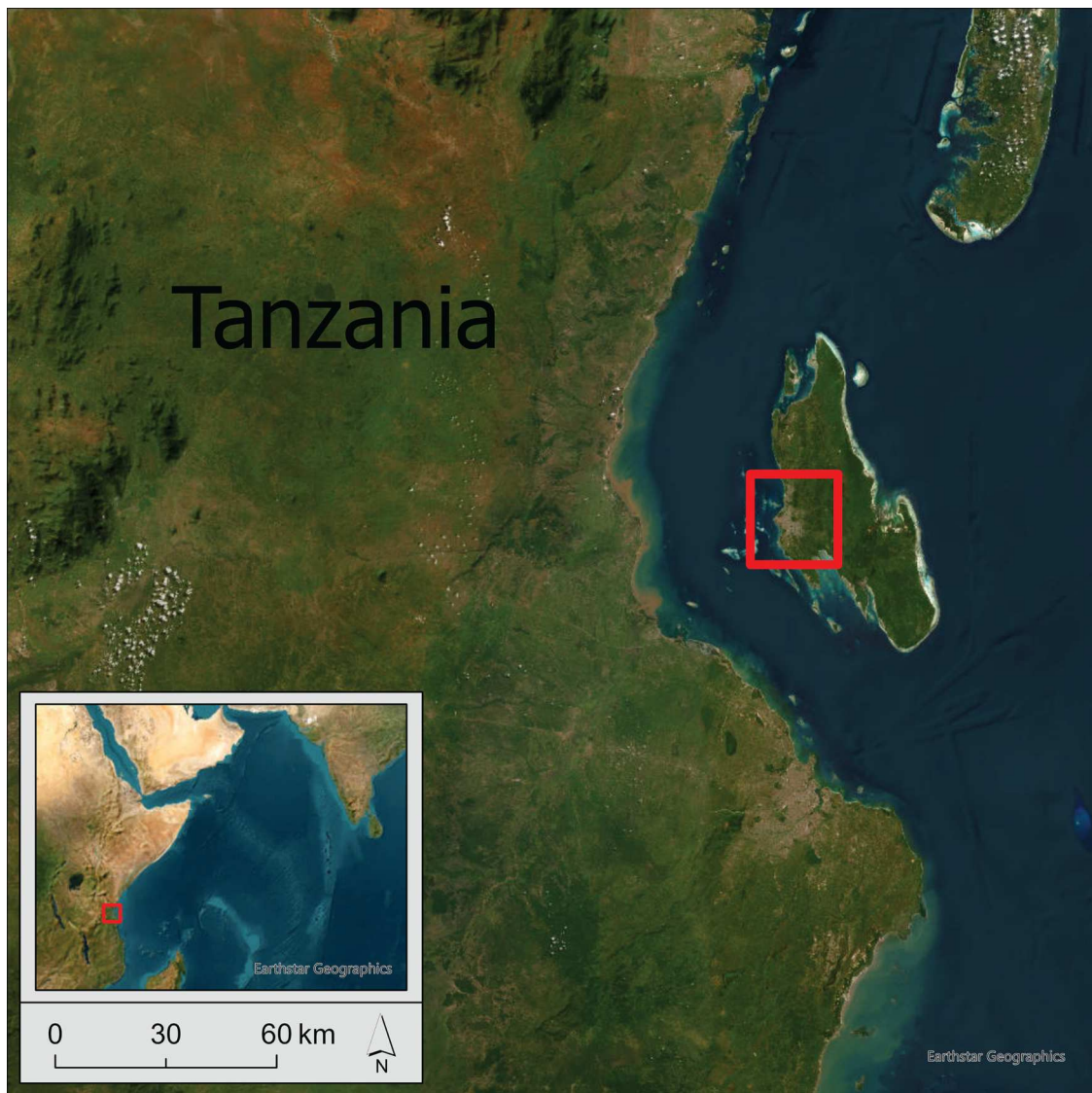


Figure 1. Overview of study area.

modern multitemporal satellite imagery from LandSat and PlanetScope that reveals urban and rural land use changes over the last 150 + years around Zanzibar Stone Town.

After the A.D. 1856 map by Guillain (1856), two maps from the early 20th and mid-20th century A.D. (Figure 3) depict a growing city, a stream network, and a countryside populated by small, dispersed hamlets and villages around Zanzibar Stone Town (*A Map of Zanzibar* 1907; Zanzibar 1947; see also Alders 2023b). By the middle of the 20th century A.D., significant changes were occurring in rural societies on the island; Middleton (1961) and Pakenham (1948) both documented the breakdown of traditional heterarchical ritual authority in Swahili “country-towns” and the erosion of kin-based systems of land tenure. Still, these changes do not seem to have been associated with significant urban expansion; by A.D. 1947, the urban center remained confined to the “native quarter,” which lay east of Zanzibar City’s stone-town, and much of the rural countryside was still populated by small villages and hamlets.

Urban growth accelerated in the second half of the 20th century A.D. Kukkonen and colleagues (2018) modeled urban growth on Unguja Island in Zanzibar by digitizing aerial imagery, IKONOS satellite data, and GeoEye-1 satellite images from 2004–2013, revealing an expansion rate of 3.8%

per year during this time. Near infrared bands from multispectral satellite images also reveal rapid urban expansion from the 1970s to the present (Figure 4). One Landsat 2 image from 1975, two Landsat 5 images from 1995 and 2009, and one composite of two mosaiced PlanetScope satellite imagery scenes from 2022 (see Supplemental Material 1 for scene list) show the extent of development within a 15 km radius of Zanzibar City. From 1975–2022, Zanzibar City’s contiguous urban space has at least tripled in size, and rural areas along major roads have filled in with suburban spread.

While Kukkonen and colleagues (2018) used hand-digitization methods to quantify urban space, this project used automated, object-based supervised classification of a Near-Differential Vegetation Index ($NDVI = [NIR - Red] / [NIR + Red]$) image derived from two mosaiced, orthorectified, and harmonized 2022 PlanetScope images with 3 m spatial resolution and four multispectral bands (see Supplemental Material 1). This process was achieved in Ecognition (10.3 Trimble Germany GmbH 2022). Object-based analysis using multi-resolution segmentation and supervised classification (scale parameter: 100, shape: 0.1, compactness: 0.5; see Watkins and Van Niekerk 2019) of this NDVI provides a quantified measure of the extent of total urban



Figure 2. A) Guillain's map of Zanzibar published in A.D. 1856 and B) Zanzibar's modern old town, with imagery from the Zanzibar Mapping Initiative.

coverage, which was then buffered by 50 m in ArcGIS Pro to account for areas presumed to be inaccessible for archaeological survey in the immediate proximity of buildings and roads, like the backyards of local residents. The accuracy of this classification was assessed through qualitative visual inspections of the 24 1 km diameter study areas. For each area, the classified space was compared visually with very high-resolution (0.7 cm) drone imagery of Unguja captured by the Zanzibar Mapping Initiative between 2016 and 2017 (see Supplemental Material 1 for a list of images). This comparison suggests that the classification of urban space is quite

accurate, which would be expected given stark spectral differences between vegetated and built environments. Since the aim of the study was to assist in planning field surveys that would avoid built space, this qualitative assessment of accuracy was deemed sufficient, and a quantitative accuracy assessment was not carried out. Figure 5 shows a visual representation of the NDVI and a polygon of classified urban space superimposed over the 50 m buffer polygon of urban space. Supervised classification of an NDVI of a 15 km radius around Zanzibar City creates a model showing areas that are already off-limits for archaeological prospection. However,

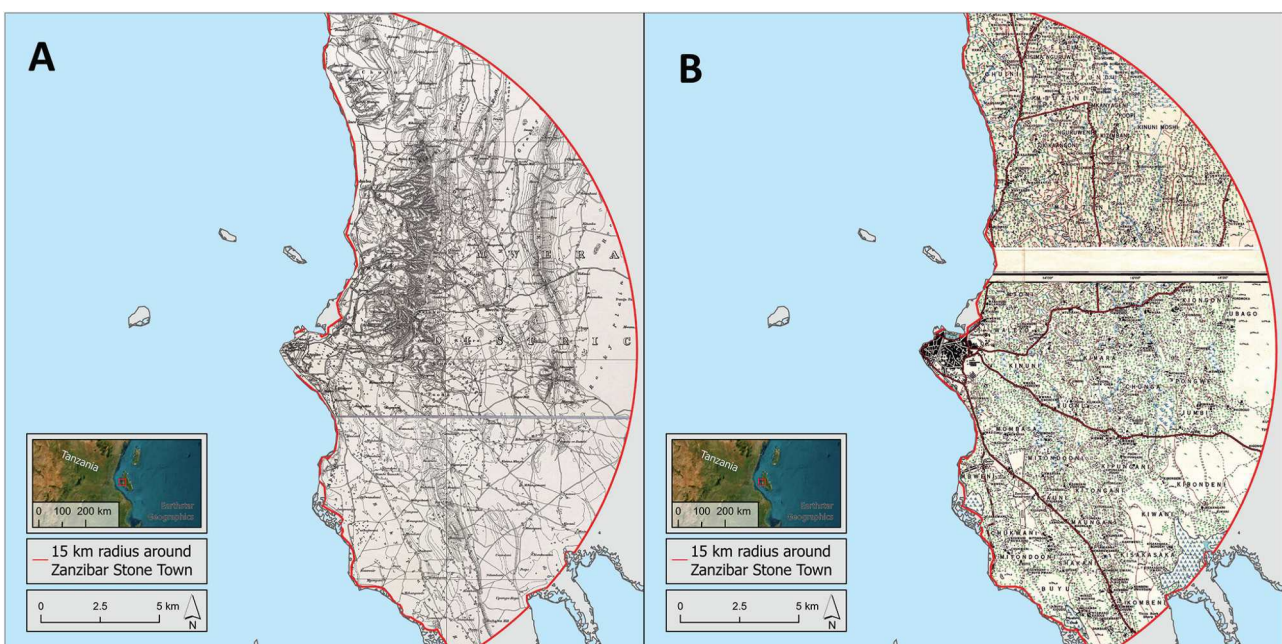


Figure 3. Zanzibar City's countryside, A) A.D. 1907 and B) A.D. 1947.

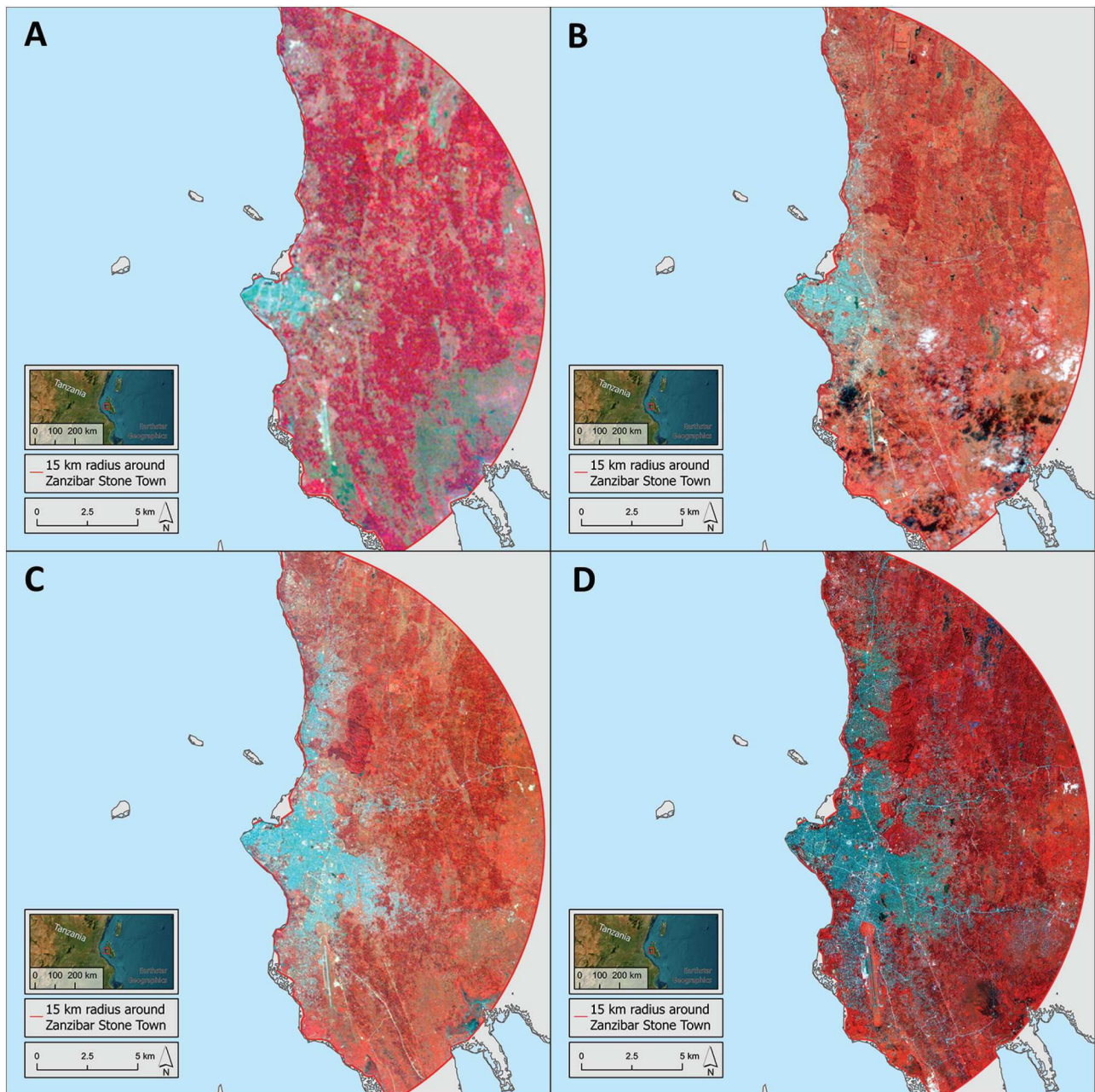


Figure 4. Zanzibar City's growth as seen through near-infrared bands in imagery from A) 1975 (Landsat 2), B) 1995 (Landsat 5), C) 2009 (Landsat 5), and D) 2022 (Planet). Blue and gray colors represent urban areas; reddish colors represent vegetated and bare earth areas.

this model also reveals certain areas even relatively close to the city's old quarter that remain uncovered and potentially available for investigation.

Finding the Interstices: Planning Field Surveys in Zanzibar City's Hinterland

Surveys were planned in the 15 km radius around Zanzibar Stone Town in order to identify settlement pattern changes over time in relation to sociopolitical changes in the urban center. More specifically, this meant clarifying the spatial and ecological patterns of rural settlement from the earliest occupations on the island to the formation of plantations in the 19th century A.D. and collecting artifact assemblages that would enable dating and analysis of craft production and interaction. Previous research on Unguja (see Alders 2023a) informed a decision to stratify the potential survey universe by distance to the sea and distance from streams.

Sampling proportionally from each of these areas would capture a broad range of settlement types and enable an understanding of the different environments and ecological affordances that structured rural settlement trajectories around the urban center. A stream model was derived from the A.D. 1907 map of the island (see Alders 2023b). 500 m buffers were created around these digitized streams in ArcGIS Pro. Next, two buffer zones were created using an outline of the island: one between 0 and 5 km from the coast and one covering areas greater than 5 km from the coast. The aim was to divide the city's hinterland into four areas: zones near the coast and near streams, zones near the coast and far from streams, zones far from the coast and near streams, and zones far from the coast and far from streams. Figure 6 shows the stratified survey zones.

Based on the supervised classification of urban space from the 2022 Planet satellite image, inaccessible areas covered by development were eliminated, creating a "Swiss cheese"

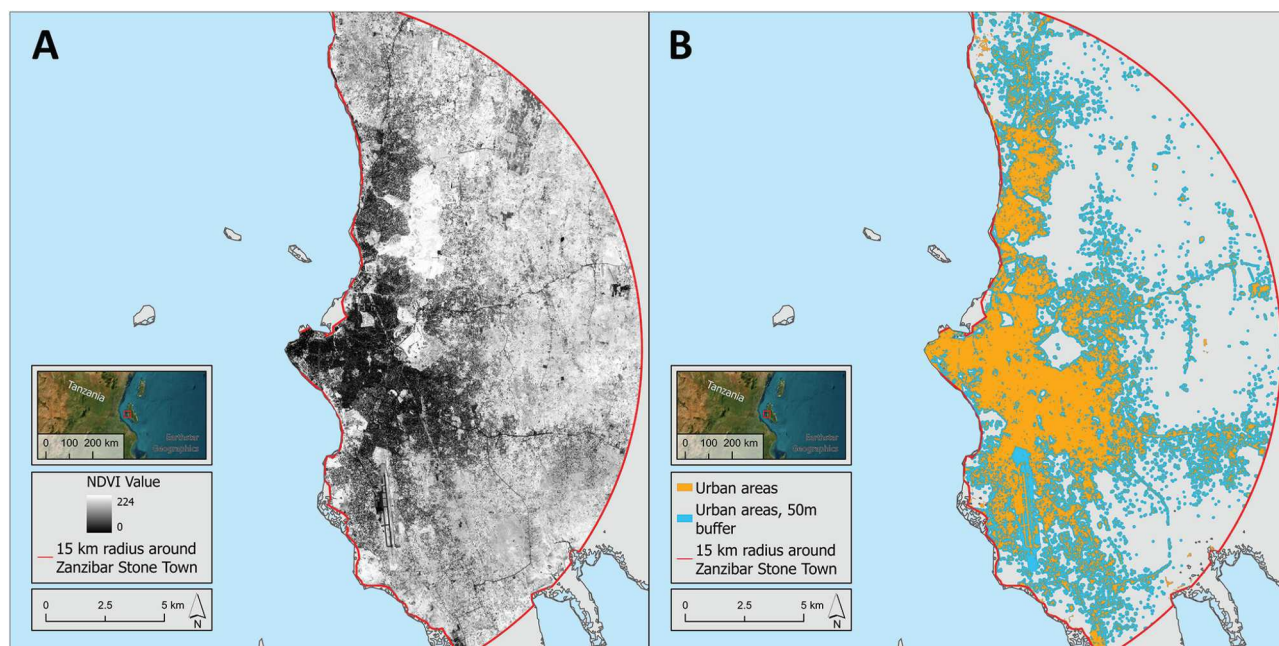


Figure 5. A) NDVI and B) classified urban space.

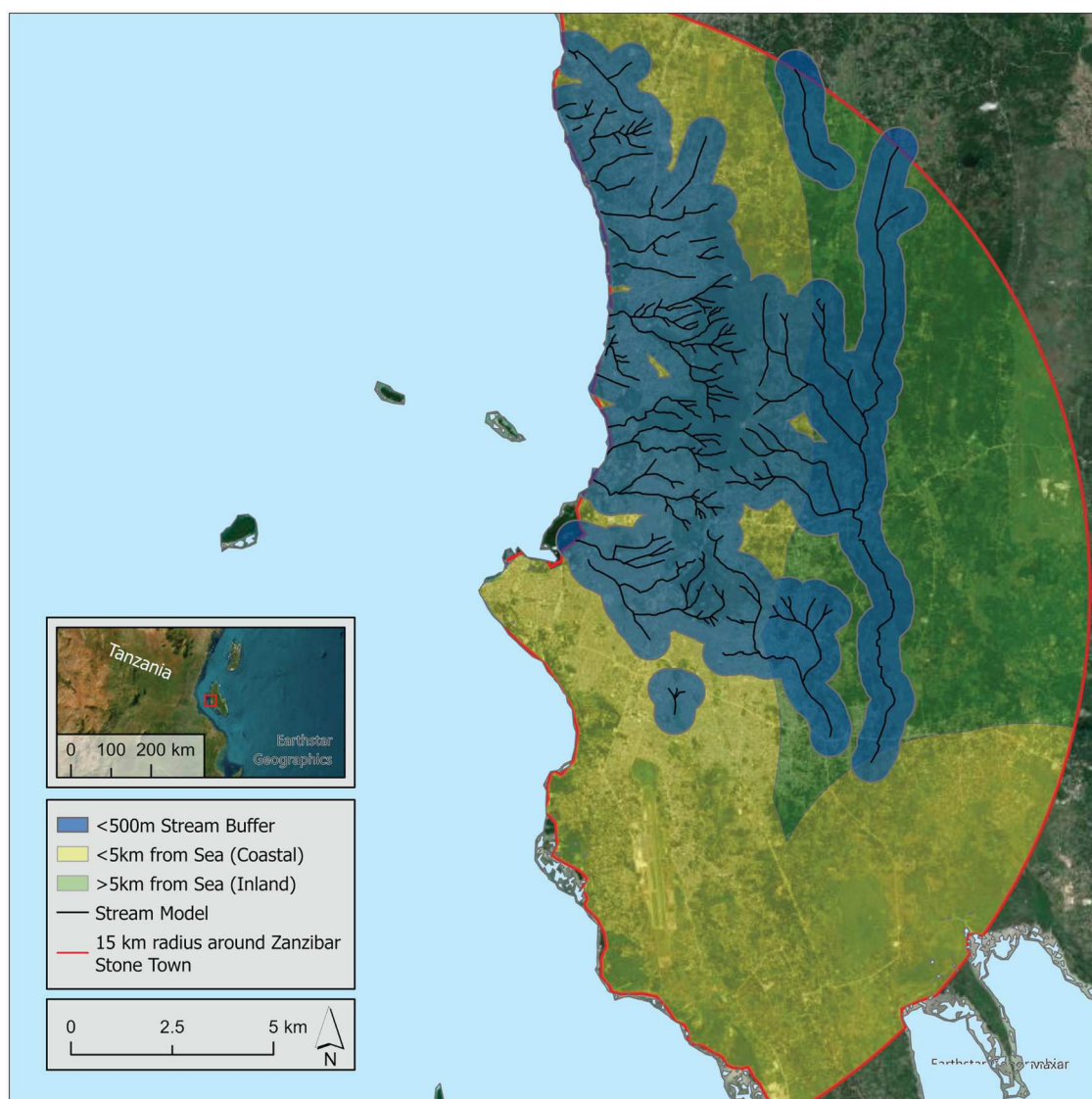


Figure 6. Stratified zones showing distance to the sea and distance from streams.

model of stratified areas for potential archaeological survey within the interstices of modern development. Then, 20 transect areas were selected proportionally to different stratifying factors: distance to the sea and distance from streams. 10 transect areas were spread across the zones near streams, while 10 others were spread across zones greater than 1 km from streams. 12 areas were assigned to the near-coastal zone, while eight were assigned to the inland zone; this is in proportion to the size of each zone relative to the overall hinterland area. Within each of these zones, survey areas were selected randomly using the Create Random Points tool in ArcGIS Pro. A 1 km circular buffer was created around each randomly assigned point. Finally, four additional survey areas were placed to intentionally sample open areas close to Zanzibar Stone Town in the interstices of modern houses. Figure 7 shows the survey model with the planned transect areas and subtracted urban space.

Within each survey area, visual inspection of high-resolution UAV imagery from the Zanzibar Mapping Initiative enabled the manual selection of transects along routes that would be favorable for recovering archaeological deposits. At least two 1 km transects for each area were placed to intentionally avoid rice valleys, military campgrounds, or other obstructions that would limit the effectiveness of

survey. Each transect consisted of a 100×1000 m polygon. In total, 48 transects were placed across the hinterland region.

When fieldwork commenced, the team began each survey area by consulting with the *sheha*, or local mayor, of the locality in question, who would assign a community member to accompany the survey and help discuss research with local residents. Survey involved five team members equipped with three Trimble GNSS receivers in a line spaced 25 m apart. The central team member would follow the center of the transect polygon, while the two team members on the right and left wing would follow each side. Two more team members would stand staggered in between. The team would walk forward and call out when archaeological materials were encountered. If more than one team member encountered an archaeological findspot, the group would spread out and investigate. Sites consisted of a scatter of more than 20 ceramic sherds of diverse types. Finds of less than 20 sherds or finds of a single broken vessel consisting of more than 20 sherds were recorded as find spots. When a site was located, the team would spread out to determine the scatter's boundaries and then perform a systematic surface collection by walking in a smaller line across the scatter. If topsoils were deep enough to obscure

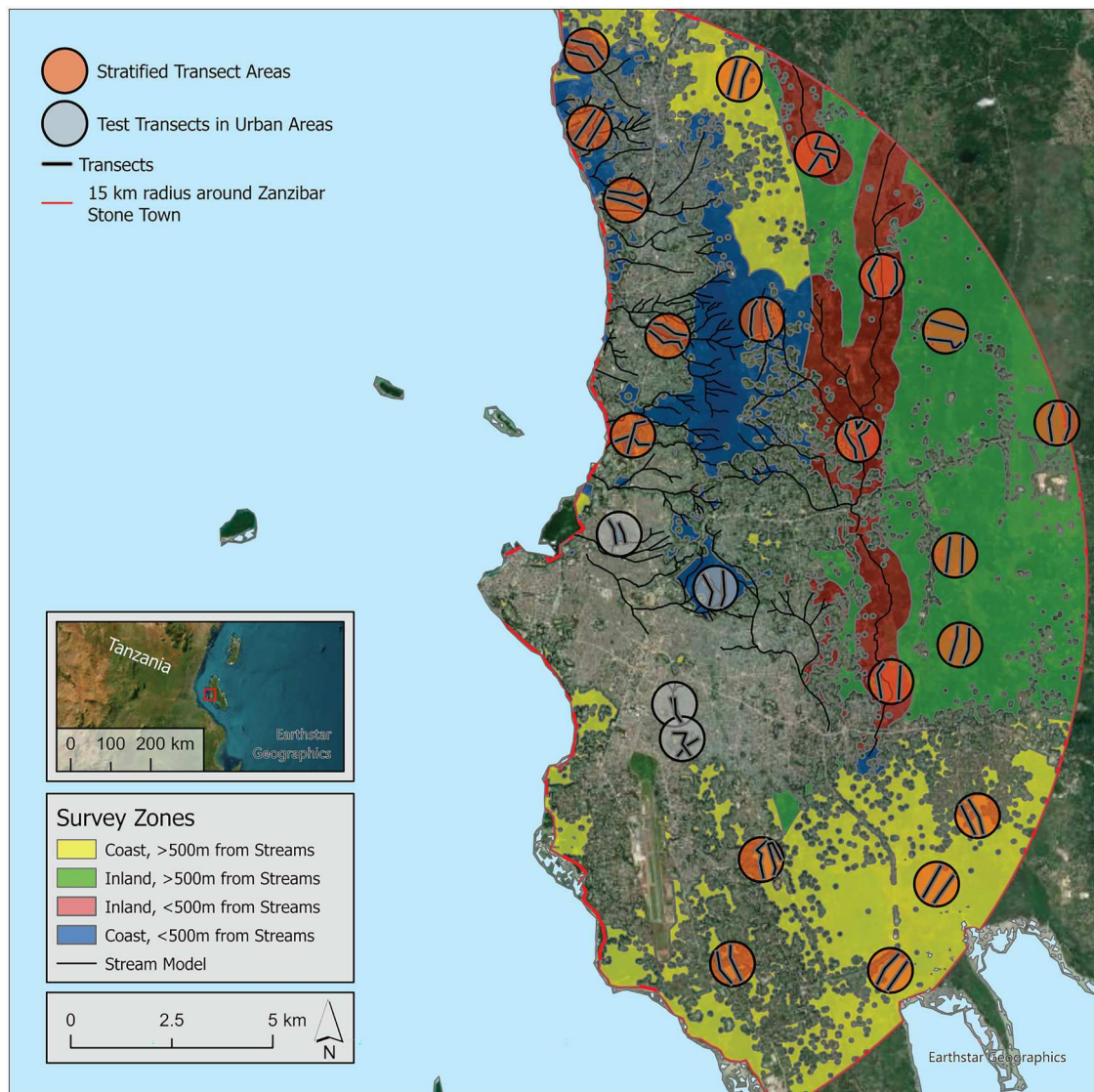


Figure 7. Survey zones with urban space removed and transect areas overlain.

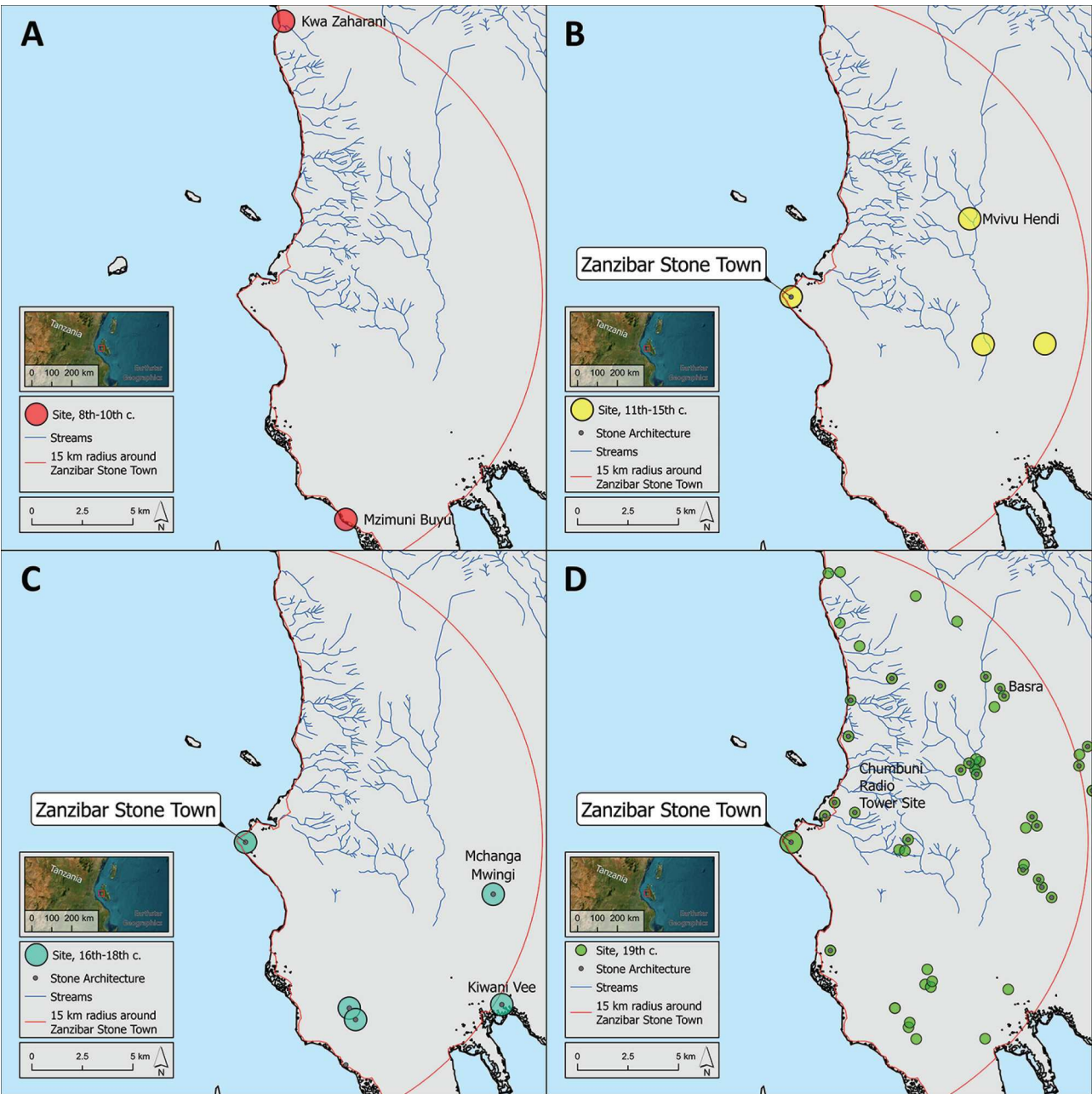


Figure 8. Survey results, showing recorded sites by period. Stream network is digitized from the A.D. 1907 map of Unguja in Zanzibar (see Alders 2023b).

subsurface deposits, the team would dig shovel-test pits (STPs) in a grid formation across the site to investigate the extents of deposits underground. In a few cases, the

team returned to certain sites to dig a more extensive STP grid if it was suspected that subsurface deposits would reveal important aspects of site history.

Table 1. Overview of sites recorded during survey.

Survey regions	8th–10th century A.D.	11th–15th century A.D.	16th–18th century A.D.	18th–19th century A.D.	Unknown date	Total sites per region
Inland, far from streams (4 systematic zones)	0	0	0	4	0	4
Inland, near streams (4 systematic zones)	0	2	0	7	0	9
Coast, far from streams (6 systematic zones)	0	0	0	10	2	12
Coast, near streams (5 systematic zones)	1	0	0	3	1	5
Tests in urban areas (2 systematic zones)	0	0	0	4	0	4
Total sites (systematic)	1	2	0	28	3	34
Total sites (unsystematic)	1	1	3	13	1	19
Total sites	2	3	3	41	4	53



Figure 9. Sherds representing Siraf storage jars (top row and middle right), turquoise-glazed ware jars (middle-left), and some later 19th century A.D. Chinese and European wares (bottom row).

Survey Results

One survey zone near the coast and by streams was abandoned due to the presence of a military camp, and two other survey zones in urban areas were also not attempted due to marshy conditions that made pedestrian access impossible. However, 22 survey zones were completed, and surveys recorded 53 new archaeological sites in a 15 km radius around Zanzibar Stone Town (Figure 8). 34 sites were recorded through systematic transects, while 19 sites, almost all from the 19th century A.D., were found and recorded during conversations with residents and while moving between different systematic survey zones (Table 1). Sites were broadly dated using diagnostic imported and local ceramics, following established chronological associations for the region (Fleisher 2003; Horton 1996).

Rural and Urban Trajectories

Figure 8 shows the progression of settlement change from the 8th–19th centuries A.D. Rural settlement expansion into non-coastal environments correlates with key phases of urban development in Zanzibar Stone Town, from the 11th–15th centuries A.D. when the town grew as an independent Swahili urban center and in the 19th century A.D. when the town grew as a wealthy colonial entrepot. In these periods, some rural settlements show evidence for increased

integration with urban social and economic networks. The following sections describe settlement trends from the 8th–19th century A.D. in Zanzibar City’s hinterland in more detail.

The 8th–10th centuries A.D.

Prior to urbanization at Zanzibar Stone Town, early village communities occupied coastal environments to the north (Kwa Zaharani) and south (Mzimuni Buyu) of the western peninsula. At these sites, Swahili people settled just inland from beaches in natural harbors, a settlement trend in line with late 1st millennium A.D. sites elsewhere on the island at Fukuchani, Unguja Ukuu, or Mkokotoni (see Crowther et al. 2016; Fitton 2018; Fitton et al. 2022; Rødland 2021). Similar sites developed across a large region of the eastern African coast in the late 1st millennium A.D. on coastlines from Kenya to Mozambique at sites like Shanga (Horton 1996), Tumbe (Fleisher and LaViolette 2013), and Chibuene (Sinclair, Ekblom, and Wood 2012). At these sites, surveys recorded locally produced ceramics of the late 1st millennium A.D. Other finds included daub, ground stone objects, and imported ceramics of the late 1st millennium A.D., including Siraf storage jars and turquoise glazed ware storage jars (Figure 9). A final find at both sites was a large quantity of marine shell, suggesting that this was an important



Figure 10. A) Late sgraffiato fragments of the 12th–14th century A.D. recovered from Mvivu Hendi and B) sgraffiato jug fragments dug out of a riverbed at the same site by a farmer.

component of the diet of early Swahili people, as is the case at other late 1st millennium A.D. coastal sites in eastern Africa (Quintana Morales et al. 2022).

The 11th–15th centuries A.D.

Communities created small settlements inland at the start of the 2nd millennium A.D. Surveys recorded three 11th–15th century A.D. sites along water features in the east of Zanzibar Stone Town. Two of these sites lie directly along streams, while a third site lies on a bluff overlooking a pond that fills with water and dries out seasonally. The site of Mvivu Hendi lies within an area of dense 18th–19th century A.D. occupation including multiple stone wall fragments and a natural freshwater spring. Mvivu Hendi produced daub fragments, local ceramics of the 11th–15th centuries A.D. (Horton 1996, 260–270), some late, degraded sgraffiato sherds (Figure 10) relative to local ware, and a small handful of later 19th century A.D. ceramics. Given the diversity of finds and the site of the artifact scatter, this site may have been a hamlet or small village. The other two sites produced no imported sherds but did produce local earthenware, iron slag, and daub fragments. With fewer recovered artifacts and less intensive surveys at these sites, it is less clear whether they represent permanent habitation areas or more ephemeral types of occupation (e.g., camps for shifting cultivation).

Compared to 11th–15th century A.D. rural village sites in northern Unguja (Alders 2023a), the sites around Zanzibar Stone Town are poorly preserved, and it is difficult to draw significant conclusions about their nature. These sites see localized flooding and alluvial action which washes surface deposits downslope into swampy low-lying areas, destroying significant stratigraphy. While surveying at Mvivu Hendi, a local resident approached our field team with several large sgraffiato jug vessel fragments (see Figure 10) that he dug out of the bottom of the dry stream bed during the dry season while trying to access water for crops. At a depth of over 2 m, he came down onto the intact sgraffiato jug, which he broke accidentally with his hoe. Sgraffiato jugs are rare and may date specifically to the 12th century A.D. (Horton,

Brown, and Oddy 1986); the presence of a sgraffiato jug buried almost 2 m in mud suggests that much of the site of Mvivu Hendi is now lost and that the original site may have been more intensively occupied than current surface deposits would suggest.

Rural villages here date to the 11th–15th centuries A.D. on the basis of a conservative estimate of occupation using both local and imported ceramic types as dating proxies. However, village sites of this period really only have evidence for a single imported ware—late sgraffiato, a glazed earthenware of the Persian/Arabian Gulf that dates more concretely from the 12th–14th centuries A.D. (Horton 1996, 281–289). Not present at any of these sites are earlier sgraffiato wares of the 10th–11th century A.D. or later black-on-yellow ware, Chinese celadon, or monochrome glazed wares of the 14th and 15th centuries A.D. Going by imported ceramics alone, these villages could be seen to date specifically to the 12th–14th centuries A.D. This would align even more strongly with the most intensive phase of urban expansion on the Swahili coast, especially with urban sites like Tumbatu that were founded and abandoned from the 12th–14th century A.D. or with the site of Kilwa that reached an apogee in the 14th century A.D. before settlement growth at the site abruptly halted and monumental structures like Husuni Kubwa were abandoned in an unfinished state (Horton et al. 2022). Overall, rural villages recorded inland in Unguja may not have been abandoned as a result of Portuguese colonial incursions at the end of the 15th century A.D. but may have declined as part of an overall urban disruption in the 14th century A.D. ¹⁴C dates from these sites are needed to clarify their exact chronologies independent of ceramic evidence.

The 16th–18th centuries A.D.

Starting in the 16th century A.D., the Portuguese made Zanzibar Stone Town their base of operations on the island. Rural agricultural regions were largely unoccupied during this time, a similar result found in northern Unguja (Alders 2023a). Swahili communities in this period appear to have



Figure 11. Ruined Swahili pillar tomb at Mchanga Mwingi.

sought out more secluded places for settlement, possibly reflecting increased sociopolitical turbulence. The southern site of Kiwani Vee was occupied from at least the 15th–18th centuries A.D., and it produced only a single imported

sherd, a glazed blue monochrome ware of the 15th century A.D. The settlement's residents appear to have been relatively isolated from interactions with the wider Indian Ocean world or preferred autonomy rather than integration with



Figure 12. Newly available Chinese, European, Indian, and Middle Eastern ceramics of the 19th century A.D.

the economic systems of the early modern period. The site's extreme seclusion on a spit of land cut off from the mainland by mangroves and high tides may have enabled residents there to persist through Portuguese colonial rule more readily than their neighbors elsewhere. Marine products were an important resource for communities during this period, evidenced by large quantities of marine shell at Kiwani Vee.

Other sites of this period consist of monumental stone tombs to the south of Zanzibar Stone Town, built by Swahili people in rural places for the first time. Earlier Swahili tombs were a feature of public space in precolonial towns of the 11th–15th centuries A.D., like at Chwaka (LaViolette, Fleisher, and Horton 2023) or Gede (Pawlowicz 2019). But the tombs recorded south of Zanzibar Stone Town during this period, dated to the 17th and 18th centuries A.D. based on comparison with tombs elsewhere, were unattached to any apparent settlement. Figure 11 shows the ruined pillar tomb of Mchanga Mwingi.

STP grids around this tomb did not produce any evidence for permanent occupation in the vicinity. Instead, these rural tombs may have been an expression of new-found concerns about marking ancestral rights to rural land, as Portuguese and later Omani colonialists sought to expand into traditional Swahili territories. Traditional land tenure systems were based in kinship, with the descendants of an original founder holding the rights to settle and farm in a *kiambo*, or living place, in perpetuity (Middleton 1961). The construction of tombs in rural areas for the first time during this period may have related to attempts by Swahili people to mark the extent of their *kiambo* for the first time by referencing their original founding lineage and monumentalizing it in stone. This newfound desire to territorialize space with monumental tomb structures may relate to Swahili responses to colonial expansion.

The 19th century A.D.

In the 19th century A.D., Zanzibar Stone Town grew into one of the wealthiest cities in the western Indian Ocean, as the central hub for the burgeoning caravan trade in ivory and enslaved eastern Africans (Bishara 2017; Sheriff 2018). Controlled by the Busaid Omanis since the mid-18th century A.D., Sultan Seyyid Said relocated the capital of the empire to Zanzibar Stone Town around A.D. 1840, and by the mid-19th century A.D., the city had surpassed Muscat in customs revenues (Bishara 2017, 51). The dramatic urban transformations of the mid-19th century A.D. included a large expansion of settlement across the Shangani peninsula and inland into the *ng'ambo*, or native quarter, and the creation of large elite monumental sites in the city, including a palace, an administrative building with electricity and an elevator, and large stone Persian baths for the Busaid elite and their family members (Sheriff 2018).

Rural expansions accompanied these events, as Omani settlers transformed rural areas into plantations for growing cloves and coconut. They brought enslaved eastern Africans with them. Surveys attest that starting in the late 18th and early 19th century A.D., large areas of Unguja's rural hinterland began to be occupied for the first time. Concurrently, new industrially produced ceramics from China and Europe appeared, evidence for newly available wealth as a result of the intensified trade in ivory, spices, and enslaved people (Figure 12). Deforestation and the mass planting of clove and coconut orchards altered the island's climate and environment (Bishara 2017; Cooper 1977). Site count and site size increased during this period, especially within fertile *kinongo* zones (deep lateritic sandy and silty soils with organic content) where clove production was most favorable.

Sites from the 18th–19th century A.D. consist of scatters and shallow deposits (10–20 cm) of local coarse earthenware,



Figure 13. Stone architecture at the site of Basra recorded during survey.

imported European, Chinese, Indian, and Middle Eastern ceramics, and glass. Compared to sites of the early 2nd millennium A.D., later colonial sites span a wide range of environments, from hill ridges to streams to coastal locations. The densest 18th–19th century A.D. occupations in the northeast lie around the 11th–15th century A.D. site of Mvivu Hendi, reflecting a similar pattern observed in northern Unguja where the main centers of the late colonial plantation system developed over earlier precolonial village sites (Alders 2023a). One notable site dating to the 18th and 19th centuries A.D. is a stone house mound in an open agricultural area quite close to Zanzibar Stone Town, called the Chumbuni Radio Tower Site (see Figure 8). The area is kept undeveloped because it was formerly meant to be made into a radio tower; today, the government maintains it as a place for military trainees to drill and grow food. Surveys revealed a house mound of stone rubble under a large banyan tree and within a dense ceramic scatter with local and imported wares dating to the 18th–19th centuries A.D. Relatively deep deposits (ca. 50 cm) spread over a wide area may yield evidence for earlier occupations. The site's good preservation so close to Zanzibar Stone Town suggests that it may be a key area for future investigations that would reveal craft and trade interactions between rural and urban residents of the town in the colonial period.

This period also produced the first evidence for stone domestic architecture in inland regions, like structures recorded at the site of Basra (Figure 13). A northeastern cluster of 19th century A.D. sites in areas near streams includes a large quantity of stone structures and probably represents an area settled by relatively wealthy Omani planters. In the southeast, 18th–19th century A.D. sites may reflect smaller occupations by Swahili agriculturalists and rural people given the lack of large stone buildings and lower imported ceramic ratios. These sites are nearer to the monumental rural tombs, which may have remained significant places marking traditional Swahili authority over lands to the south of the urban center. The settlement patterns recorded here—stone-built plantation houses in the northeast and smaller rural sites associated with Swahili monumental tombs in the southeast—give a preliminary insight into the spatial dynamics of colonial contact on Unguja at a regional scale.

Discussion

Survey results demonstrate that while rapidly developing suburban areas outside of modern eastern African cities add an additional challenge, their rural hinterlands are not yet beyond archaeological investigation. Supervised classifications of urban areas using multitemporal satellite imagery like that which is available from LandSat and Planet Inc. enable surveyors to target areas within the interstices of suburban sprawl. Furthermore, environmental models enable the stratification of survey units across multiple environments within available areas for survey. The increasing availability of free high spatial resolution, multispectral, and multitemporal imagery, along with UAV accessibility for archaeologists, means that these types of surveys will only become more commonplace in the future if archaeologists see the theoretical and anthropological merit in carrying them through. The largest urban centers like Zanzibar City, Mombasa, or Malindi have the potential to inform a

complete understanding of urban processes, social complexity, and multi-scalar social transformations. The results discussed here are part of a first step toward understanding the long-term trajectories of eastern Africa's largest and most densely inhabited cities. Coastal eastern Africa can contribute to global perspectives on urbanization, and geospatial archaeology is uniquely suited to investigate the courses of settlement change and social transformation associated with urban formation in this region. Beyond geospatial methods and the scope of this paper, archival and historical data about urban planning and development in African cities may also be of use when considering the long-term trajectories of urbanization and its impact on archaeological heritage.

Viewing the survey results, some long-term patterns are visible and help clarify the urban and rural trajectories of Zanzibar Stone Town and its hinterland. Coastal environments seem to have been preferred locations for settlement in the late 1st millennium A.D., with little to no evidence for inland settlement during this time (see Alders 2023a). The interface between coastal streams and the sea may have been foci for early Swahili agriculturalists who arrived on Unguja in the late 1st millennium A.D., enabling small communities to access fresh water while also engaging in specialized marine resource subsistence and participating directly in local and regional trade networks. Only about 1–2 ha in size, the 1st millennium A.D. sites of Kwa Zaharani and Mzimuni Buyu may have been small hamlets or villages comparable in size to Kimimba on Pemba (LaViolette and Fleisher 2018, 385). Kimimba developed only 2 km south of the large village of Tumbe, whose residents may have controlled access to imported ceramics to the smaller village of Kimimba (LaViolette and Fleisher 2018, 390). In contrast, Kwa Zaharani and Mzimuni Buyu both lie at least 20 km from any other known large settlements on Unguja in the late 1st millennium A.D. Surveys of two other nearby freshwater streams that reach the sea to the north of Zanzibar City did not turn up any evidence for other late 1st millennium A.D. occupations. The residents of these small 1st millennium A.D. coastal villages may have been relatively isolated, suggesting that they obtained imported wares through direct trade with sea-going merchants coming from other parts of the island, the coast, or the western Indian Ocean. Overall, the emerging picture of Unguja in the late 1st millennium A.D. is of a number of autonomous village communities across the western side of the island, fishing, farming, and taking advantage of the efficiencies of water-based transport to communicate and exchange with the outside world on their own terms. The largest of these was Unguja Ukuu, which may have developed urban dynamics and which has been studied extensively (e.g., Fitton et al. 2022; Juma 2004; Wynne-Jones et al. 2021). Surveys here expand knowledge about the broader social landscape in which Unguja Ukuu developed.

Starting in the 2nd millennium A.D., an emergent pattern is the relationship between land use in rural areas and periods of urban development. The emergence of urbanism at Zanzibar Stone Town in the 11th century A.D. co-occurred with initial forays inland and the founding of small villages away from the coast for the first time. Urban social dynamics may have driven people to settle and farm inland, ending centuries of specialized dependence on marine resources on the immediate coastlines of the island. Starting in the

early 2nd millennium A.D., Zanzibar Stone Town developed into an urban center with stone architecture and evidence for long-distance trade networks (Power et al. 2020). Hosting public feasts and building public Islamic architecture like mosques and ablution facilities were key strategies by which nascent elites in early urban centers sought to gain clients and increase their own status (Fleisher 2010, 2013; Fleisher and Wynne-Jones 2010). Concurrently, non-elites sought access to the cosmopolitan and Islamic material culture of emergent towns and enmeshed themselves into patron-client networks to attain these things (Alders 2024).

A broad social demand for intensified grain production may have led non-elite Swahili people to move inland for the first time to provision feasting events related to elite social legitimation. Elites were probably not able to force clients inland to farm grain, but, more likely, some number of non-elite people may have moved inland to farm to obtain agricultural products that were highly in demand in public feasts and which could be exchanged for access to the cosmopolitan material culture of the Indian Ocean. The lack of marine shell at inland sites and their spatial associations with deep agricultural soils and stream networks suggests their agricultural orientation, but more research is necessary to clarify their subsistence base. The presence of open eating bowls at small rural sites during this period attests to the greater integration of rural communities within the dynamics of competitive feasting events related to early urbanization (Fleisher 2010; Walshaw 2015). Sgraffiato bowls at rural sites like Mvivu Hendi (see Figure 10) may have been gifts distributed by urban elites, provided in the contexts of feasting where clientage and patronage were negotiated.

An initial episode of deforestation may have accompanied agricultural expansion starting in the 11th and 12th centuries A.D. as village communities cleared forests for permanent agricultural production, fuel, and settlement. Settling inland at the start of the 2nd millennium A.D. would have required intensive investments of time and labor to clear forested land for farming and settlement space. This may have been achieved slowly and incrementally through swidden farming methods that grew out of early demands for agricultural produce. Initial forays inland may have involved the retrenching of pathways produced by mobile shifting cultivators practicing swidden agriculture in ways similar to how shifting cultivators in the east and south of the island farm today, where much of the landscape still is overgrown with brush (Alders, Davis, and Haines 2024). Hunting and gathering in forests, as attested from late 1st millennium A.D. deposits at Kuumbi Cave to the south (Shipton et al. 2016), were likely also ways that Swahili people initially encountered and shaped inland environments. Still, most places probably remained forested even into the late Colonial era, as attested by European visitors who described large-scale deforestation to clear lands for plantations in the mid-19th century A.D. (Cooper 1977, 59).

These early village sites were already abandoned by the start of the Colonial period, but new settlements emerged in the 16th century A.D., and rural land remained significant. Monumental tombs built far from settlements in the 17th and 18th centuries A.D. seem to attest to Swahili efforts to mark ancestral territory in rural places at a time when Portuguese and early Omani settlers were increasingly contesting access to agricultural land. In the 19th century A.D., the relationship between elite urban development and the elaboration of plantation systems on rural land is clear, since

plantations formed the basis of Zanzibar Stone Town's dizzying wealth during this era (Bishara 2017; Sheriff 2018). Along with the caravan trade in ivory and enslaved people, agricultural production on clove plantations was a central line of revenue for urban elites in Zanzibar Stone Town, a phase of accumulation which transformed the city into one of the wealthiest metropolises in the Indian Ocean during this period. Immediately around Zanzibar Stone Town, the infilling of swampy areas to the immediate east of the town likely began, though this was not completed until the mid-20th century A.D. (Sheriff 2018).

Guyer and Belinga's (1995) well-known exploration of wealth-in-people tied political power in precolonial and early modern Africa to extraverted elite strategies aimed around accumulating clients and dependents. Archaeologists have argued that precolonial African social dynamics were characterized by the primacy of wealth-in-people accumulation, compared to other strategies like the exploitation of land or natural resources (Fleisher and Wynne-Jones 2010; McIntosh 1999; Monroe 2013; Stahl 2014). Wealth-in-people is thought to be a key factor in the origins of urban civilizations on the African continent, as well as the idea that precolonial power consolidation, state formation, and urbanism did not necessarily rely on classical anthropological models of power over land, which are ultimately derived from classical economic and Marxist perspectives.

Increasingly, however, anthropologists and historians have drawn attention to the nexus of land, wealth-in-people, and power in precolonial Africa, charting ways in which claims to land, and land's productive capacities, mattered in the constitution of precolonial African polities alongside wealth-in-people (e.g., Lentz 2013; MacGaffey 2013; Mseba 2020; Shipton 2009). Archaeological research looking at long-term urban trajectories in the hinterland of Zanzibar Stone Town contributes to this emergent framework. The case study of Zanzibar Stone Town shows how urban trajectories entangled patron-client systems and kin networks with the productive capacities of rural places. As much as precolonial elites depended on cultivated relationships with clients on the island and abroad for legitimating power and monopolizing foreign trade, they also relied on access to the agricultural productivity of inland areas where non-elites settled for the first time to farm. Non-elites were able to strategically initiate agricultural production in inland areas and create grain surpluses to access the cosmopolitan material culture and Islamic ritual spaces in town that elites controlled. Relationships between these groups likely played out within systems of clientage and patronage, but these social systems were entangled with the materiality of rural land, stream systems, specific soil zones, and the ecological knowledge necessary to clear land and farm millet, sorghum, and rice. Alongside other factors related to urbanization and political inequality like the domestication of foreign objects for local consumption (Moffett and Walz 2023), maritimity (Fleisher et al. 2015), increased marine resource consumption (Quintana Morales et al. 2022), and a shift from millet to rice-based diets (Walshaw 2010, 2015), the settlement of rural agricultural landscapes was an essential factor in the emergence and development of urbanism on Unguja and may have been a more significant factor than previously noted across the Swahili region in eastern Africa.

Models of urbanization in coastal eastern Africa have moved toward a consideration of urban function in relation

to rural hinterlands (LaViolette and Fleisher 2005) and the ways that daily practices came to shape public and private space within towns themselves (Wynne-Jones and Fleisher 2014). Future research might study daily practices in the rural settlement systems around urban centers to view the incremental construction of rural places from this theoretical viewpoint. In addition to broad, regional views of settlement change in rural areas, future studies may investigate how specific rural places developed spatially through incremental revisitation and reuse. The palimpsest-like overlapping of activities at sites like Mvivu Hendi and Mzimuni Buyu over the last 1000 years, where shrines and water sources associated with spirits and ancestors likely played a role in site reuse, might lead to new perspectives on connectivity across urban and rural landscapes.

Conclusion

While much of rural Unguja's archaeological heritage likely lies beneath suburban expansions that occurred between 1970 and the present, the results of this study attest to the potential for surveys in the interstices of urban development, deduced through geospatial modeling, to systematically recover sites that remain. The settlement trends and material culture recorded during these surveys shed light on urban and rural trajectories, emphasizing how rural places were entangled with urban transformations over the last millennium.

A final consideration is the need to balance archaeological survey with the mandate to involve African descendant communities in archaeological research (Schmidt and Pikirayi 2016). Despite time constraints and the need to complete systematic surveys over approximately 270 km² and more than 20 different administrative wards, our survey team tried to ensure that we met with relevant stakeholders in each area. This usually entailed meeting first with the local sheha, or mayor, and taking along one of their assistants to accompany us while we walked transects. Previous outreach to communities on Unguja largely reflected community desires to see research published in Swahili and disseminated locally; this was achieved for the results of the 2019 surveys to the north and is ongoing for results from 2023. Otherwise, community outreach happened while in the physical act of walking survey transects. Often, farmers and other community members would travel with us for some or all of the transect to discuss our findings and the history of the region. Very often, local residents would lead us away from the systematic survey lines to show us stone ruins elsewhere, which we would map and record. These were almost exclusively sites of recent centuries, mainly consisting of 19th and 20th century A.D. house rubble mounds where local people have oral histories of settlement.

A challenge with community engagement is that rapid urbanization has altered landscapes of social memory. For example, when seeking to learn oral histories of the collapsed pillar tomb at Mchanga Mwingi, we were informed that all local residents were newcomers to the area and that the older residents who may remember stories about the tomb now lived elsewhere. Population shifts are a key factor that must be accounted for when thinking about community-based archaeological research in Africa (e.g., Chirikure et al. 2010), though these dynamics do not necessarily preclude engagement. Overall, openness to community interactions while conducting surveys has been a positive aspect

of research, and future investigations aim to deepen ties with local residents.

Africa's trend toward urbanization is the most rapid component of an overall global trend toward an increasingly urbanized world. As city space expands into previously rural landscapes, field archaeologists everywhere will need to increasingly deal with fieldwork in urbanizing environments. Synthetic field research approaches that combine remote sensing, geospatial modeling, and systematic stratified archaeological field surveys like the one demonstrated here may prove to be increasingly relevant and necessary for conducting archaeological research in the 21st century A.D. Rapidly urbanizing environments can be modeled and sampled systematically, and the results can inform anthropological understandings of sociopolitical trajectories, as well as enable the conservation and recording of archaeological and cultural heritage for future generations.

As archaeologists have begun to recognize the potential for Africanist archaeology to contribute to anthropological debates of global significance around urban transformations, human-environment interactions, and colonial contact, the evidence for these transformations is vanishing under urban development. The pillar tomb of Mchanga Mwingi, for example, lies just a little over 100 m from an area of rapid urban expansion, with new houses being constructed all around the vicinity. If it is not conserved, it may be gone in the next two–three years. Including archaeological and local stakeholders in this process will be essential, and archaeologists should approach this problem with a sense of urgency. Geospatial technologies like those described in this paper may enable new investigations of African landscapes to elucidate the rural histories of rapidly urbanizing places.

Endnote

1. In this study, Zanzibar refers to the modern political entity and archipelago encompassing the islands of Unguja and Pemba. Zanzibar Stone Town refers to the ancient and historical urban settlement on the Shangani peninsula in the western part of the island of Unguja. Zanzibar City refers to the modern city that developed out of the ancient town.

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