

Article

Climates of Change in Northern Kenya and Southern Ethiopia: From Scientific Data to Applied Knowledge

Paul J. Lane ^{1,*}, Freda Nkirote M'Mbogori ², Hasan Wako Godana ³, Margaret Wairimu Kuria ⁴, John Kanyingi ⁵, Katelo Abduba ⁶ and Ali Adan Mohamed ⁷

¹ Department of Archaeology, University of Cambridge, Cambridge CB2 3DZ, UK

² Archaeology Division, National Museums of Kenya, Nairobi P.O. Box 40658-00100, Kenya; fnkirote@museums.or.ke

³ Department of Anthropology, Borana University, Yabello P.O. Box 19, Ethiopia; hasan.wako@bru.edu.et

⁴ Sites & Monuments, National Museums of Kenya, Nairobi P.O. Box 40658-00100, Kenya; kuriamargaret19@gmail.com

⁵ British Institute in Eastern Africa, Laikipia Rd., Kileleshwa, Nairobi P.O. Box 30710-00100, Kenya; survey@biea.ac.uk

⁶ Department of Culture, County Government of Marsabit, Marsabit P.O. Box 20-60900, Kenya; kateloabduba693@gmail.com

⁷ Ababuro Culture Conservation and Development CBO, Kalacha, Marsabit P.O. Box 176-60500, Kenya; alimerro@gmail.com

* Correspondence: pjl29@cam.ac.uk

Abstract

This paper outlines the implementation and core results of a combined archaeological, historical, and ethnographic study of the histories of well construction and water management among Boran, Gabra, and Rendille pastoralists in arid and semi-arid areas of Northern Kenya and Southern Ethiopia. Co-developed with representatives from different local communities from the outset, this project sought to document the spatial distribution of different types of hand-dug wells found across the study areas, their associated oral histories and, if possible, establish through archaeological means their likely date of initial construction. Concurrent with addressing these academic objectives, this project aimed to train a cohort of local heritage stewards in archaeological, historical, and ethnographic data collection and interpretation, equipping them with the necessary skills to monitor sites of heritage value and further record additional elements of the tangible and intangible heritage of the study areas. This paper discusses the archaeological work that the community trainees participated in, the strategies developed with them to create wider awareness of this heritage, and its implications for identifying ways to “weather” climate change in the future.

Keywords: Kenya; Ethiopia; hand-dug wells; stone cairns; community engagement; climate change; knowledge co-production



Academic Editors: Sharon Steadman, John Frederick Haldon and Arlen F. Chase

Received: 9 May 2025

Revised: 11 August 2025

Accepted: 23 August 2025

Published: 29 August 2025

Citation: Lane, P.J.; M'Mbogori, F.N.; Godana, H.W.; Kuria, M.W.; Kanyingi, J.; Abduba, K.; Mohamed, A.A. Climates of Change in Northern Kenya and Southern Ethiopia: From Scientific Data to Applied Knowledge. *Heritage* **2025**, *8*, 352. <https://doi.org/10.3390/heritage8090352>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The archaeological and cultural heritage sites found across the arid and semi-arid pastoral landscapes of Northern Kenya and Southern Ethiopia have survived multiple changing climatic and environmental conditions over several millennia. However, these environments are facing fresh, unprecedented challenges, including increased frequency and severity of floods and droughts likely due to changes to regional weather systems arising from current global heating [1–5]. These climate-driven threats are both direct and

indirect. Flash flooding and fierce winds causing severe erosion and deflation pose the most obvious direct threats to various categories of archaeological sites. Possible permanent displacement of resident populations and increased precarity of local livelihoods, largely reliant on mobile pastoralism, also have the potential to undermine cultural practices and belief systems associated with places and landscape features that have been accorded spiritual and heritage value. Resettlement of displaced families, whether permanently or temporarily, by relief agencies and government bodies may further lead to inadvertent damage to undocumented archaeological sites in those localities identified for use as temporary camps, feeding stations, and/or temporary health posts, especially given the current weak systems of development control in both countries.

In the past, protection of contemporary cultural sites was ensured through an ideology of communal identity and the authority of traditional institutional leadership; however, these safeguarding features had no bearing on the protection of older archaeological sites and monuments in these locations since local inhabitants typically do not identify with these remains and most are largely unaware of their notional scientific significance and importance. Moreover, even highly visible monuments, such as clusters of deep, hand-dug wells and the numerous stone cairns distributed across these arid and semi-arid landscapes, tend to be associated in oral traditions with earlier, semi-mythical peoples, despite the continued reliance by both people and livestock on water drawn from the hand-dug wells [6].

Surviving archaeological sites are important archives and sources of information on how populations in the past responded to previous episodes of marked climate change, the adaptive strategies they developed and how these may (or may not) have enhanced social, ecological, and cultural resilience that might be beneficial to efforts aimed at reducing societal vulnerability to current climate change [7–10]. Damage to and loss of archaeological records due to factors driven by current climate change thus have implications for present- and future-oriented research fields as well as for more historically oriented disciplines.

With such observations in mind, our ongoing research entails working with pastoral communities in Northern Kenya and Southern Ethiopia to strengthen the protection of archaeological and other cultural sites within these landscapes from direct and indirect negative effects of climate change and other escalating threats. This research also seeks to generate new information on past human responses to climate change that can inform efforts to enhance the current cultural and socio-ecological resilience of these same pastoralist communities. A fundamental principle guiding these actions was that creation of local public awareness of the importance of protecting heritage sites can be significantly enhanced through the direct involvement of community members in research activities as equal knowledge producers [11–13]. Additionally, ensuring longer-term continuity of community-driven heritage protection also requires equipping a cohort of community heritage stewards with the requisite skills in archaeological site recording and monitoring, oral history documentation, and related research skills for recording tangible and intangible cultural heritage, supported by various knowledge dissemination and public engagement strategies. This paper provides a summary of the approach we have adopted as an example of collaborative community archaeology involving a combination of knowledge co-production, capacity building, and advocacy suited to helping demonstrate to different stakeholders the wider relevance of archaeological research and heritage against a context of escalating climate change and socio-ecological challenges.

2. Project Goals and Objectives

The aims of our project encompass both the production of new knowledge about human–environment relations, including the history of water management and settlement

in our study regions, and the creation of a new community of citizen researchers trained and empowered to collect, interpret, and utilise archaeological, historical, and anthropological data for their own cultural and personal sense of wellbeing and community resilience. Integrating these dual elements is also envisaged as an ethically appropriate approach to raising wider public knowledge of the deep histories of our study areas and the nature and scale of current threats to tangible and intangible heritage in these localities, and to embedding community stakeholders in processes of archaeological heritage documentation, monitoring, and future management. A particular aspiration is to equip our collaborators with the appropriate skills and knowledge to empower them to lead the preparation of Biocultural Community Protocols [14] for protecting customary rights and cultural heritage in their home areas. It is hoped this will serve as a counterpoint to governmental approaches that have tended to overlook the rich tangible and intangible heritage of these localities.

More specifically, the project's objectives are to achieve the following:

- (1) Document the spatial distribution of hand-dug wells across both areas through a combination of field survey, oral interviews, and remote-sensing mapping;
- (2) Link these datasets to existing and newly collected archaeological, historical, and palaeoenvironmental records for the region;
- (3) Undertake parallel ethnographic documentation of recent and current systems of water management;
- (4) Empower the communities in our study areas through the transfer of various archaeological skills, including how to identify surface archaeological materials through surveys, the practical basics of archaeological excavations, and how to record archaeological and other cultural sites;
- (5) Train community participants in ethnoarchaeological, historical, and cultural heritage data collection methods, promote awareness of different conservation actions, and enable competence and fluency in presenting defensible cultural demands to local and national government officials and other external actors.

3. Theoretical Framework

Both the research activities and the skills and knowledge transfer elements of the project are framed in terms of community-based landscape historical ecology, co-produced by a group of external research scientists and resident, mobile pastoralists with family and clan histories of extended occupancy of one or the other of our two study areas. Following foundational studies such as those by Carole Crumley [15,16] and William Balée [17], landscape historical ecology is defined here as a form of integrated landscape analysis that draws extensively on archaeological, palaeoecological, and historical records to reconstruct continuities in and changes to human–environment relations over extended periods of time (at least centennial and sometimes millennial scales), with the explicit purpose of generating knowledge about past system dynamics that can be used for informing current and future beneficial approaches to addressing environmental and climatic challenges [18–20]. Our approach to knowledge co-production seeks to emulate methods proposed for enhancing transdisciplinary research, e.g., [21,22], with a specific orientation toward generating knowledge “co-produced through the combination of scientific perspectives with other types of relevant perspectives and experience from real world practice including policy-making, administration, business and community life” [23] (p. 111). Emphasis is also placed on using this approach to identify and define forms of landscape biocultural heritage [24,25] of relevance to local community livelihoods and cultural affordances from the perspective of enabling sustainable futures [26].

4. Study Areas and Research Context

Located in the cultural landscapes of Northern Kenya and Southern Ethiopia, our research has focused on areas along the eastern side of the Chalbi Desert, around Marsabit mountain, the arid lands north of North Horr and Marsabit up to the Kenya–Ethiopia border, and the lands between Moyale and Yabello in Southern Ethiopia (Figure 1). Prior to the creation of the border in 1907, there was significant movement and interaction between the two localities, and while this has diminished since the creation of two distinct nation-states, unregulated movement across this border by kin-related groups and as part of the seasonal mobility of herders in search of grazing pastures remains common. Several different ethnic groups also occupy these areas, sharing similar livelihoods, cultural traditions, and histories of interaction. Ethnicities within Marsabit County (Kenya) include Gabra, Borana, Rendille, Daasanach, Elmolo, Somali, Samburu, and Turkana. In Yabello (Ethiopia), Borana are the primary ethnic group, although individuals identifying as Burji, Sakuye, Waayu, Konso, and Amhara are also present. Mobile pastoralism is the main livelihood strategy for the majority of these, although some communities—such as the Burji in Kenya—practice agropastoralism in the highlands. In Kenya, these include Mt. Marsabit, Mt. Kulal, and the Hurri Hills, while in Ethiopia, the main areas where crop cultivation and livestock herding are combined are the upland regions near Yabello. Around the shores of Lake Turkana, groups of Turkana, Elmolo, and Daasanach combine livestock herding and fishing.

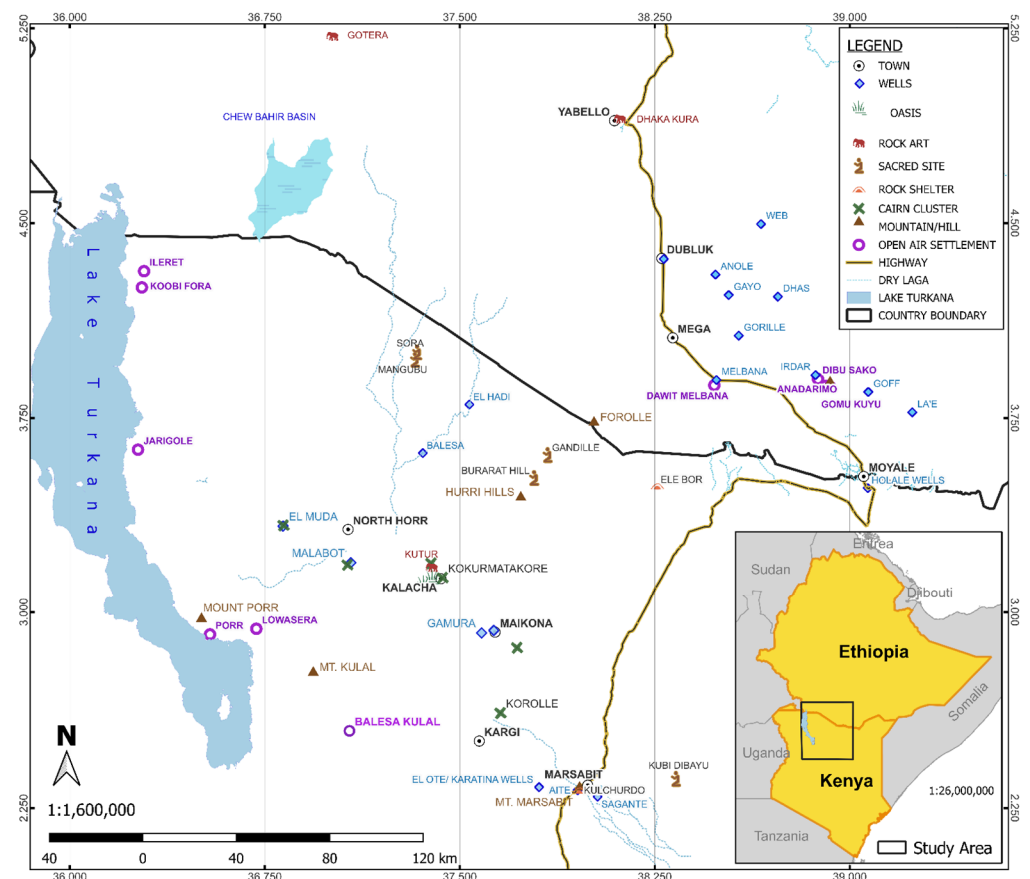


Figure 1. Location of main research areas in Northern Kenya and Southern Ethiopia.

Our field research on the Kenyan side of the border has tended to focus on areas currently occupied primarily by Gabra, and to a lesser extent Borana and Rendille peoples, while on the Ethiopian side, our research has concentrated on areas inhabited mostly by Borana. According to some scholars, Borana claim that all those currently inhabiting

Northern Kenya derive from the same ancestors with “those who kept camels [becoming] Gabra; those who kept goats [becoming] Rendille”, and so on [27] (p. 191, fn. 10). Others argue that the history and processes of ethnogenesis have been more complex, entailing recurrent centripetal and centrifugal socio-economic processes [28]. This is reflected in the oral histories of different clans and phratries, which are best described as rhizomic in structure [29], with overlapping practices and customs (as an example, the Gabra follow the Borana system of custom and law (*aadaa seera*), whereas their personal ornamentation, calendar, and rituals are more similar to Rendille practices [27]).

Historically, access to water in both localities was through seasonal rivers, oases, springs, and ancient hand-dug wells (some of which are known as *Tula*—see below). Recently, these sources have been supplemented by modern boreholes, dams, and water pans. While there is considerable variation in their form, depth, and associated architectural features, the social systems of well management are quite similar. Available oral histories attest to the initial construction of the deeper wells in our study areas some 600 or more years ago [30–32]. The oral histories of the contemporary populations here often refer to a semi-mythical people called “Wardai” as the early inhabitants of these two regions and as the excavators of the oldest wells. These accounts also suggest the Wardai were pushed out of these landscapes by the current populations toward the Upper Tana valley, in what is now Kenya, where their Orma descendants now reside [33]. In some accounts, the stone cairns that are found across these landscapes are also attributed to the Wardai, who are considered in these traditions to have been giants due to their ability to use heavy stone tools to dig complex well systems.

5. Previous Archaeological Research

Previous archaeological research in the study areas has been unevenly distributed, with localities bordering Lake Turkana receiving most attention owing to the fossil-rich Pliocene and early Pleistocene deposits there [34–36]. The Holocene archaeology of the Turkana–Omo Basin is also rich, and as with the Plio-Pleistocene records, most research has concentrated around the Kenyan sections of Lake Turkana. Here, extensive traces of early-to-mid-Holocene remains associated with some of the earliest evidence in the region for the manufacture and use of ceramics by Late Stone Age (LSA) fisher–foragers (dating to between ca. 12,000 and 9000 BP) have been investigated [37–41]. These sites attest to the nature of activity in the region during the earlier phases of the African Humid Period and are related to the expansion of human settlement across the wider “Green Sahara” [42,43]. Many of these same localities have yielded evidence of initial “Neolithisation” processes associated with the introduction of domestic animals into Southern Ethiopia and Northern Kenya during the Pastoral Neolithic (PN) [44–48], and early manifestations of mortuary complexes and associated monumentalism [49–53] (note, not all of these sites are located on the east side of Lake Turkana in Marsabit County—several of the key sites are in Turkana County, on the west side of the lake; nonetheless, as they attest to the same archaeological phenomena, they are cited here). In contrast to the LSA forager–fisher sites, these PN sites are associated with the onset of drier conditions during the mid-Holocene from ca. 5000 years ago [54,55].

By contrast, other areas of Marsabit County east of Lake Turkana have received much less archaeological attention. Previous research around North Horr, ca. 90 km east of Lake Turkana and at the northern end of the Chalbi Desert, identified several, partially deflated scatters of lithics, pottery, faunal remains, ostrich eggshell beads, and other artefactual remains dating from ca. 5000 to 600 BP [56–58]. The very fragmentary faunal material includes a mix of cattle, ovicaprids, zebra, gazelle, and unidentified large wild bovinds. Surveys around the margins of the Chalbi Desert have also identified dense clusters of

stone cairns of various types, with the most common types being simple cairns and ring cairns. A small sample of those on Kokurmatakore Hill on the outskirts of Kalacha have been excavated [59–61]. The available radiocarbon dates suggest that the cairns were built and used over several centuries between ca. 3500 BP and 125 BP, with the earliest type (simple mound) likely associated with PN communities. Dated material associated with the ring cairns yielded a range of dates from the fourteenth to nineteenth centuries CE, while the platform cairns appear to date to the late first- to early second millennium CE. The excavators thought these might relate to an early incursion of Oromo speakers into Northern Kenya, while the ring cairns were thought to have been erected by either Eastern Cushitic or Nilotic speakers [61].

On Mount Marsabit, excavations in a small rock shelter (Kulchurdo) yielded a large sample of lithics made on locally available lava and a faunal assemblage dominated by wildspecies. These likely date to the late fourteenth to early fifteenth century CE, indicating the continued presence of forager populations well after herding economies had been established [62]. Farther north, at least two rock shelters and numerous additional surface scatters have been documented at Ele Bor, ca. 12 km south of the Kenya–Ethiopia border. The two excavated sites indicate even longer, localised continuity of hunter–gatherer economies reliant on broad-based foraging from at least the seventh millennium BCE to the mid-first millennium CE, associated with generalised LSA lithic assemblages on quartz, lava, and obsidian. Ceramics, some similar to forager pottery from around Lake Turkana, first appear here in horizons dated to between the late sixth- to early fourth millennium BCE, while grinding equipment was in use by the third millennium BCE [63,64].

Less archaeological research has been conducted in our study area in Southern Ethiopia, with most research focused around Yabello, where Desmond Clark [65] investigated several small rock shelters containing Late Pleistocene and Holocene lithic assemblages, and in some cases, also rock paintings; and around Gotera, over 100 km to the east in the Chew Bahir Basin, where a complex of over nine open-air Middle Stone Age (MSA)–LSA sites have been investigated [66,67]. Some of the sites near Yabello were re-investigated in the 1990s by Hundie Girma [68], who confirmed the presence of horizons spanning the transition from LSA foraging to cattle, sheep, and goat herding and the adoption of pottery, including potential early PN material similar to Nderit wares found around Lake Turkana [47]. More recent work has also located a wider corpus of painted pastoral rock art in rock shelters and on more open rock faces [67,69]. One site, known as Dhaka Kura (or Crow’s Rock; designated YAB6 by Girma) is especially rich, including “representations of humpless and humped cattle, wild animals (e.g., gazelle and warthog) and other subjects. . .alongside geometric patterns of different colours, sizes and styles” [69] (p. 216).

6. Methods

In common with other community archaeology aimed at knowledge co-production and landscape historical ecology projects [70–76], we employ a mixed-methods approach that combines standard archaeological field methods, ethnographic and oral historical research techniques, palaeoecological sampling, remote-sensing mapping, GIS analyses, and diverse forms of public engagement and empowerment strategies including exhibitions, photovoice methods, and the production of educational materials.

Our archaeological efforts seek to contextualise local oral histories through a programme of targeted archaeological foot survey, mapping, and recording of different types of wells to generate a basic typology and, if possible, recover in situ organic materials that might allow for radiocarbon dating of episodes of construction, repair, and abandonment. The surveys are accompanied by selective test–excavation of other archaeological remains (especially cairns and stone-walled enclosures) in the vicinity of well clusters. Those inves-

tigated so far were chosen based on assessments made in the field of their preservation and potential to yield datable materials, and in consultation with the participating community members. This work is supplemented by targeted ethnographic and historical research, remote-sensing mapping of potential archaeological sites, and the collation and digitisation of archaeological legacy data, including unpublished records of rock art [77]. Self-selected community members are involved in all these activities and are provided relevant training in the field in various survey, excavation, recording, and documentation techniques. As discussed below, our public engagement strategy has combined the preparation of public exhibitions, the provision of teaching materials for local schools, public talks and lectures, academic publications, and the use of social media and web-based platforms, also involving our community collaborators.

7. Preliminary Archaeological Results

This section provides a basic summary of the archaeological work undertaken thus far; fuller accounts will be published elsewhere in due course. In Kenya, our archaeological research has focused on the eastern side of the Chalbi Desert from Kalacha northward via North Horr, Balesa, and El Hadi to the Kenya–Ethiopia border. Over 100 individual wells, mostly found in dense clusters along seasonal rivers, were documented (Figure 2).

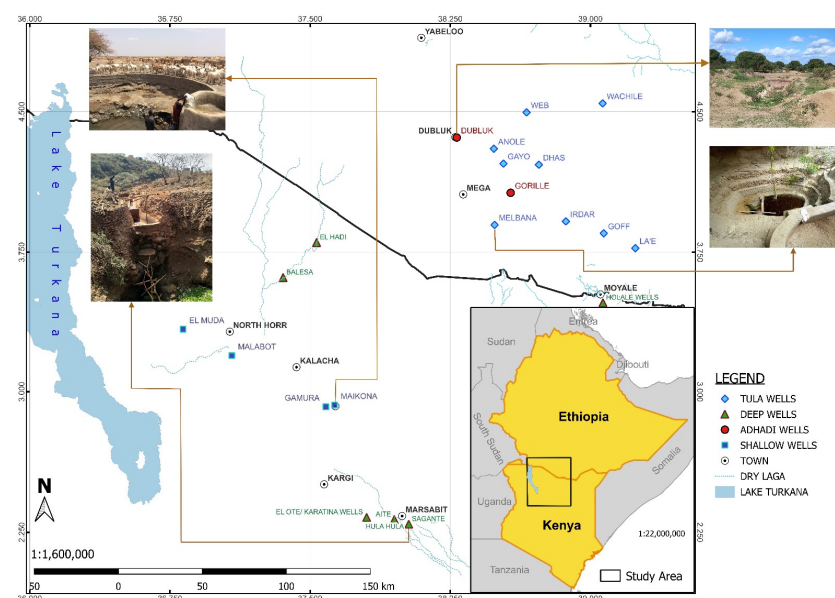


Figure 2. Location of traditional hand-dug wells of different types documented as part of the Wellbeing Project (map prepared by John Kanyingi, BIEA).

As noted above, numerous stone cairns of different forms (Figure 3) occur across this landscape, and the project has focused on detailed mapping of several of these concentrations through a combination of ground survey and remote sensing. Four examples (two ring cairns and two simple cairns) have been excavated thus far. The excavations exposed single inhumation burials in each of the cairns (Figure 4). Poor collagen and apatite preservation meant that none yielded viable samples for radiocarbon dating. Based on comparisons with the previously excavated cairns near Kalacha [61], these examples most likely date to between 3500 and 125 years ago, with the ring cairns potentially being the most recent. Additionally, numerous stone-walled enclosures also occur in the vicinity of the wells (Figure 5). Some mark the remains of recent seasonal encampments; others appear more substantial and may date to an era when annual rainfall was higher and more frequent than today. Artefact scatters were recorded at a sample of these enclosures,

although the finds were mostly undiagnostic, and test excavations at a large complex at El Hadi produced numerous shell beads and fragments in situ that returned erroneously old (>43,000 BP) radiocarbon dates.

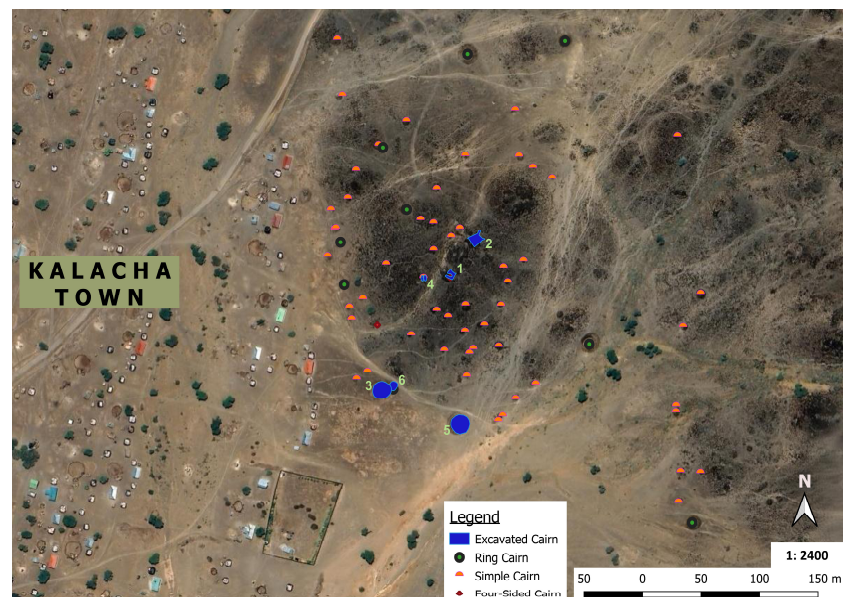


Figure 3. Location of cairns on Kokurmatakore Hill, Kalacha, excavated by Stiles and Munro-Hay (numbered cairns refer to their excavated cairns as per their numbering) in relation to other cairns on Google Earth™ (map prepared by John Kanyingi, BIEA).

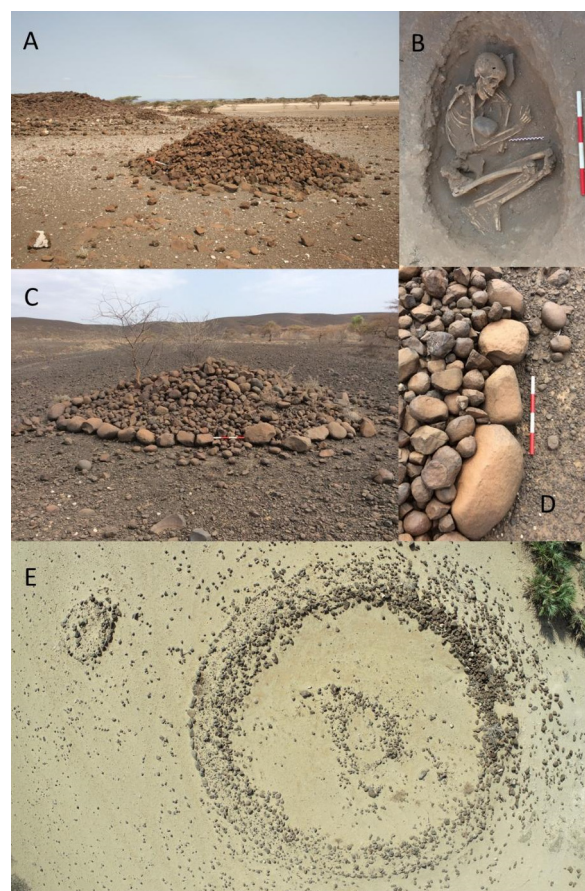


Figure 4. *Cont.*

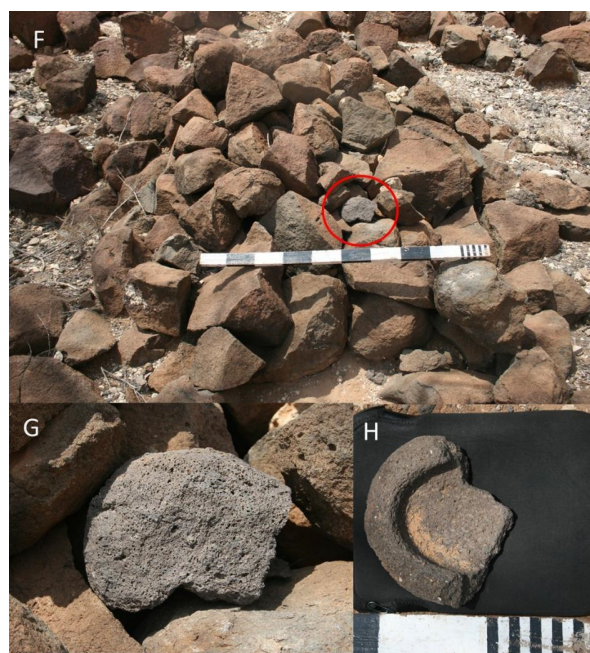


Figure 4. Examples of different types of stone cairn found around Kalacha and Korole, Marsabit County, Kenya: (A) Simple mound. (B) Excavated burial, El Muda, scale 40 cm. (C) Kerbed cairn, scale 40 cm. (D) Detail of stone kerb, scale 40 cm. (E) Drone photo of a ring cairn, Korole. (F) Small, simple cairn with broken Pastoral Neolithic stone bowl (circled), scale 50 cm. (G) Detail of a broken Pastoral Neolithic stone bowl on a simple cairn. (H) Pastoral Neolithic stone bowl from surface of a small, simple cairn, scale 20 cm. (Photos: Paul Lane; drone photo: John Kanyingi, BIEA).

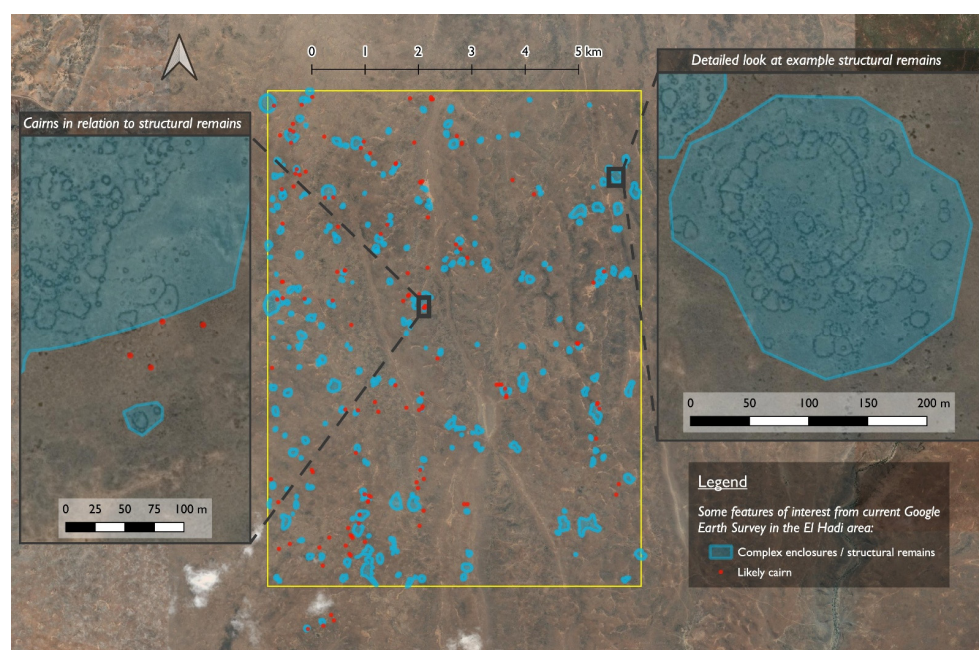


Figure 5. Illustration of stone-walled enclosures visible on Google Earth™ in proximity to a cluster of hand-dug wells near Balesa, Marsabit County, Kenya. Image prepared by Ed Burnett, MAEASaM Project, University of Cambridge.

To provide a sounder framework on which to infer human adaptations to changing environmental conditions around the Chalbi Desert, five sedimentary cores were recovered from different localities on the eastern side for palaeoecological analysis. The longest of these, from the Erederi spring near Kalacha, extending c. 6.25 m, has been analysed. The

lowest sediments, dated to the mid-Holocene around 5200 cal. BP, indicate the presence of freshwater and saline lake habitats. Over the following millennia, these transitioned to terrestrial conditions with relatively abundant gallery tree species along perennial river courses and subsequent grassland expansion from c. 1200 to 515 cal. BP as the regional environment became drier [78].

Research in Ethiopia, undertaken in collaboration with community members and researchers from Borana University at Yabello and Addis Ababa University, was concentrated around the *Tula* well complex at Irdar. As in Northern Kenya, different types of stone cairns and stone-walled enclosures were recorded. These are noticeably different in terms of their style of construction and walling compared with the enclosures recorded on the Kenyan side of the border, as illustrated by the walling documented at Dawiti Melbana (Figure 6). Additionally, in one case (Gumuu Kuyyuu Hill), the hilltop settlement appears to have been ringed by numerous stone cairns—one of which was excavated, yielding remains of a child burial, radiocarbon-dated to c. 4000 BP. Excavation of two other cairns, at Dibu Sako/Guba Adi near Irdar, exposed well-preserved adult inhumations (Figure 6C). Radiocarbon dates on associated materials suggest these were in use between 900 and 600 years ago. While based at Irdar, the team worked with the users, owners, and managers of community wells in five localities (Melbana, Dubluq, Dhas, Irdar, and Gayo), documenting the physical characteristics of 65 individual wells, their associated histories, and current status.



Figure 6. Archaeological research in Southern Ethiopia in 2022: (A) Example of stone walling at Dawiti Melbana. (B) Excavations in progress at Dibu Sako. (C) Excavated burial at Dibu Sako. (Photos: John Kanyingi, BIEA).

From the data produced so far, there seems to have been an obvious relationship between the wells, cultural heritage, and other archaeological sites [6,79]. Many ancient burial cairns lie close to the wells, as do scatters of archaeological materials (that included MSA lithics, LSA microliths, ostrich eggshell beads, PN stone bowl fragments, and pottery sherds of various dates). Cairns also cluster around some of the contemporary cultural heritage sites. More research is needed to resolve the many chronological uncertainties however, and to better link settlement, burial, and economic practices to the different episodes of regional environmental change, as documented in the Erederi core and at other palaeoecological sampling localities around Lake Turkana and the Chew Bahir Basin, so as to better determine how societies responded in the past to climatic adversity. Despite such limitations, this project has been particularly successful in raising public awareness of the significance of the region's archaeological sites and monuments for understanding how pastoralist communities adapt to climate change and the kinds of insights for the future that can be drawn from such remains. The following sections describe how this has been achieved and the emerging role of community groups as local heritage stewards and champions in protecting these resources.

8. Implementing Awareness Strategies in Northern Kenya and Southern Ethiopia

Building on the findings and recommendations of archaeologists from around the world, e.g., [11–13], our project has endeavoured to raise awareness of the rich archaeology of our study areas at all levels of community membership and to create digital data that can be used for future site monitoring, adaptation, or development control. While formal, legal responsibilities for the protection of archaeological and other cultural sites in Kenya and Ethiopia rest with the relevant national and local government authorities (in Ethiopia, the main national authority with a legal mandate to protect archaeological sites is the Ethiopian Heritage Agency, while in Kenya, it is the Sites and Monuments Division of the National Museums of Kenya), the communities living around these sites also have a major role to play. Hence, the creation of awareness of the wider significance and heritage value of different sites and monuments is of critical importance for ensuring archaeological site protection and the promotion of heritage conservation goals through local advocacy and other actions.

While stone cairns, rock art sites, and contemporary cultural sites are often easy to recognise, other archaeological sites on these landscapes are not as obvious to members of the public unfamiliar with the concept of archaeology and its forms of practice. By providing basic training and participation in archaeological survey, excavation, recording techniques, and cognate fields such as ethnoarchaeology, oral history, and material ethnography, the project aspires to change this by establishing a cohort of local community members able to report finds and help keep the national authorities informed of fresh exposures, alert them to any site that may be under threat, and communicate information about the local archaeology and its significance to members of their own communities.

For impactful results, our collaboration with local inhabitants has focused on creating awareness about the aims of the project, the significance of archaeological sites (scientific, cultural, and economic) in the region, the imminent threats facing cultural sites (including those by climate change and external actors), and the role local communities can play in mitigating these threats. We have approached this by (i) hosting stakeholder meetings; (ii) delivering basic training in field archaeology; (iii) providing training in oral history and material ethnography; (iv) mounting exhibitions and producing popular books; (v) creating archaeological heritage clubs at local primary and secondary schools; and (vi) using different media to generate broader awareness.

8.1. Workshops for Stakeholder Engagement

Our initial goal of engaging the local communities as partners and heritage owners has guided us throughout our project. At the outset, we held three consultation workshops (in 2018–2019), two in Kenya and one in Ethiopia. The stakeholders at these workshops included elders, scholars, Community-Based Organisation (CBO) representatives, representatives from county government, and representatives from related government departments in both Kenya and Ethiopia, such as the Department of Tourism. The 3-day workshops were attended by 40 stakeholders (20 attendees in both Ethiopia and Kenya). These had been picked by our local project coordinators during the project scoping stage. Using PowerPoint presentations and group discussions, stakeholders were informed of the project's aims, the Holocene archaeology of the study areas, the potential contributions that archaeological and historical knowledge can make to planning for more sustainable futures, the possible future trajectories of current climate change, and potential end users of the project outcomes. A didactic approach was adopted, aimed at eliciting questions, suggestions, and opinions regarding the project goals and responding to these by incorporating stakeholder responses into the project design and implementation. One of the early outcomes was the creation of steering committees for both Northern Kenya and Southern Ethiopia, comprising six different stakeholders for each region who would be part of everyday project activities and decision-making.

In addition to hosting workshops, the team visited different decision-makers, including Cultural Heritage departmental heads, government officers in charge of water management, County Governors, Unit administrators, chiefs, and community leaders in the two study areas. With them, we discussed the importance of the sites in their localities and the imminent threats they are facing. Emphasis was placed on identifying possible benefits that might accrue from protecting these sites from the negative impacts of climate change and human activities. Interviewees were selected based on their standing in their community, regardless of whether they had participated in the workshops. Recapitulation of the project goals in these meetings helped generate more locally specific discussions on the archaeology and cultural materials in these localities.

At the end of the initial phase of project funding, a concluding workshop was held in Nairobi involving 30 invited stakeholders drawn from Kenya and Ethiopia. These included senior government officials, politicians, elders, CBO representatives, local administrators, academics, and members of the public with an interest in heritage management. During this workshop, we disseminated the results of our archaeological and ethnographic work, GIS mapping, and the results of the community training in archaeological field methods. For the latter, one of the newly trained members gave a presentation. This workshop served as a pathway to influence policy as the attendees were very engaged and were mostly interested in implementing changes regarding their cultural landscapes. Various ways of doing this were discussed and the positivity was encouraging. The roles of attendees in project activities aimed at enhancing public awareness were also discussed.

8.2. Creation of Awareness Through Practical Experience

The steering committees created after the initial workshops identified the individuals for archaeological training, selecting representatives from each of the areas targeted for field investigation. These areas were chosen based on the presence of ancient wells, stone cairns, and other biocultural sites and materials. Both regions (Yabello and Marsabit) nominated 15 members each for training in archaeological excavation methods, identification of surface archaeological materials, mapping of sites, and ethnoarchaeological and oral history data collection. The data collected during these field seasons were later used in the exhibitions

and discussed in a trilingual popular book (see below), summarising the findings of the first phase of research.

Surveys: Together with community archaeology trainees, community point persons (from the steering committees), and trained archaeologists in this project, archaeological surveys were conducted in both Northern Kenya (around Balesa, El Hadi, El Muda, Kalacha, Kargi, Maikona, and North Horr), and in Southern Ethiopia (around Dubluq, Mega, Irdar, Gayo, Wachille, Web, Borbor, Gorille, Dhas, and Anole). Some of these surveyed areas contain both ancient wells and burial cairns within the same vicinity. Of note were El Muda, Balesa, El Hadi, and Irdar. Others contained several cultural sites as well as ancient wells. Other archaeological sites in these areas include stone-built monuments (e.g., Borbor Site), and rock art sites (in Kalacha, El Muda, Mega, and a crocodile rock art site west of Dubluq). Several archaeological habitation sites flanked by burial cairns were found and surveyed in Southern Ethiopia (notably on top of Komu Kuyu Hill in Irdar) and on a series of low hills close to El Hadi town in Kenya. Participation in these activities provided community participants with basic archaeological training about how to identify different types of archaeological remains in their landscapes, how to identify different archaeological materials, and in various recording techniques and procedures.

Mapping: Mapping of wells, cultural sites, and archaeological sites was undertaken around the well clusters of Balesa, El Hadi, El Muda, Kalacha, Kargi, Maikona, and North Horr in Northern Kenya, and in Dubluq, Mega, Irdar, Gayo, Wachille, Web, Borbor, Gorille, Dhas, and Anole in Southern Ethiopia. Apart from taking coordinates, team members also documented the morphology, sizes, and depths of these wells, along with additional information on the surroundings, the well entrance, and the presence of additional elements such as tanks and water troughs for animals. Although some wells are still in use, others have fallen out of use owing to their collapse or abandonment, and team members interviewed local inhabitants to establish the causes at different locations.

As part of the mapping exercise, participants were trained in using handheld GPS devices to log the locations of surface finds whenever encountered during foot surveys. The activities served the dual purpose of training a cadre of community archaeologists on how to record sites and materials and in reporting these to research institutions, while also expanding the known archaeology of the two study areas.

Excavations: Excavations provided project participants with additional practical experience while also serving to establish what these physical traces can tell us about past human activities and populations. Nine sites that the team had identified during surveys as having potential were selected for test excavation. These comprised two cairns in Balesa; one in El Hadi; three sites (two cairns and one settlement) in El Muda in Marsabit County; and three sites in Yabello Administrative District around Irdar (two at Dhibu Sako and one at Komu Kuyu) (Figure 6).

These excavations exposed participants to excavation methods, and apart from answering the archaeological questions, the activity served to demonstrate the archaeological importance of the burial cairns in their landscapes, thus erasing the notion that they are places where Italians buried treasure (a common view in Ethiopia). Perhaps most significantly, by being witness to the excavation of stone cairns and the exposure of human burials, our community archaeologists are now able to inform others in their community that the cairns are burial places. For Borana and Gabra, it is a taboo to disturb the dead; hence, as knowledge of the true functions of the cairns spreads, this may help ensure protection of these archaeological sites. More generally, the excavations have helped demonstrate that these features are not mere piles of stones (*boralle*) but instead hold important records of their predecessors' settlement and burial practices. While working in the field gave them practical experience, daytime and evening discussions regarding the finds and possi-

ble interpretations gave them the opportunity to learn how to put evidence together for reporting purposes.

8.3. Ethnohistorical and Ethnoarchaeological Research

The teams were also involved in ethnohistorical and ethnoarchaeological research with community leaders, elders, and other community members aimed at collecting data about these cultural landscapes, water management practices, and the functioning of a pastoral economy (Figure 7). Community focus groups were held around each well cluster. In addition, individual members of the community and especially people who are directly involved in water management—the Abba Erega and Abba Konfi, including the retired ones—were interviewed. Other than the water managers, women, and individual elders, a sample of individuals respected by their communities as key heritage knowledge keepers were also interviewed. Our interviewees also provided information regarding their perceptions of archaeological sites, rock art, and monuments in the region. Their responses indicated a widespread lack of awareness about most of the archaeological sites in their localities and their historical significance. It was also clear that the contemporary cultural sites enjoy a degree of community protection, although, with the dwindling of the authority of traditional institutions and the growing influence of external actors in the form of governmental, non-governmental, and religious organisations, the maintenance of socio-ecological systems has been weakened. These interactions also served as avenues for talking with participants about climate change, the dangers it poses to these archaeological sites, and their potential roles as stewards of this heritage. While these interviews provided information for helping answer our research questions, they also gave our community trainees, who were mostly young or early middle-aged, the chance to learn more about their cultures and landscapes.



Figure 7. Oral history interview in progress at the Balesa wells (Photo: Paul Lane).

8.4. Trilingual/Bilingual Exhibitions and Publications

At the end of the initial phase of research, we installed a trilingual (Oromo, Kiswahili, and English) exhibition at the Kenya National Museum in Nairobi. This was opened by the Deputy Governor of Marsabit County (Northern Kenya) and the Member of Parliament of Saku Constituency in the same area, and attended by over 200 people (Figure 8). Other Kenyan dignitaries included the former mayor of Nairobi who is also a senior patron of the National Museums of Kenya (NMK) and officials from the Ministry of Water and Sanitation and the Ministry of Education. Attendees from Southern Ethiopia included the Provincial Commissioner of Yabello and the Administrator of Guchi District where we worked. Scholars, elders, and members of the general public from both countries also attended. This exhibition was an eye-opener for many attendees and for the public regarding the range of archaeological sites in their home areas, the threats they are facing, and their state of conservation, especially as this was the first exhibition the NMK had curated on the archaeology of these regions. During its four-month run, the exhibition was seen by over five thousand people, many of whom were school-age students and their teachers from around the country.



(a)



(b)

Figure 8. Project exhibitions: (a) The Marsabit Deputy Governor and other Ethiopian and Kenyan dignitaries attending the opening of the exhibition at the National Museum, Nairobi, September 2022. (b) Community archaeologist Ali Gufu Ibrae giving visitors a guided tour at the exhibition opening in Kalacha, October 2022. (Photos: (a) Paul Lane; (b) Katelo Abduba).

Due to public demand, for both dissemination and awareness, we duplicated and installed the trilingual exhibition at Kalacha, Marsabit County, where the opening was attended by about 300 people including school-going students. The exhibition has also been shown during cultural festivals in Marsabit, where it was viewed by hundreds of people, and it is now domiciled in the Marsabit County Office's cultural exhibition space. A bilingual (Oromo and English) exhibition was later installed in two localities in Southern Ethiopia (Yabello and Irdar), where we had undertaken fieldwork; this has been given a permanent home at Borana University in Yabello. It is our hope that this will serve as another pathway to the creation of awareness leading to policy change.

To promote more permanent respect and understanding for archaeological and cultural heritage among administrators and policy-makers, we produced a trilingual (Oromo, Kiswahili, and English) book (reproduced in a bilingual (Oromo and English) format for Ethiopian readership) aimed at a lay audience to accompany the exhibition (Figure 9). Copies were shared widely with different stakeholders and policy-makers. We envisage this as a tool that could help inform those policy-makers who make decisions about cultural heritage, education, and socio-economic development in our study locations and currently lack insights drawn from knowledge of long-term historical, archaeological, and palaeoecological data. These books were also distributed to relevant government ministries (especially those with responsibilities for land, water, the environment, and culture), development agencies, CBOs, and Non-Governmental Organisations (NGOs).

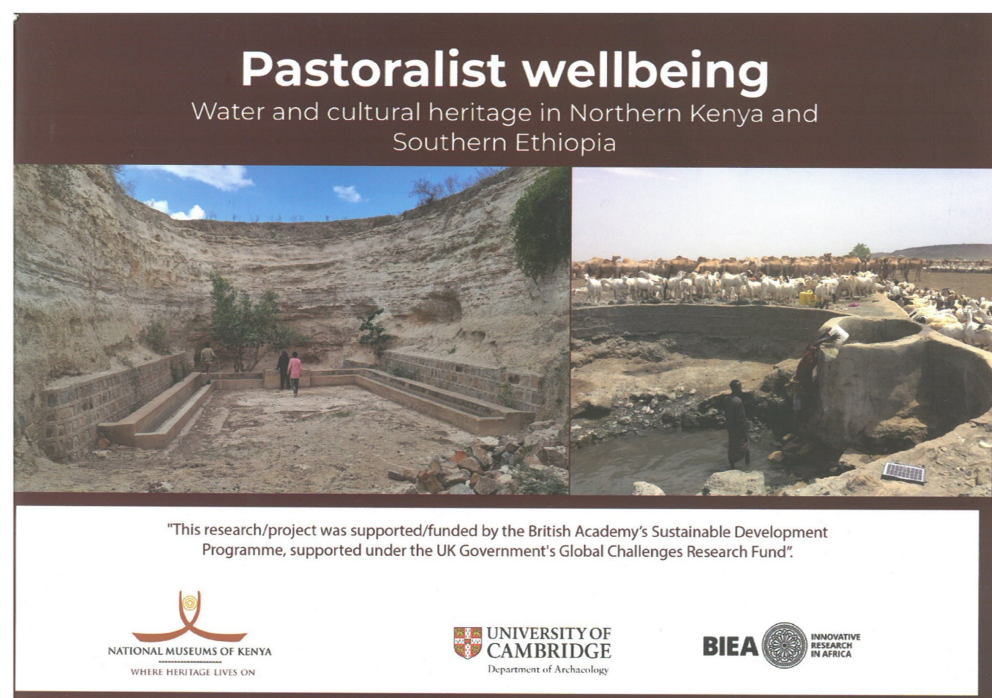


Figure 9. Cover page from the trilingual exhibition book.

8.5. School Archaeological Heritage Clubs

Heritage clubs have been set up in a sample of secondary and primary schools near Kalacha, Marsabit County, with the help of CBOs and our community archaeology researchers who had benefited from the initial archaeological training. The clubs' patrons, who are appointed by each school, also participated in a workshop and training organised by the project to discuss the project's results and identify learning tools and approaches that could prove effective for teaching school children about archaeology and the past in their area. As it transpired, the initial workshop on archaeology was as important for the club

patrons (since few of them had any prior understanding of the discipline), as it was for their students. Once informed about archaeological practice and how to identify archaeological remains, however, they quickly started devising practical exercises for their club members to implement (Figure 10). The project's team members also helped with these exercises and occasionally joined the students during their field projects. The students are now more aware of the archaeological sites and materials within their landscapes, and most learned that they had archaeological remains nearby (and in several cases on their school grounds) directly as a consequence of joining their school's Archaeological Heritage Club. The clubs have now expanded their activities to include discussions about climate change and its effects on archaeological sites, how the clubs can play a role in identifying and reporting any possible archaeological loss (in their opinion) because of adverse weather, and also how club members can help by informing their parents about the archaeological remains found in these landscapes.



Figure 10. Heritage Club activities in Kalacha: (A) Freda M'Mbogori explaining stone tool use to primary school students, Rage Primary School, Kalacha. (B) Katelo Abduba instructing Rage Primary School Heritage Club students in measuring a stone cairn within their school compound. (C) Ella V. Beaudoin working with students at Kalacha Girls Secondary School, August 2023. (Photos: (A,C) Paul Lane; (B) John Roba).

8.6. Media Engagements to Generate Broader Awareness

To sensitise external actors and the public on conservation issues and the negative effects of climate change in Northern Kenya and Southern Ethiopia, we engaged with international and local media and used social media to reach diverse audiences. The most widely circulated of these was an audio–visual article “*Tapping into deep history to manage water scarcity in Africa,*” prepared in collaboration with the International Science Council (ISC) and BBC Storyworks for their Unlocking Science series in 2021–2022. This became the second most shared article in the series during the first two months of broadcast, and saw the highest average time spent on any page across the entire series. In our targeted locations, the article was viewed most by 25–34-year-old adults, with strong click rates from women across our target countries, which the ISC report pointed out was unusual. The

BBC further reported that they saw a very strong average click-through rate on our article of 1.97%; nearly double the Facebook industry benchmark of 1%. Twitter statistics for the same article saw the most views from an audience engaged in the “#UnlockingScience” series, as well as for key words “recycling,” “anthropology,” and “archaeology” hitting our chosen demographics mostly from Somalia, Ethiopia, Kenya, Uganda, and Tanzania, and with the highest overall engagement in the series (including retweets, clicks, and likes). The article also had the highest engagements from audience members following from global organisations such as the United Nations Development Programme (“@UNDP”) and the United Nations Educational, Scientific, and Cultural Organization (“@UNESCO”) [80]. Other broader awareness engagement included the project’s website and social media accounts (YouTube, Facebook, and Twitter [as it was then]) as well as through the British Institute in Eastern Africa’s, the National Museums of Kenya’s, and the Mapping Africa’s Endangered Archaeological Sites and Monuments (MAEASaM) Project’s social media pages. We also reached many audiences through presentations at the British Academy, British Institute in Eastern Africa (seminars and annual lecture), University of Addis Ababa, University of Cambridge, and various international conferences including at the *Heritage in Crisis* conference in Tbilisi, Georgia, the 5th Shanghai Archaeological Forum meeting in Shanghai, and a keynote at the 29th European Archaeological Association held in Belfast, Northern Ireland, in 2023.

9. Climate Change Awareness, Threats, Adaptation, and Mitigation Strategies

“Climate change” as a phenomenon is not widely recognised by most pastoralist communities in Northern Kenya and Southern Ethiopia, and neither the drivers of current global heating nor fears of the potential negative effects of current climate change are topics of everyday, voiced concern. However, these communities are intimately familiar with adverse weather conditions that historically caused them severe hardship periodically, and which are now more frequent, extensive, and devastating. Historical and ethnographic data [32,81,82] suggest that communities were quite skilled at recognising signs of impending weather events and imminent floods or droughts, allowing them to take appropriate actions to protect their livelihoods.

Our own research suggests this indigenous knowledge is deeply woven into the fabric of Gabra and Borana communities in Southern Ethiopia and Northern Kenya, and often finds expression in rituals and ceremonies throughout life’s stages. This knowledge is also transmitted to future generations, forming a strong foundation for their epistemologies and agency. Traditional leadership systems, such as the *Luba* among the Gabra and *Gada* among the Borana, play an important role by coordinating grazing committees and village meetings and directing routine monitoring of grazing and watering locations. Individual mitigation strategies include sustaining social exchange networks and stock-friendships that allow herds to be split between different localities during periods of drought, thereby spreading the risks of stock loss [82]. These institutions are reported to have contributed to maintaining socio-ecological resilience during previous ecological crises [32,83–86]. Likewise, oral histories document significant environmental events, like floods, droughts, and locust invasions, among others [84–86]. These records chronicle the devastation caused by these events and the measures taken for mitigation, adaptation, or recovery.

Whereas pastoral systems across Northern Kenya and Southern Ethiopia are well-adapted to the prevailing arid and semi-arid environments, the archaeological sites and monuments that provide material testimony to previous pastoralist adaptations are now facing escalating direct and indirect threats from climate change, as in other parts of Africa [87]. Violent desert winds driven by the Turkana Jet have become more frequent, and

aeolian erosion has increased owing to the loss of vegetation cover during years of extended drought. Surface scatters of material have long been susceptible to aeolian erosion, and many are already deflated and subject to stratigraphic mixing; however, they are also now exposed to additional threats from violent flash flooding when the rains return. Aeolian and fluvial erosion are also impacting elements of the built heritage, especially the stepped, wooden ramps that lead down into the deeper wells, while waterlogging of low-lying areas following flash floods may well be stimulating microbial decay of organic materials that had previously survived due to arid conditions.

Additionally, as well as causing direct damage to archaeological and cultural sites (Figures 11 and 12), archaeological remains are now at greater risk from being either destroyed or damaged due to changing adaptive strategies. For example, because droughts are typically now more prolonged and frequent than even in the recent past, some communities are becoming more nomadic and making greater use of temporary camps (*foora*) for their herds when searching for suitable grazing land, while still maintaining a permanent or semi-permanent settlement elsewhere. In *foora*, temporary dwellings are erected along with animal kraals. As documented through systematic mapping of enclosures visible on satellite imagery, the distribution and number of *foora* are intensifying as herd management systems are adapted to meet the challenges of a changing climate. Stones from archaeological burial cairns are sometimes used for building kraals, and the *foora* may also be built over archaeological remains and incorporate ancient stone walls and cairns, causing damage to sites (Figure 12). The damage caused by such actions is generally inadvertent rather than due to deliberate attempts at destruction, arising from a lack of awareness of the historical and archaeological value of what might appear to be no more than a convenient pile of stones (*boralle*). These losses largely go unreported, and thus no action is taken by the relevant heritage authorities to either protect the sites or to recover the materials which may otherwise be destroyed. It is likely that in the absence of heightened awareness of the local archaeology, this kind of threat will intensify.



Figure 11. (A) Abandoned modern borehole well, Gayo, Ethiopia, April 2022; (B) litter-strewn abandoned well at Wachille, Ethiopia, April 2024; (C) flooded well, Dubluq, Ethiopia, April 2024 (photo credit: Freda Nkirote M'Mbogori).

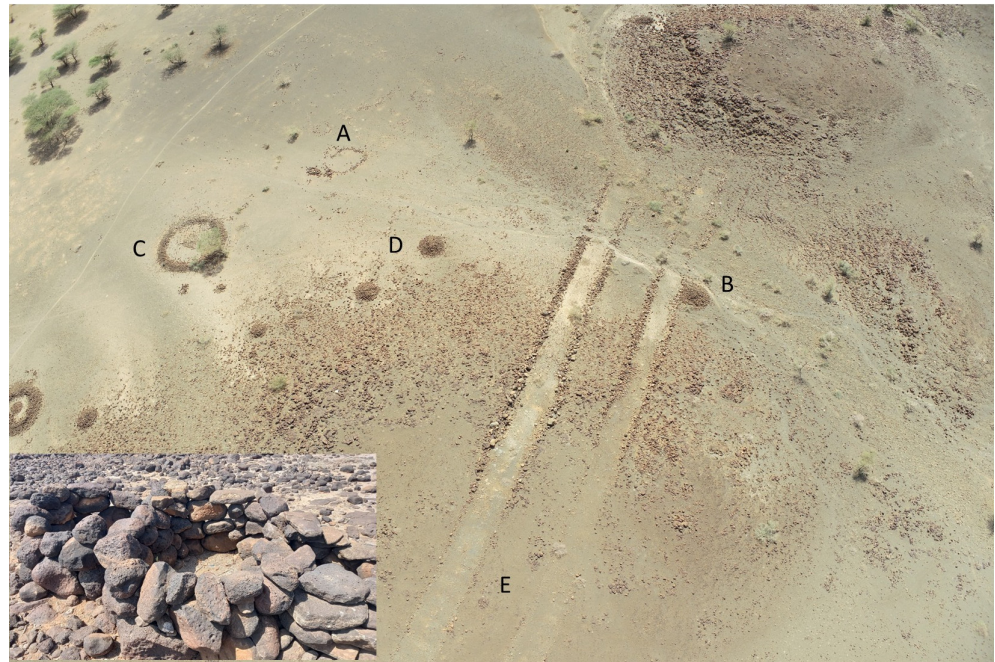


Figure 12. Drone image of cairns north of Kalacha, showing damage from recent *foora* construction (A) and geological exploration work (E linear bands), including partial damage to a cairn (B). C = ring cairn, D = simple kerbed cairns; inset—example of a *foora* goat pen, June 2022. Photo credits: John Kanyingi/BIEA.

The ancient wells that have been maintained and used for over five centuries are also now in danger of being lost because of collapsing walls and changes in attitudes toward them. The introduction of boreholes by government and non-government agencies appears to be contributing to this. Some boreholes are intended to make it easier for livestock to access water during droughts because the animals are usually weak and unable to descend the ramps leading down to the watering area found in many traditional hand-dug wells. Due to the ease of accessing water from the boreholes as opposed to the hand-dug wells, some families are now abandoning the latter (which require regular, routine maintenance) and embracing the use of boreholes and pans. Boreholes can be used throughout the year but, unfortunately, when drought sets in, they can quickly run dry. Likewise, pans may dry up rapidly within the first few months of a drought that might last several years. When this happens, the abandoned ancient wells cannot be rejuvenated because they require considerable investment of labour and firm leadership. Because of the impoverishment of community members during droughts, youth migration to urban centres, and decline in the authority of traditional institutions, the organisation of labour needed to revitalise the collapsed and neglected ancient wells is becoming increasingly untenable in many areas.

Droughts, which have caused great human suffering in Northern Kenya and Southern Ethiopia, also attract external actors to these regions who come to save lives through the provision of relief food and much-needed health care. This too can lead to inadvertent damage to undocumented archaeological remains. Feeding centres develop close to cultural sites, especially near ancient wells, a situation that attracts people in need of food, medical treatment, and other services. Given that many burial cairns are located in proximity to ancient wells, stones may be removed and used in various ways including to construct houses, boundaries, and small animal kraals. These feeding centres sometimes become areas of high population concentration, leading to land degradation and thereby causing further damage to nearby tangible heritage.

10. Impact of the Project in This Study, the Preservation and Protection of Heritage

Our efforts at the creation of archaeological awareness in Southern Ethiopia and Northern Kenya brought to the fore the scientific, economic, and social benefits that protection of these landscapes can bring, and the possible loss of much of what communities have held dear for many centuries if conservation plans are not put in place and other actions taken. As appreciation of the archaeological heritage took root among our community participants, a new sense of attachment to the wells and the deeper heritage emerged. Participants were proud to have been involved on an equal footing with the project scientists, and that the project had sought to communicate the deep history of the wells and other elements of their cultural landscapes to wider, public constituencies. At the outset of our work, local communities in both study areas tended to view archaeological research as a foreign, Western endeavour, with no relevance to their own lives or sense of history. Hence, there was little understanding of what archaeology entails or how it can be used to address societal issues and concerns in the present.

The willingness and enthusiasm shown by the local communities in the Marsabit and Yabello regions with whom we worked has begun to change these attitudes. The training of community archaeologists, for example, was intended originally for just five individuals in each region but that number tripled due to demand and interest. Moreover, although only fifteen from each region received formal training, several more expressed interest in participating but were unable to do so owing to time and financial constraints. This response was a clear indication that more public engagement is needed and that the local communities are willing to take leadership in the protection of their cultural heritage, whether archaeological, historical, or contemporary, if provided the appropriate tools and guidance. The main hindrance to their participation seems to derive from their lack of knowledge of relevant disciplines and the lack of opportunities to engage intelligently with visiting archaeological research teams.

Rapid mapping of several hundred archaeological and cultural sites in our areas of focus proved an effective means of raising awareness and stimulating participation. The mapped sites include ancient wells (both those in use and abandoned), stone cairns, rock art, monuments, and contemporary cultural sites where different clan ceremonies and rituals are performed (these data have been added to a cross-border database of archaeological sites and monuments currently being developed by the Mapping Africa's Endangered Archaeological Sites and Monuments Project, coordinated by P.J.L and hosted by the University of Cambridge [88,89], and which is continuing the use of remote sensing to map other sites and monuments in our study localities). The mapping work generated data for use by various stakeholders and introduced our trainees to various forms of archaeological and cultural sites, their locations, and their interconnections. During the mapping, participants gained new understanding of the cultural and archaeological makeup of their landscapes, and they began noticing similar archaeological features in their home areas that previously had not seemed important to them. Mapping and physical visits to these sites created a sense of ownership. We hope this will foster voluntary monitoring and reporting by the community members since they now understand and appreciate the research value of these sites.

Of note is that the archaeological and other cultural sites within Northern Kenya and Southern Ethiopia are interconnected and, therefore, conscious conservation or protection initiatives are likely to lead to the general protection of the cultural landscapes of these areas. For example, the ancient wells and their environments have been protected in some cases for over 500 years through community actions because of their importance for "weathering" [90] periodic climatic adversity. Specifically, in the past, settlement was

not allowed within several kilometres of the wells. Other land uses near the wells were also highly regulated, creating an environmental buffer zone around them. This helped to protect critical grazing areas that could be utilised during times of drought. At the same time, by virtue of being located close to some of the wells, many cairns and other archaeological features also benefitted, albeit inadvertently, from protection.

The exhibitions, stakeholder meetings, and the popular books have all helped to make the archaeological and cultural sites more readily visible to the wider public, thus adding to the number of knowledgeable people. The trained community archaeologists can now speak more fluently about archaeology, climate change, and the threats it poses to cultural landscapes, and so are better able to initiate discussion about cultural heritage conservation and protection. For instance, as a follow-up activity to the initial phase of data collection and after instruction in the Photovoice methodology [91,92], in 2023–2024, our core group of community collaborators designed a digital exhibition on the theme “*Water, Heritage, Sustainability*”. For this, each member selected two photographs, from dozens they had taken on their mobile phones, to illustrate key ideas on this theme that are important to them as members of their community, and about which they provided a few lines of explanation. Some highlighted what they saw as problems, such as the build-up of litter in and around wells, or damage to wells, while others chose to highlight other issues with many focusing on the importance of water in rituals, ceremonies, and everyday life (the exhibition will go live on a revamped project website in 2026, and an article on the process and content is in preparation).

Many of the students and community researchers involved in this project have since become ambassadors for archaeology in their respective areas within the region. For example, one community researcher (who holds an MA in Education), from Marsabit county government, has enrolled for a Master’s degree in Archaeology at a Kenyan university and, in his county government role, now informs members of the wider public in the county about the intersections between archaeology, climate change, and emerging threats to cultural heritage. Another community researcher joined the project as a student from Borana University, Yabello, and is now part of its teaching staff and has formed an “archaeology club” there, and voluntarily teaches others what he learnt during this project. Others have played coordinating and facilitating roles in follow-up activities including in a two-day workshop involving local government and NGO representatives from Marsabit county on integrating cultural heritage into future climate change adaptation scenarios, using the KESHO participatory modelling tool [93], and identifying locations for documenting indigenous knowledge concerning different kinds of traditional containers and the individuals skilled in their manufacture as part of a project to record endangered material knowledge in our study areas (both sets of activities will be reported on at a future date in more detail).

Perhaps the most important consequence arising from our awareness campaigns was in Southern Ethiopia, where we witnessed a new policy initiative. While undertaking fieldwork, the project team had frequent meetings with local policy-makers and community leaders to talk about the dangers facing *Tula* wells and their associated cultural heritage landscapes. Emphasis was placed on the range of current threats that could result in total loss of archaeological, cultural, and historical sites, and the loss of intergenerational knowledge and livelihood sustainability. In response, local government officials, in consultation with the national government, decided to delink the administration of two of the units (Irdar and Webb) from Guchi and Wachille, respectively, and to elevate them to become independent administrative units. Given this new status, they were renamed Tula Irdar and Tula Webb. The addition of the word “Tula” was a conscious policy decision intended to

promote the *Tula* wells and their landscapes for cultural heritage preservation and cultural tourism through sensitisation and creation of local pride and awareness.

11. Conclusions

In conclusion, by creating awareness among local communities, a sense of ownership is fostered that forms the basis for agency. In this way, the monitoring and protection of sites becomes a calling rather than an imposed responsibility. Although a community's reasons for conserving an archaeological site might differ from those of a professional heritage manager, they can still find a sense of purpose as the cultural, social, and economic benefits arising from protection are recognised and begin to accrue. For policy-makers and administrators, the benefits of archaeological and cultural sites' preservation and conservation in our region tend to be seen mostly in terms of the potential economic returns that might arise from increased cultural tourism. This is because both regions are marginalised economically and politically, and government officials see cultural tourism as a possible source of jobs and revenue for local communities that could offset such marginalisation.

Creation of awareness to instil agency in Northern Kenya and Southern Ethiopia communities for monitoring and conserving archaeological and other cultural sites, whether on the basis of economic benefits (in the case of cultural tourism) or their cultural beliefs about not disturbing the dead (in the case of ancient burial cairns), is also timely. As extended droughts have become more frequent and the flooding that typically follows their ending has become more severe (Figure 13), the region's diverse and varied mix of archaeological sites has become more vulnerable to both the direct and indirect threats these worsening climatic conditions have initiated.



Figure 13. Impacts of flash flooding in late 2022 on contemporary society: (A) Passers-by help push a loaded Land Cruiser through the flood waters. (B) Flood damage to a recently constructed bridge on the Kalacha–Marsabit highway. (C) A herd of sheep and goats drowned during a flash flood. (Photos: Hassan Godana).

There have been challenges, and several remain. As discussed above, most of the excavated sites remain poorly dated and settlement sites with well-preserved stratigraphic deposits that would allow for the recovery of faunal and botanical remains and other economic indicators that might demonstrate how previous inhabitants responded to past episodes of significant climate change have yet to be located. Similarly, it has not been possible to determine archaeologically when the practice of well digging first began, owing to the lack of surviving deposits or dateable structural evidence that might relate to these initial phases of construction. Both factors severely limit attempts to infer how resilient communities were to climate change in the past, and hence also the utility of the existing archaeological information for informing strategies aimed at enhancing the resilience of contemporary communities. While the chances of establishing archaeologically when well digging began seem remote, further archaeological survey and targeted excavation of habitation sites may generate the necessary datasets for better understanding how past societies responded to the cycles of environmental change documented in the Erederi sediments and how resilient they really were in the face of severe climate change. In tandem, more research is needed on determining the social, economic, and political consequences of different episodes of population expansion and migration, such as the sixteenth and seventeenth southward expansion of Oromo peoples [94], and the timing and impacts of the spread of other Cushitic language speakers into the Ethiopia–Kenya borderlands [95].

This project has been far more successful in raising public consciousness of the rich archaeological and ethnographic heritage of our study areas and the growing threats to this heritage from current climate change and other factors. Nonetheless, despite widespread public support in the areas where this project has run for the creation of museums in these areas to showcase this rich heritage, there has been no movement yet on the part of the relevant local and national authorities to allocate resources needed to create these institutions. Likewise, local governments, NGOs, and development agencies continue to pay scant heed to integrating heritage promotion and protection into their activities aimed at addressing the UN’s Sustainable Development Goals, despite the recognised value of doing so and the existence of relevant guidelines, e.g., [96–98].

Hopefully, the willingness with which the leaders responded to our programmes and the urgency they adopted in crafting their own programmes for awareness creation and policy change do signal a better future for archaeological and other cultural sites in these two regions. To be effective over the long term, however, requires recognition of local communities as the first point of call for heritage site protection efforts. This can be achieved through advocacy and targeted community empowerment programmes. As we hope to have shown, when designed and undertaken in this manner, archaeological research, site conservation, and protection initiatives are likely to be well-received by communities who are eager to be knowledge co-producers, especially if they understand the project. Finally, this style of research can generate practical and realistic actions for site protection and ways to involve a wide range of stakeholders in climate change mitigation measures for archaeological and other cultural heritage sites.

Author Contributions: Conceptualisation, P.J.L. and F.N.M.; methodology, P.J.L. and F.N.M.; field research: F.N.M., H.W.G., P.J.L., M.W.K., J.K., K.A., and A.A.M.; formal analysis, F.N.M., H.W.G., P.J.L., M.W.K., and J.K.; investigation, F.N.M., H.W.G., P.J.L., M.W.K., J.K., K.A., and A.A.M.; data curation, P.J.L. and J.K.; writing—original draft preparation, F.N.M. and P.J.L.; writing—review and editing, P.J.L., F.N.M., H.W.G., M.W.K., J.K., K.A., and A.A.M.; visualisation, J.K. and P.J.L.; project administration, F.N.M. and P.J.L.; funding acquisition, F.N.M. and P.J.L. All authors have read and agreed to the published version of the manuscript.

Funding: Initial funding (2018–2022) for this project was provided by a grant (SDP2\100167) from the British Academy awarded to Freda Nkirote M’Mbogori (PI) and Paul Lane (Co-I) for a project

on Wellbeing: Indigenous wells, pastoralist biocultural heritage, and community archaeology for sustainable development in Northern Kenya and Southern Ethiopia, as part of its 2018 Sustainable Development Programme funded by the UK's Department for Business, Energy, and Strategy (through the Global Challenges Research Fund). Additional funding was provided to P.J.L. (PI) and F.N.M. (Co-I) from the McDonald Institute for Archaeological Research, University of Cambridge, the University of Cambridge AHRC Impact Acceleration Account Research Fund (AHIF IAA JCAG/36), the University of Cambridge ODA GCRF and Newton Consolidation Accounts Research Fund (ODA GCRF JCAG/357), and the British Institute In Eastern Africa to support the creation of School Heritage Clubs, the BBC Storyworks video, the Photovoice training and exhibition, and the KESHO workshop on modelling future scenarios of change.

Data Availability Statement: Our data have been added to a cross-border database of archaeological sites and monuments currently being developed by the Mapping Africa's Endangered Archaeological Sites and Monuments Project, coordinated by P.J.L., and hosted by the University of Cambridge [88,89], which is continuing the use of remote sensing to map other sites and monuments in our study localities. See the following: <https://maeasam.org/>.

Acknowledgments: We wish to acknowledge all the institutions and individuals who have supported us in one way or another during all the stages of this research. We thank in particular the British Academy, the British Institute in Eastern Africa, the McDonald Institute, the University of Cambridge AHRC Impact Acceleration Account Research Fund, and the University of Cambridge ODA GCRF and Newton Consolidation Accounts Research Fund for funding the research supported here; the British Institute in Eastern Africa, the National Museums of Kenya, Borana University, Addis Ababa University, and Ababuro Culture Conservation and Development CBO for logistical support, research facilitation, and in the case of the B.I.E.A. and N.M.K., for the loan of equipment and vehicle hire. We also wish to thank all of our Kenyan and Ethiopian community archaeology research teams for their dedication, enthusiasm, and contributions to different strands of this project, and especially our "prefect" Ali Gufu. We would also like to thank all the people of Northern Kenya and Southern Ethiopia with whom we have interacted over the course of this project and for their enthusiasm and support throughout. We are grateful to the editors of this special issue for their invitation to contribute a paper, for their guidance, comments on an earlier draft, and their patience with us! We would also like to thank our anonymous reviewers for their comments and constructive suggestions. All remaining errors and misunderstandings are our own.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of this study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

BBC	British Broadcasting Corporation
BIEA	British Institute in Eastern Africa
CBO	Community-Based Organisation
ISC	International Science Council
LSA	Late Stone Age
MA	Master of Arts
MAEASaM	Mapping Africa's Endangered Archaeological Sites and Monuments
MSA	Middle Stone Age
NGO	Non-Governmental Organisation
NMK	National Museums of Kenya
PN	Pastoral Neolithic
UNDP	United Nations Development Programme
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization

References

1. Cuni-Sanchez, A.; Omeny, P.; Pfeifer, M.; Olaka, L.; Mamo, M.B.; Marchant, R.A.; Burgess, N.D. Climate change and pastoralists: Perceptions and adaptation in montane Kenya. *Clim. Dev.* **2019**, *11*, 513–524. [\[CrossRef\]](#)
2. Worku, M.A.; Feyisa, G.L.; Beketie, K.T. Climate trend analysis for a semi-arid Borana zone in southern Ethiopia during 1981–2018. *Environ. Syst. Res.* **2022**, *11*, 2. [\[CrossRef\]](#)
3. Schilling, J.; Werland, L. Facing old and new risks in arid environments: The case of pastoral communities in Northern Kenya. *PLoS Clim.* **2023**, *2*, e0000251. [\[CrossRef\]](#)
4. Asokan, S.M.; Kweyu, R.M.; Makokha, M.; Obando, J.A. Prolonged drought and governance challenges in Turkana County, Kenya—Access to water and livelihood changes. *Environ. Dev.* **2025**, *55*, 101193. [\[CrossRef\]](#)
5. Fanta, S.S.; Yesuf, M.B.; Merkos, M.T.; Demissie, T.A. The spatio-temporal trend of climate and characterization of drought in Borana Zone, Ethiopia. *Sci. Rep.* **2025**, *15*, 4743. [\[CrossRef\]](#)
6. M'Mbogori, F.N.; Kinyua, M.G.; Ibrae, A.G.; Lane, P.J. Changes to water management and declining pastoral resilience in Marsabit County, northern Kenya: The example of Gabra wells. *WIREs Water* **2022**, *9*, e1609. [\[CrossRef\]](#)
7. Sandweiss, D.H.; Kelley, A.R. Archaeological contributions to climate change research: The archaeological record as a paleoclimatic and paleoenvironmental archive. *Annu. Rev. Anthropol.* **2012**, *41*, 371–391. [\[CrossRef\]](#)
8. Hambrecht, G.; Rockman, M. International approaches to climate change threats and cultural heritage. *Am. Antiq.* **2017**, *82*, 627–641. [\[CrossRef\]](#)
9. Hollesen, J.; Callanan, M.; Dawson, T.; Fenger-Nielsen, R.; Friesen, T.; Jensen, A.; Markham, A.; Martens, V.; Vladimir, P.; Rockman, M. Climate change and the deteriorating archaeological and environmental archives of the Arctic. *Antiquity* **2018**, *92*, 573–586. [\[CrossRef\]](#)
10. Jackson, R.C.; Dugmore, A.J.; Riede, F. Rediscovering lessons of adaptation from the past. *Glob. Environ. Change* **2018**, *52*, 58–65. [\[CrossRef\]](#)
11. Atalay, S. *Community-Based Archaeology: Research with, by, and for Indigenous and Local Communities*; University of California Press: Berkeley, CA, USA, 2012.
12. Schaepe, D.M.; Angelbeck, B.; Snook, D.; Welch, J.R. Archaeology as therapy: Connecting belongings, knowledge, time, place, and well-being. *Curr. Anthropol.* **2017**, *58*, 502–533. [\[CrossRef\]](#)
13. Humphris, J.; Bradshaw, R. Understanding 'the community' before community archaeology: A case study from Sudan. In *Participatory Archaeology and Heritage Studies Perspectives from Africa*; Schmidt, P.R., Ed.; Routledge: Abingdon, UK, 2018; pp. 94–108.
14. Köhler-Rollefson, I.; Kakar, A.R.; Mathias, E.; Rathore, H.S.; Wanyama, J. Biocultural community protocols: Tools for securing the assets of livestock keepers. In *Biodiversity and Culture: Exploring Community Protocols, Rights and Consent*; International Institute for Environment and Development: London, UK, 2012; pp. 109–118. Available online: <https://coilink.org/20.500.12592/g663t2> (accessed on 4 August 2025).
15. Crumley, C.L. (Ed.) *Historical Ecology: Cultural Knowledge and Changing Landscapes*; School of American Research: Santa Fe, NM, USA, 1994.
16. Crumley, C.L. Historical ecology: A robust bridge between archaeology and ecology. *Sustainability* **2021**, *13*, 8210. [\[CrossRef\]](#)
17. Balée, W. (Ed.) *Historical ecology: Premises and postulates*. In *Advances in Historical Ecology*; Columbia University Press: New York, NY, USA, 1998; pp. 13–29.
18. Marchant, R.; Lane, P.J. Past perspectives for the future: Foundations for sustainable development in East Africa. *J. Archaeol. Sci.* **2014**, *51*, 12–21. [\[CrossRef\]](#)
19. Armstrong, C.G.; Shoemaker, A.C.; McKechnie, I.; Ekblom, A.; Szabó, P.; Lane, P.J.; McAlvay, A.C.; Boles, O.J.; Walshaw, S.; Petek, N.; et al. Anthropological contributions to historical ecology: 50 questions, infinite prospects. *PLoS ONE* **2017**, *12*, e0171883. [\[CrossRef\]](#)
20. Stump, D.; Isendahl, C. (Eds.) *The Oxford Handbook of Historical Ecology and Applied Archaeology*; Oxford University Press: Oxford, UK, 2019.
21. Pohl, C. From science to policy through transdisciplinary research. *Environ. Sci. Policy* **2008**, *11*, 46–53. [\[CrossRef\]](#)
22. Pohl, C.; Rist, S.; Zimmermann, A.; Fry, P.; Gurung, G.S.; Schneider, F.; Speranza, C.I.; Kiteme, B.; Boillat, S.; Serrano, E.; et al. Researchers' roles in knowledge co-production: Experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. *Sci. Public Policy* **2010**, *37*, 267–281. [\[CrossRef\]](#)
23. Polk, M. Transdisciplinary co-production: Designing and testing a transdisciplinary research framework for societal problem solving. *Futures* **2015**, *65*, 110–122. [\[CrossRef\]](#)
24. Lindholm, K.J.; Ekblom, A. A framework for exploring and managing biocultural heritage. *Anthropocene* **2019**, *25*, 100195. [\[CrossRef\]](#)
25. Ekblom, A.; Shoemaker, A.; Gillson, L.; Lane, P.; Lindholm, K.J. Conservation through biocultural heritage—Examples from sub-Saharan Africa. *Land* **2019**, *8*, 5. [\[CrossRef\]](#)

26. Lane, P.J.; Sulas, F. Learning from the deep past: Critical perspectives on biocultural heritages for well-tempered futures. In *Critical Approaches to Heritage for Development*; Cross, C., Giblin, J.D., Eds.; Routledge: London, UK, 2023; pp. 124–142.
27. Kassam, A. The people of the five “drums”: Gabra ethnohistorical origins. *Ethnohistory* **2006**, *53*, 173–193. [[CrossRef](#)]
28. Schlee, G. *Identities on the Move: Clanship and Pastoralism in Northern Kenya*; Routledge: London, UK, 1989.
29. Schlee, G. Interethnic clan identities among Cushitic-speaking pastoralists. *Africa* **1985**, *55*, 17–38. [[CrossRef](#)]
30. Tiki, W.; Oba, G. Transforming labour and technology of the ancient Tula wells for watering livestock in Borana, Ethiopia. *Nomadic Peoples* **2019**, *23*, 218–240. [[CrossRef](#)]
31. Tiki, W.; Oba, G.; Tvedt, T. Human stewardship or ruining cultural landscapes of the ancient Tula wells, southern Ethiopia. *Geogr. J.* **2011**, *177*, 62–78. [[CrossRef](#)]
32. Tiki WOba, G.; Tvedt, T. An indigenous time related framework for reconstructing impact of disasters on ancient water systems in southern Ethiopia 1560–1950. *J. Hist. Geogr.* **2013**, *41*, 33–43. [[CrossRef](#)]
33. Tablino, P. *The Gabra: Camel Nomads of Northern Kenya*; Kolbe Press: Limuru, Kenya, 1999.
34. Bobe, R. Fossil mammals and paleoenvironments in the Omo-Turkana Basin. *Evol. Anthropol. Issues News Rev.* **2011**, *20*, 254–263. [[CrossRef](#)]
35. Lepre, C.J. Early Pleistocene lake formation and hominin origins in the Turkana–Omo Rift. *Quat. Sci. Rev.* **2014**, *102*, 181–191. [[CrossRef](#)]
36. Hammond, A.S.; Mavuso, S.S.; Biernat, M.; Braun, D.R.; Jinnah, Z.; Kuo, S.; Melaku, S.; Wemanya, S.N.; Ndiema, E.K.; Patterson, D.B.; et al. New hominin remains and revised context from the earliest *Homo erectus* locality in East Turkana, Kenya. *Nat. Commun.* **2021**, *12*, 1939. [[CrossRef](#)]
37. Robbins, L. *The Lothagam Site*; Michigan State University: East Lansing, MI, USA, 1974; Museum Anthropological Series 1(2).
38. Phillipson, D.W. Lowasera. *Azania J. Br. Inst. East. Afr.* **1977**, *12*, 1–32. [[CrossRef](#)]
39. Robbins, L.H. Lake Turkana archaeology: The Holocene. *Ethnohistory* **2006**, *53*, 71–93. [[CrossRef](#)]
40. Beyin, A.; Prendergast, M.E.; Grillo, K.M.; Wang, H. New radiocarbon dates for terminal Pleistocene and early Holocene settlements in West Turkana, northern Kenya. *Quat. Sci. Rev.* **2017**, *168*, 208–215. [[CrossRef](#)]
41. Keding, B. Middle Holocene fisher-hunter-gatherers of Lake Turkana in Kenya and their cultural connections with the north: The pottery. *J. Afr. Archaeol.* **2017**, *15*, 42–76. [[CrossRef](#)]
42. Tierney, J.E.; Lewis, S.C.; Cook, B.I.; LeGrande, A.N.; Schmidt, G.A. Model, proxy and isotopic perspectives on the East African Humid Period. *Earth Planet. Sci. Lett.* **2011**, *307*, 103–112. [[CrossRef](#)]
43. Manning, K.; Timpson, A. The demographic response to Holocene climate change in the Sahara. *Quat. Sci. Rev.* **2014**, *101*, 28–35. [[CrossRef](#)]
44. Lynch, B.M.; Robbins, L. Cushitic and Nilotic prehistory: New archaeological evidence from north-west Kenya. *J. Afr. Hist.* **1979**, *20*, 319–328. [[CrossRef](#)]
45. Marshall, F.B.; Stewart, K.; Barthelme, J.W. Early domestic stock at Dongodien in northern Kenya. *Azania J. Br. Inst. East. Afr.* **1984**, *19*, 120–127. [[CrossRef](#)]
46. Barthelme, J.W. *Fisher-Hunters and Neolithic Pastoralists in East Turkana, Kenya*; BAR International Series: Oxford, UK, 1985; Volume 254.
47. Ndiema, K.E.; Dillian, C.D.; Braun, D.R.; Harris, J.W.K.; Kiura, P.W. Transport and subsistence patterns at the transition to pastoralism, Koobi Fora, Kenya. *Archaeometry* **2011**, *53*, 1085–1098. [[CrossRef](#)]
48. Grillo, K.M.; McKeeby, Z.; Hildebrand, E.A. “Nderit Ware” and the origins of pastoralist pottery in eastern Africa. *Quat. Int.* **2022**, *608*, 226–242. [[CrossRef](#)]
49. Hildebrand, E.; Grillo, K.M.; Chritz, K.L.; Fischer, M.L.; Goldstein, S.T.; Janzen, A.; Junginger, A.; Kinyanjui, R.N.; Ndiema, E.; Sawchuk, E.; et al. Buffering new risks? Environmental, social and economic changes in the Turkana Basin during and after the African Humid Period. *Holocene* **2022**, *32*, 1373–1392. [[CrossRef](#)]
50. Grillo, K.M.; Hildebrand, E.A. The context of early megalithic architecture in eastern Africa: The Turkana Basin c. 5000–4000 BP. *Azania Archaeol. Res. Afr.* **2013**, *48*, 193–217. [[CrossRef](#)]
51. Hildebrand, E.A.; Grillo, K.M.; Sawchuk, E.A.; Pfeiffer, S.K.; Conyers, L.B.; Goldstein, S.T.; Hill, A.C.; Janzen, A.; Klehm, C.E.; Helper, M.; et al. A monumental cemetery built by eastern Africa’s first herders near Lake Turkana, Kenya. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 8942–8947. [[CrossRef](#)]
52. Sawchuk, E.A.; Pfeiffer, S.; Klehm, C.E.; Cameron, M.E.; Hill, A.C.; Janzen, A.; Grillo, K.M.; Hildebrand, E.A. The bioarchaeology of mid-Holocene pastoralist cemeteries west of Lake Turkana, Kenya. *Archaeol. Anthropol. Sci.* **2019**, *11*, 6221–6241. [[CrossRef](#)] [[PubMed](#)]
53. Sawchuk, E.A.; Hildebrand, E.A.; Hill, A.C.; Contreras, D.A.; Edung, J.E.; Janzen, A.; Kurewa, A.; Munene, J.K.; Ndiema, E.; Grillo, K.M. The Jarigole mortuary tradition reconsidered. *Antiquity* **2022**, *96*, 1460–1477. [[CrossRef](#)]
54. Wright, D.K.; Forman, S.L. Holocene occupation of the Mount Porr strand plain in southern Lake Turkana, Kenya. *Nyame Akuma* **2011**, *76*, 47–62.

55. Blossies, C.; Forman, S.L.; Wright, D.K. Water level history for Lake Turkana, Kenya in the past 15,000 years and a variable transition from the African Humid Period to Holocene aridity. *Glob. Planet. Change* **2015**, *132*, 64–76. [\[CrossRef\]](#)
56. Wright, D.K.; Forman, S.L.; Kiura, P.; Blossies, C.; Beyin, A. Lakeside view: Sociocultural responses to changing water levels of Lake Turkana, Kenya. *Afr. Archaeol. Rev.* **2015**, *32*, 335–367. [\[CrossRef\]](#)
57. Stiles, D. A diachronic study of the demography, human ecology, and history of pastoral groups of northern Kenya. *Nyame Akuma* **1981**, *18*, 14–17.
58. Phillipson, D.W. Aspects of early food production in northern Kenya. In *Origin and Early Development of Food-Producing Cultures in North-Eastern Africa*; Krzyzaniak, L., Kobusiewicz, M., Eds.; Polish Academy of Sciences: Poznan, Poland, 1984; pp. 489–495.
59. Wright, D.K. Long-term dynamics of pastoral ecology in northern Kenya: An old model for new resilience. *J. Anthropol. Archaeol.* **2019**, *55*, 101068. [\[CrossRef\]](#)
60. Stiles, D. Archaeological and ethnographic studies of pastoral groups of northern Kenya. *Nyame Akuma* **1980**, *17*, 20–24.
61. Stiles, D. Preliminary results of archaeological and palaeoenvironmental research in northern Kenya. *Nyame Akuma* **1982**, *20*, 19–25.
62. Stiles, D.; Munro-Hay, S.C. Stone cairn burials at Kokurmatakore, northern Kenya. *Azania J. Br. Inst. East. Afr.* **1981**, *16*, 151–166. [\[CrossRef\]](#)
63. Phillipson, D.W.; Gifford, D. Kulchurdo rock shelter and the Stone Age of Mount Marsabit. *Azania J. Br. Inst. East. Afr.* **1981**, *16*, 167–174. [\[CrossRef\]](#)
64. Phillipson, D.W. The origin of prehistoric farming in East Africa. In *Ecology and History in East Africa*; Ogot, B., Ed.; East African Publishing House: Nairobi, Kenya, 1979; pp. 41–63.
65. Gifford-Gonzalez, D. The fauna from Ele Bor: Evidence for the persistence of foragers into the later Holocene of arid north Kenya. *Afr. Archaeol. Rev.* **2003**, *20*, 81–119. [\[CrossRef\]](#)
66. Clark, J.D. Short notes on the Stone Age sites at Yavello, southern Ethiopia. *Trans. R. Soc. S. Afr.* **1943**, *31*, 29–37. [\[CrossRef\]](#)
67. Chavaillon, N.; Chavaillon, J. *Gotera, un Site Paléolithique Récent d'Éthiopie*; Recherche sur les civilisations, Mémoire Series; Éditions Recherche sur les Civilisations: Paris, France, 1985; p. 59.
68. Spinapolic, E.E.; Gallinaro, M.; Zerboni, A. New Investigations in Southern Ethiopia (Yabelo and Gotera): Pleistocene and Holocene Archaeological Evidence. *Sci. Dell'Antich.* **2017**, *23*, 37–47.
69. Girma, H. The Emergence of Prehistoric Pastoralism in Southern Ethiopia. Ph.D. Thesis, University of Florida, Gainesville, FL, USA, 2001, unpublished.
70. Gallinaro, M.; Zerboni, A.; Solomon, T.; Spinaploce, E.E. Rock art between preservation, research and sustainable development—A perspective from southern Ethiopia. *Afr. Archaeol. Rev.* **2018**, *35*, 211–223. [\[CrossRef\]](#)
71. Eriksson, O.; Ekblom, A.; Lane, P.J.; Lennartsson, T.; Lindholm, K.J. Concepts for integrated research in historical ecology. In *Issues and Concepts in Historical Ecology: The Past and Future of Landscapes and Regions*; Crumley, C., Lennartsson, T., Westin, A., Eds.; Cambridge University Press: Cambridge, UK, 2018; pp. 145–181.
72. Fatorić, S.; Seekamp, E. Knowledge co-production in climate adaptation planning of archaeological sites. *J. Coast. Conserv.* **2019**, *23*, 689–698. [\[CrossRef\]](#)
73. Roué, M.; Nakashima, D.; Krupnik, I. (Eds.) *Resilience Through Knowledge Co-Production: Indigenous Knowledge, Science, and Global Environmental Change*; Cambridge University Press: Cambridge, UK, 2022.
74. Madry, S.; Westin, A.; Jones, E. (Eds.) *Practicing Historical Ecology: Methods for the Collection, Analysis, and Integration of Interdisciplinary Historical Data*; SLU Swedish Biodiversity Centre, Swedish University of Agricultural Sciences: Uppsala, Sweden, 2024.
75. Santana-Cordero, A.M.; Szabó, P.; Bürgi, M.; Armstrong, C.G. The practice of historical ecology: What, when, where, how and what for. *Ambio* **2024**, *53*, 664–677. [\[CrossRef\]](#)
76. Cybulski, J.D.; Sharpe, A.E.; Carvajal-Contreras, D.R.; De Gracia, B.; Dillon, E.M.; García-Pérez, I.; Isaza-Aizpurúa, I.I.; Núñez-Cortés, Y.; Monge-Blanco, S.; Smith-Guzmán, N.E.; et al. Historical ecology of the Southern Central American Pacific coast. *Philos. Trans. B* **2025**, *380*, 20240042. [\[CrossRef\]](#)
77. Shelton, O. The Pastoralist Rock Art in Marsabit County, Kenya: Developing New Spatial and Comparative Processes. Bachelor's Dissertation, Department of Archaeology, University of Cambridge, Cambridge, UK, 2022, unpublished.
78. Muiruri, V.; Courtney-Mustaphi, C.; Marchant, R.A.; M'Mbogori, F.N.; Minya, A.; Lane, P.J. High resolution multi proxy insights on mid-to-Late Holocene paleoenvironmental change in arid Marsabit County, northern Kenya. *The Holocene*, n.d., *in review*.
79. Ochungo, P.; Khalaf, N.; Merlo, S.; Beldados, A.; M'Mbogori, F.N.; Tiki, W.; Lane, P.J. Remote sensing for biocultural heritage preservation in an African semi-arid region: A case study of indigenous wells in northern Kenya and Southern Ethiopia. *Remote Sens.* **2022**, *14*, 314. [\[CrossRef\]](#)
80. International Science Council. Unlocking Science Campaign Report. January 2023; Unpublished report.
81. Kagunyu, A.; Wandibba, S.; Wanjohi, J. The use of indigenous climate forecasting methods by the pastoralists of Northern Kenya. *Pastoralism* **2016**, *6*, 7. [\[CrossRef\]](#)
82. Iticha, B.; Husen, A. Adaptation to climate change using indigenous weather forecasting systems in Borana pastoralists of southern Ethiopia. *Clim. Dev.* **2019**, *11*, 564–573. [\[CrossRef\]](#)

83. Debela, N.; McNeil, D.; Bridle, K.; Mohammed, C. Adaptation to climate change in the pastoral and agropastoral systems of Borana, South Ethiopia: Options and barriers. *Am. J. Clim. Change* **2019**, *8*, 90424. [[CrossRef](#)]
84. Robinson, L.W.; Berkes, F. Applying resilience thinking to questions of policy for pastoralist systems: Lessons from the Gabra of northern Kenya. *Hum. Ecol.* **2010**, *38*, 335–350. [[CrossRef](#)]
85. Oba, G. *Climate Change Adaptation in Africa: An Historical Ecology*; Routledge: Abingdon, UK, 2014.
86. Oba, G. *Pastoralist Resilience to Environmental Collapse in East Africa since 1500*; Springer International Publishing: Cham, Switzerland, 2024.
87. Brooks, N.; Clarke, J.; Ngaruiya, G.W.; Wangui, E.E. African heritage in a changing climate. *Azania Archaeol. Res. Afr.* **2020**, *55*, 297–328. [[CrossRef](#)]
88. Lane, P.J.; Merlo, S.; The MAEASaM Project Team. The perils of endangerment: Reflections on Mapping Africa’s endangered archaeological sites and monuments. In *Reporting Heritage Destruction: A Double-Edged Sword?* Rouhani, B., Finlayson, B., Clack, T., Eds.; Oxford University Press: Oxford, UK, in press.
89. Mapping Africa’s Endangered Archaeological Sites and Monuments. Available online: <https://maeasam.org/> (accessed on 21 April 2025).
90. Petek-Sargeant, N.; Lane, P.J. Weathering climate change in archaeology: Conceptual challenges and an East African case study. *Camb. Archaeol. J.* **2021**, *31*, 437–454. [[CrossRef](#)]
91. Beh, A.; Bruyere, B.L.; Lolosoli, S. Legitimizing local perspectives in conservation through community-based research: A photovoice study in Samburu, Kenya. *Soc. Nat. Resour.* **2013**, *26*, 1390–1406. [[CrossRef](#)]
92. Dedrick, M. Photovoice as a method for the development of collaborative archaeological practice. *J. Community Archaeol. Herit.* **2018**, *5*, 85–100. [[CrossRef](#)]
93. Kariuki, R.W.; Munishi, L.; Courtney-Mustaphi, C.J.; Capitani, C.; Shoemaker, A.; Lane, P.J.; Marchant, R. Using stakeholders’ perspectives and spatial modelling to develop scenarios of future land use and land cover change in northern Tanzania. *PLoS ONE* **2021**, *6*, e0245516.
94. Pankhurst, R. (Ed.) The Oromo migration. In *The Ethiopian Borderlands: Essays in Regional History from Ancient Times to the End of the 18th Century*; The Red Sea Press: Lawrenceville, NJ, USA, 1977; pp. 277–323.
95. Amutabi, M.N. Cushitic Migration and Settlement in Kenya. In *The Palgrave Handbook of Kenyan History*; Nasong’o, W.S., Amutabi, M.N., Falola, T., Eds.; Palgrave Macmillan: Cham, Switzerland, 2023. [[CrossRef](#)]
96. Labadi, S. *Rethinking Heritage for Sustainable Development*; UCL Press: London, UK, 2022.
97. Grounds, S.; El Faouri, B.F.; Wills, C. Exploring the intersection of heritage and sustainable development: Lessons from the ICOMOS GA2023 ‘Heritage as Sustainability Program’. *Hist. Environ.* **2024**, *35*, 108–123.
98. Nocca, F. The role of cultural heritage in sustainable development: Multidimensional indicators as decision-making tool. *Sustainability* **2017**, *9*, 1882. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.