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# Addressing the Anthropocene from the Global South: integrating paleoecology, archaeology and traditional knowledge for COP engagement

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The triple planetary crisis of climate change, pollution, and biodiversity loss necessitates more holistic, comprehensive, and integrated public policy approaches. Within the United Nations Framework Convention on Climate Change, this crisis highlights significant conflicts over forms of knowledge and conceptualization, affecting how international policies are formed. **Indigenous knowledge systems have become increasingly acknowledged for their vital role in addressing the challenges of the Anthropocene.** Conferences of the Parties institutions like the International Indigenous Peoples Forum on Climate Change emphasize the critical, although not always recognized, importance of Indigenous territories, which contain eighty percent of the world's biodiversity. Here, we show that research in paleoecology, archaeology and history demonstrates the long-term significance of traditional knowledge and Indigenous land management practices for contemporary ecosystem dynamics. Drawing from these varied studies and perspectives also reveal the socio-economic inequalities resulting from centuries of European colonialism. We showcase three case studies on; (i) pastoralism in eastern Africa, (ii) natural resource management in southeast Asia and (iii) adaptation to

**Abbreviations:** COP, Conferences of the Parties; UNFCCC, United Nations Framework Convention on Climate Change; CIEL, Center for International Environmental Law; IIPFCC, Indigenous Peoples Forum on Climate Change; IPCC, Intergovernmental Panel on Climate Change; SIDS, Small Island Developing States; LDCs, Least Developed Countries; UN, United Nations; LCIPP, Local Communities and Indigenous Peoples Platform; IUCN, International Union for Conservation of Nature; IIFB, International Indigenous Forum on Biodiversity; IPO, Indigenous Peoples Organisations.

sea level rise in the Caribbean, which touch upon highly diverse human resilience strategies across space and time. Despite efforts at the COP28 to accelerate climate action and incorporate diverse knowledge systems, significant challenges remain. The need for a pluralistic knowledge, rather than a one-size-fits-all approach, blending scientific language with artistic and narrative forms, is proposed as critical for fostering effective communication and developing more effective and equitable solutions for global environmental governance.

#### KEYWORDS

Anthropocene, Global South, traditional knowledge, climate change, COP agenda

## 1 Introduction

The current triple planetary crisis, represented by the entanglement of climate change, pollution and biodiversity loss, emphasizes an urgent need for more holistic approaches to public policy making. Specifically, this crisis highlights conflicts regarding forms of knowledge and conceptualization (Haraway, 2016), and how they translate into international policy-making schemes<sup>1</sup>. The Conferences of the Parties (COP) on Climate Change is a key forum where actions to tackle global crises are discussed and legally binding agreements are formed. However, the framework by which these crises are defined directly impacts the decisions made in established sectors. The current scientific paradigm ruling the United Nations Framework Convention on Climate Change (UNFCCC) process reproduces a 'representative' program of scientific discourse as an objective realm that speaks for a muted natural world (Haraway, 2016). Marginalized groups with counter-hegemonic perspectives have, however, challenged the development structures proposed by the high-level policymakers as a one-size-fits-all<sup>2</sup> approach to global environmental governance, and the need for more polyphonic dialogue has become evident through these UNFCCC processes.

Against this background, the significance of traditional knowledge systems practiced by Indigenous and local communities for addressing Anthropocene crises has been emphasized in recent years (IIPFCC and CIEL, 2020) through the creation of consultative forums like the International Indigenous Peoples Forum on Climate Change (IIPFCC). The Intergovernmental Panel on Climate Change (IPCC) and its subsidiary reports now recognize the importance of Indigenous territories for the Earth system, which contain around 40% of global protected areas, 80% of global biodiversity,

and major carbon sinks. In addition, the Kunming-Montreal Biodiversity Framework set the goal of conserving 30% of Earth's terrestrial, coastal and marine ecosystems as protected regions by 2030, with a partial recognition of Indigenous perspectives on nature conservation (Stephens, 2023). These reports acknowledge the disproportionate impact of the Anthropocene on these same territories and the Global South. Moreover, there is growing recognition that unequal global socioeconomic relationships and land degradation in the 21st century has been shaped by centuries of European invasion and colonization (Anderson and Bollig, 2016; Roberts et al., 2023; Levis et al., 2024).

When carried out in close coordination with Indigenous and local communities, paleoecological, archaeological and historical research has demonstrated, not only the long-term<sup>3</sup> importance of Indigenous land management for contemporary ecosystem dynamics but also the historical events and processes that have led to socio-economic and Earth system inequalities in the 21st century (Levis et al., 2024). Yet, there is currently only a limited part of the COP on Climate Change negotiations that addresses these bodies of knowledge (Chakraborty and Sherpa, 2021). In this paper, we outline a preliminary program highlighting the significance of Indigenous knowledge, as well as palaeoecological, archaeological and historical studies, when considering the challenges of climate change today. By bringing together case studies focused on the Global South, we mobilize evidence for human landscape management and adaptation. We argue that understanding long-term historical processes can shed light on land use disruptions and reorganizations caused by colonialism and extractivist projects. This can be utilized for policy-making regarding adaptation and mitigation in the light of the latest COP28 outcomes.

Our approach complements (Kohler and Rockman, 2020), demonstrating how examples can be brought together to develop broader, more influential insights into how societies typically respond to climate variability. This long-term view connects with the concept of *landesque capital*, recognizing humans have actively invested labor in enhancing land fertility, emphasizing the positive

1 The concept of the Anthropocene has been criticized by some authors as 'Eurocentric, Anthropocentric and bourgeois' (Estenssoro, 2021), as it mirrors how Western culture has largely shaped a unilateral knowledge system. In a critique of the Anthropocene as a concept (Moore, 2017), argues that the current climatic catastrophe has been generated by the modern capitalist system over the last five centuries, resulting in a 'Capitalocene' epoch, with responsibility for this crisis falling on specific historical actors rather than humanity as a whole.

2 Concerns on how general policymaking often overlooks the intricacies of how regional populations equitably benefit from assigning value to deforestation and carbon emissions are outlined in wider UN frameworks like REDD+ (i.e., Pohl Schnake and Coppiarolo, 2019).

3 The temporal range in question varies depending on the case study and the geographical location. For sea level rise it could be ca.10,000 years, whereas for the other cases, pivotal historical turnpoints such as European colonization are also crucial to understand current dynamics and challenges in the face of climate change impacts. We propose to adapt the time-range according to the topic affected by policy-making.

aspects of agency and influence of human societies (Håkansson and Widgren, 2016; Barca, 2020). For example, enduring traces of the past, such as anthropic soils (i.e., agricultural terraces or Amazonian Dark Earths), crop varieties, or conservation practices, represent potential assets for the present. Such positive strategies that have been disrupted by historical processes, could be widely revitalized (i.e., check-dam reconstruction in the Peruvian Andes (Branch et al., 2023), agricultural landscape reconstruction in Lake Titicaca (Erickson and Walker, 2009).

We call attention to these themes using selected examples that enable a linkage between critical challenges in the 21st century Anthropocene and deeper time human-environment interactions, including: (1) Traditional pastoralism, land management and biodiversity conservation in eastern Africa; (2) Water management, agroforestry and socio-political resilience in Greater Angkor, Cambodia; and (3) Sea level change and human adaptations to relocation in the Small Island Developing States (SIDS) of the Caribbean.

## 2 Connection to COP

The imbalance between developed and Least Developed Countries (LDCs) is a key issue entangled within the geopolitical disputes and negotiations of COP. Closely related to this, is the inclusion of subaltern groups that embody profound criticisms of development as an overarching goal that will lead to a sustainable future, especially when this “development” does not modify the global economic system in terms of perpetuated resource exploitation (Klier and Folguera, 2017). This often leads to other forms of extractivism, no different from fuel-based systems, that pose severe impacts to biodiversity and water resources (Svampa, 2019). For example, the replacement of a fuel-based capitalism for “Green capitalism” is a major issue in the current energy transition to reduce emissions. Many raw materials (e.g., lithium, rare minerals) needed for this transition are sourced from LDCs and/or in Indigenous communities’ ancestral lands. Indigenous communities are currently leading the critique of development (Kopenawa and Albert, 2013; Cusicanqui, 2015) and how a Just Transition Scheme<sup>4</sup> should be designed.

Since COP26, Indigenous Peoples have gained some visibility in the UNFCCC process, yet this has not directly translated into meaningful participation in land protection and human rights negotiations (Almås-Smith and Carling, 2022). The inclusion of plural knowledge systems in the UNFCCC process still carries the legacy of colonialism and inequality in terms of access to decision-making spaces (Orlove et al., 2022), hindering diverse perspectives on Climate Change and necessary responses. Additionally, the predominance of natural scientific discourse in COP assessments, poses challenges in bridging this gap and integrating plural knowledge systems (Orlove et al., 2022). Current efforts to foster negotiation spaces within the United Nations (UN)

seek to bridge this gap through Indigenous Peoples’ initiatives. Specifically, the Local Communities and Indigenous Peoples Platform (LCIPP) informs key UNFCCC decision-making areas through its Facilitative Working Group. Representation in this body is composed of 50% Indigenous and 50% representatives from Parties. This body facilitates the implementation of its three functions of the LCIPP related to the preservation of traditional knowledge, increased engagement of Indigenous peoples and integrated policy-making (see UNFCCC, 2017; Decision 2/CP.23).

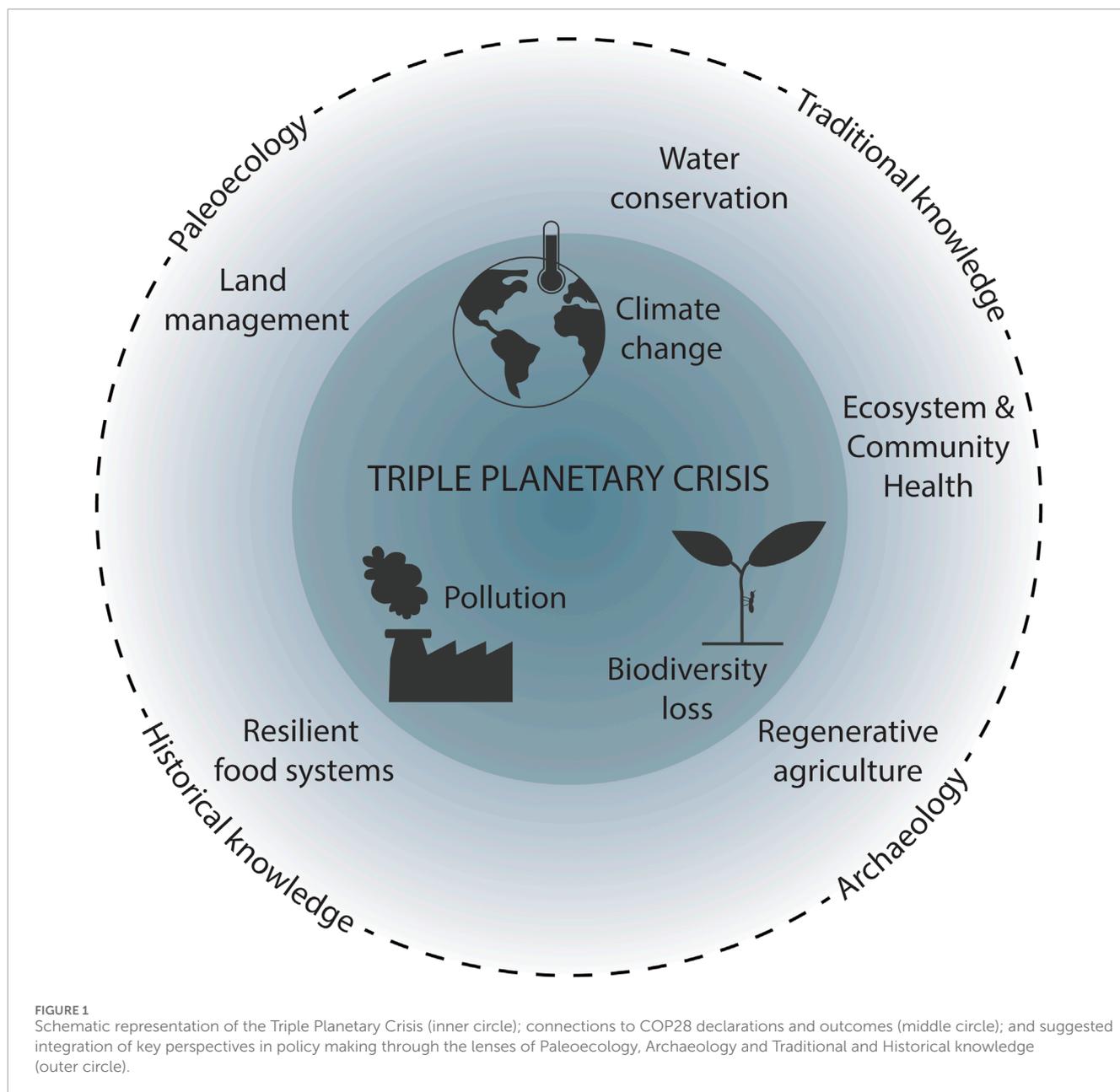
Considering this, how could the support for collaboration between knowledge systems be improved? We argue that although the IPCC reports are widely accessible, the possibility of engaging through them is extremely restrictive. For example, (Kohler and Rockman, 2020), note that, despite archaeology and history increasingly producing relevant climate crisis data to address contemporary issues, their impact on IPCC reports is marginal. However, it is possible to directly deliver scientific reports to the LCIPP or through collaborative UN networks (e.g., Nairobi Working Program<sup>5</sup>). We propose that our multidisciplinary approach—combining paleoenvironmental, archaeological, and historical data—offers critical potential to mediate between the views of the traditional knowledge holders and policymakers for more equitable futures (Figure 1). In that vein, pivotal themes like biodiversity conservation, deforestation and sea level rise offer insights into the long-term history of Anthropogenic impacts, as discussed in the following sections.

### 2.1 The archaeology of pastoralism, land management, and biodiversity conservation in Eastern Africa

Traditional pastoralism in eastern Africa involves managing livestock across nutrient-poor arid and semi-arid lands characterized by complex mobility strategies to access water and pasture (Kirkbride and Grahn, 2008; Lane, 2013; Galaty, 2021). It also involves keeping livestock in one place overnight, resulting in the accumulation of animal dung from feeding in different habitats (Shahack-Gross et al., 2008; Porensky and Veblen, 2015; Marshall et al., 2018). Since colonial invasion and administrative imposition, traditional pastoralism has been stigmatized as a nonadaptive, wasteful activity that damages the land (Fratkin, 2001; Anderson, 2002; Lankester and Davis, 2016). Contrary to this view, however, the mobility of traditional pastoralists ensures that these nutrient-rich soil patches are spread over different regions. These patches are transformed into grassy glades that continuously attract both pastoralists and wildlife (Muchiru et al., 2008; Boles and Lane, 2016). An established cyclical pattern of enrichment promotes the conservation of plant, livestock and wildlife biodiversity (Porensky and Veblen, 2015). Similar habitat enrichment, via analogous forms of pastoralism that constitute a sort of ‘bioengineering’, has been documented in arid regions of the world such as Central Asia (Ventresca Miller et al., 2020) and the Andes (Branch et al., 2023).

<sup>4</sup> Established at COP27, a Just Transition Scheme is meant to assess, design and scale up pathways to achieve the goals of the Paris Agreement in a way that is just and equitable for all, taking into account human rights (UNFCCC, 2022; 1/CP.27, Sharm el-Sheikh Implementation Plan).

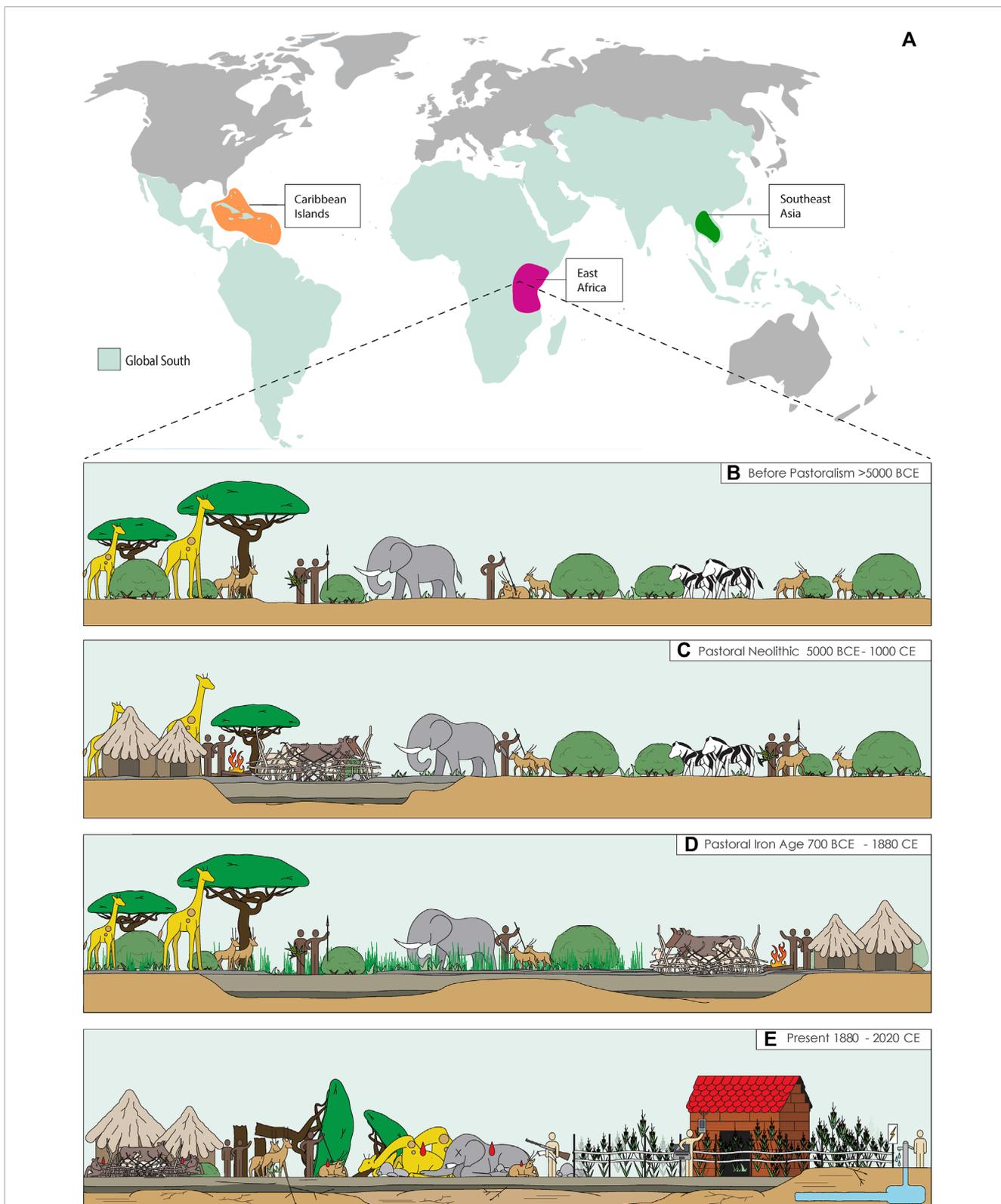
<sup>5</sup> Its objective is to assist all Parties, especially developing countries, including the LDCs and SIDS to improve their understanding and assessment of impacts, vulnerability and adaptation to climate change.



Archaeological evidence reveals that this pastoralist-wildlife relationship dates back nearly seven millennia (Figure 2) (Sutton, 1998; Shahack-Gross et al., 2008; Marshall et al., 2018; Storozum et al., 2021). Zooarchaeological records show that pastoralists had protein-rich diets dominated by livestock products (Gifford-Gonzalez and Kimengich, 1984; Ambrose and DeNiro, 1986; Leakey et al., 1943; Grillo et al., 2020; Bleasdale et al., 2021), rarely ate wild animals, and coexisted with hunter gatherers (Gifford-Gonzalez and Kimengich, 1984; Mutundu, 2010; Prendergast, 2011; Lane, 2013). Archaeological data from sites in Kenya, dating from around 3500 BCE to 500 BCE, demonstrate that nutrient-rich spots have supported healthy grassy glades for millennia (Marshall et al., 2018). Modern pastoralists also settle near these sites. Healthy grassy glades established at different times can be seen on aerial photographs of pastoral sites in eastern Africa and other parts of Africa (Boles and Lane, 2016; Marshall et al., 2018).

Policies implemented by colonial administrations in eastern Africa were designed to suppress traditional pastoralism, but have had a negative impact on biodiversity conservation (Anderson, 2002; Notenbaert et al., 2012; Lankester and Davis, 2016). The creation of country boundaries, White Highlands and Native Reserves<sup>6</sup>, as well as livestock ranches, and national wildlife parks resulted in pastoralists losing almost half of the best grazing land and the fragmentation of livestock and wildlife into restricted areas (Whittlesey, 1953; Morgan, 1963; Coldham, 1979). Today,

<sup>6</sup> White Highlands refers to confiscated land in the Rift Valley highlands and Mount Kenya set aside for exclusive European settlement, while Native Reserves were designated as marginal land set aside for Indigenous settlement.



**FIGURE 2** World map of featured case study sites situated in the Global South (A) with a focus of Pastoralism in eastern Africa: (B) Pre-pastoralism period dominated by patchy grass and shrublands, and sustainable hunting and gathering, (C) Onset of dung accumulation by incoming pastoralists and coexistence with hunters and gatherers, (D) Continuous accumulation of dung adjacent to past settlement sites and development of grassy glades, and (E) Pastoralists, hunters and gatherers, and wildlife facing calamities as a result of marginalization by modern land management strategies.

policies promote individual land ownership, fixed grazing and sedentarization, and industrialized agriculture (Abbink et al., 2014; Kirkbride and Grahn, 2008; Lind et al., 2020). Overpopulation, overstocking, land degradation, disease outbreaks, mass die-offs of livestock and wildlife, and human-wildlife conflicts are escalating in pastoral lands. Moreover, ethnobotanical studies detail how Western influences in the Maasai region of Kenya have led to cultural shifts corresponding to changes in the local landscape and the profound loss of traditional knowledge of plant use (Bussmann et al., 2018). These post-colonial land use regimes create regional gene pools with limited genetic diversity prone to biodiversity collapse. To achieve sustainable biodiversity conservation, policymakers should consider the archaeological perspective presented here as a guide to assessing the positive outcomes of regenerative pastoralism in eastern Africa and elsewhere.

## 2.2 The historical legacy of Southeast Asia: Insights from Great Angkor and its contemporary relevance

Greater Angkor in Cambodia was the epicentre of the Khmer empire between the 9th and 14th centuries CE and became the largest recorded pre-industrial urban entity by area. Its political structure alternated between central organization and decentralized regional autonomy, conferring socio-political adaptability and transformation of the region into an elaborately designed landscape (Fletcher et al., 2008; Klassen and Evans, 2020; Carter et al., 2021). Archaeological and palaeobotanical studies reveal adaptive engineering strategies in response to environmental challenges. The society had an intricate water system to irrigate large-scale rice cultivation and manage water resources during seasonal monsoons, minimizing damage from floods and droughts (Fletcher et al., 2008; Klassen and Evans, 2020). Ultimately, this interdependent hydraulic system of reservoirs and canals lost its resilience during extensive climatic extremes and Ayutthayan invasions in the 14th century, leading to a gradual population decline (Buckley et al., 2010; Penny et al., 2019). Nevertheless, Greater Angkor prospered for over four centuries as a city larger than the main coeval European centers, demonstrating urban adaptations to tropical forest settings (Roberts et al., 2023). It is also highly relevant considering the 21st-century tendency towards low-density urbanism and the resilience of such urban forms to climate change (Fletcher et al., 2024).

Under traditional Khmer rural codes, agricultural land could be claimed, as long as cultivation did not interfere with individual and communal rights. Areas with “common” forest resources (e.g., fisheries, non-timber forest products) were co-managed by households (Olivier, 1954; Diepart, 2015). An account by Chinese envoy, Zhou Daguan in 1297, corroborates the presence of extensive forests and cultivated cropland during the city’s habitation (Zhou, 2007). This socio-political organization allowed flexible adaptation to crises, enabling sustainable use of limited resources (Diepart, 2015). Over the last five centuries, however, the Angkor region has endured multiple occupations, making it a unique case study for understanding socio-political changes in land use from vast pre-industrial urbanism to varied colonial impositions. Under French administration (1863–1953), private land ownership and

“modernization” of communal land property rights were introduced to stimulate rice production, secure land and allow urban investment (Diepart, 2015). This was a clear attempt to replace small-scale Indigenous forestry use with large-scale corporate exploitation (Thomas, 1999), denying Cambodians access to forests and directly affecting their livelihoods. Today, deforestation in Cambodia is linked to rapid economic growth and the agricultural expansion of maize, cassava and plantation cash crops like rubber (MAFF, 2015; Hun et al., 2017; Kong et al., 2019; Grogan et al., 2019), reflecting trends across Southeast Asia (Hall, 2011).

Despite centuries of colonial influence, Cambodia’s history demonstrates the resilience of local populations. In the late 1970s and 1980s, a decentralized landscape management policy managed by local authorities in rural areas allowed rapid agricultural recovery in war-torn regions (Coe, 2003; Diepart, 2015). This resembles the post-decline of Greater Angkor (13–16th centuries), where socio-political reorganization and continued land use occurred rather than an abrupt fall, with people free to pursue new strategies of elite control or small-scale farming and water management in different parts of the landscape (Fletcher et al., 2017). Angkor exemplifies how certain forms of centralized socio-political mismanagement in the face of climate change can affect all layers of society. Its intricate water management system became increasingly inefficient over time, and adaptability to crises was largely driven by political and spatial reorganization in smaller polities with more constrained control and management of resources. Nevertheless, a bottom-up solution was developed by the autonomous organization of local households, which also affected the centre of power (Lucero et al., 2015). This highlights the importance of local collaborative solutions in addressing Anthropocene challenges, which is especially valuable for countries in the Global South, where Indigenous Peoples continue to resist the pressures of wider power structures, such as the global capitalist demands for the resources present in their territories.

## 2.3 Adaptation to sea level change in Small Island Developing States

Small Island Developing States, spanning regions including the Caribbean, Pacific, Atlantic, Indian Ocean, and South China Sea, are among the most vulnerable to the compounding impacts of Climate Change (United Nations, 1993). The rate of sea level rise has escalated from 1.8 mm per year in the last century to 3 mm per year over the past decade, with projections indicating a potential increase to approximately 11 mm per year by the end of the 21st century (IPCC, 2007; IPCC, 2013). Repercussions of these changes are severe, including the erosion of coastlines, significant biodiversity loss through phenomena such as coral bleaching and mangrove degradation, and the destruction of coastal industries, infrastructure, and cultural heritage (Fitzpatrick and Keegan, 2007; Griggs and Reguero, 2021; Stephenson and Jones, 2017).

Historically, communities in SIDS have developed a repertoire of adaptive strategies to cope with environmental changes. For instance, sediment core analyses have shown that during periods of significant sea level rise, island communities have adapted their agricultural and agroforestry practices to ensure food security and sustain livelihoods (Fitzpatrick and Keegan, 2007). In the Caribbean, as sea levels fluctuated during the Holocene,

communities constructed dwellings that could be easily rebuilt after extreme weather events, utilizing elevated structures or relocatable materials to mitigate the impact of flooding and storm surges (Hofman et al., 2021). These pre-colonial adaptation strategies highlight the resilience of SIDS communities in the face of climate variability, rooted in deep ecological knowledge and sustainable resource management.

Colonial policies often disrupted these established adaptive systems by imposing new economic structures and land use practices that prioritized extraction and export over local sustainability. The shift from communal to privatized land, coupled with the introduction of non-native agricultural systems (i.e., plantations), significantly altered the landscape and reduced the adaptive capacity of Indigenous populations (Saunders, 2005). From the 16th century onward, the introduction of cash crops—such as sugar—and commercial logging, along with the displacement of Indigenous communities to marginal lands and the outright genocide of Indigenous islanders in the Caribbean and elsewhere, disrupted the traditional systems that were suitable for coping with extreme events and famines (Dunning et al., 2018; Douglass and Cooper, 2020). However, traditional knowledge systems continue to play a role in environmental adaptations. In Fiji, for example, the use of specific plant species in construction has provided resilience against frequent cyclones, demonstrating an intimate understanding of local materials and their resistive properties against natural disasters (Orlove et al., 2022). In line with this, the Kunming-Montreal Biodiversity Framework has acknowledged the importance of protecting these critically threatened coastal areas through collective action, particularly through the participation of Indigenous Peoples and the implementation of sustainable community-based approaches.

### 3 Outcomes of COP 28 for Indigenous Peoples and recommendations from the ECHOES project

The aforementioned case studies demonstrate that diverse social organizations and technological advancements can coexist, indicating societies can choose varied socioeconomic paths rather than following a predetermined trajectory. Understanding past societies' diversity and adaptability is vital for addressing contemporary environmental challenges, underscoring the need for multiple development pathways in climate policy instead of a one-size-fits-all solution. COP28 stressed accelerating climate action to meet 2030 objectives, as shown by the first Global Stocktake and Carbon Emission Reports (UNFCCC, 2022). A major focus was establishing a finance scheme to expedite this transition, addressing disparities between developed nations and LDCs, and integrating diverse knowledge systems within the UNFCCC process. The implementation of the Loss and Damage fund was another pivotal agreement. However, only 3% of this funding currently reaches Indigenous climate change initiatives, as recognized during COP28. Concerns about the insufficient reach of these funds led to the launch of the Podong Initiative, co-led by the International Union for Conservation of Nature (IUCN) and IIFB Indigenous Peoples Organisations (IPO) members. This initiative aims to mobilize up to \$200 million from 2023 to 2030 in biodiversity and climate

finance, with at least 85% of these funds designated to directly reach Indigenous territories and local communities.

Despite the potential benefits, challenges remain regarding bureaucratic hurdles, equitable asset distribution and ensuring the free and informed consent of the communities (ILO 169), which could affect the long-term project sustainability. This underscores the need to bridge gaps between scientific and traditional knowledge in policy-making. Our initiative aims to integrate perspectives by creating an assessment report for the UNFCCC and relevant policymakers at the national (i.e., local governments and organizations) and international levels (i.e., IWIGIA<sup>7</sup> and IICB<sup>8</sup> that advocate linking Indigenous knowledge and global environmental policy). By highlighting our case studies, which showcase important landesque capital in addressing land management and biodiversity loss through regenerative pastoralism in Eastern Africa, water management techniques in pre-industrial Cambodia, and relocation and adaptation practices in the SIDS, we provide evidence that supports cost-effective adaptation and mitigation solutions, while offering a long-term perspective on Indigenous/pre-colonial adaptations prior to recent historical disruptions. We advocate for a pluralistic knowledge approach (Orlove et al., 2022), blending scientific language with artistic and other narrative forms to foster more effective, dialogic communication for broader audiences. Echoing Haraway (2016), we argue that changing the narrative is a potent tool for contesting futures where development excludes rather than includes, ensuring a more comprehensive approach to biodiversity loss compensation and climate justice.

### Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

### Author contributions

VZ: Conceptualization, Writing—original draft, Writing—review and editing. MZ: Conceptualization, Writing—original draft, Writing—review and editing. VC-A: Conceptualization, Writing—original draft, Writing—review and editing. VI: Conceptualization, Writing—original draft, Writing—review and editing. RL: Conceptualization, Writing—original draft, Writing—review and editing. FS: Conceptualization, Writing—original draft, Writing—review and editing. RR: Conceptualization, Writing—original draft, Writing—review and editing. DH: Conceptualization, Writing—original draft, Writing—review and editing. SM: Conceptualization, Writing—original draft, Writing—review and editing. GJ: Conceptualization, Writing—original draft, Writing—review

<sup>7</sup> International Work Group for Indigenous Affairs

<sup>8</sup> International Indigenous Forum on Biodiversity

and editing. MA: Conceptualization, Writing–original draft, Writing–review and editing. DJ: Conceptualization, Writing–original draft, Writing–review and editing. RW: Conceptualization, Writing–review and editing. PR: Conceptualization, Writing–original draft, Writing–review and editing. LF: Conceptualization, Writing–original draft, Writing–review and editing.

## Consortium/group statement

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## References

- Abbink, J., Askew, K., Feyissa, D., Fratkin, E., Gabbert, E. C., Galaty, J., et al. (2014). Lands of the future: transforming pastoral lands and livelihoods in eastern Africa. Halle/saale: Max Planck institute for social anthropology.
- Almås-Smith, O., and Carling, J. (2022). *Taking stock: a rapid review and critical analysis of UNFCCC COP26 outcomes and potential implications for indigenous peoples' rights*. Moreton-in-Marsh, England, United Kingdom: Forest Peoples Programme.
- Ambrose, S. H., and DeNiro, M. J. (1986). Reconstruction of African human diet using bone collagen carbon and nitrogen isotope ratios. *Nature* 319 (6051), 321–324. doi:10.1038/319321a0
- Anderson, D. M. (2002). *Eroding the commons: the politics of ecology in baringo, Kenya, 1890s–1963*. Athens, OH, United States: Ohio University Press.
- Anderson, D. M., and Bollig, M. (2016). Resilience and collapse: histories, ecologies, conflicts and identities in the Baringo-Bogoria basin, Kenya. *J. East. Afr. Stud.* 10 (1), 1–20. doi:10.1080/17531055.2016.1150240
- Barca, S. (2020). “Forces of reproduction: notes for a counter-hegemonic Anthropocene,” in *Elements in environmental humanities* (Cambridge University Press). doi:10.1017/9781108878371
- Bleasdale, M., Richter, K. K., Janzen, A., Brown, S., Scott, A., Zech, J., et al. (2021). Ancient proteins provide evidence of dairy consumption in eastern Africa. *Nat. Commun.* 12 (1), 632. doi:10.1038/s41467-020-20682-3
- Boles, O. J. C., and Lane, P. J. (2016). The Green, Green Grass of Home: an archaeological approach to pastoralist settlement in central Kenya. *Azania Archaeol. Res. Afr.* 51 (4), 507–530. doi:10.1080/0067270X.2016.1249587
- Branch, N., Ferreira, F., Lane, K., Wade, A., Walsh, D., Handley, J., et al. (2023). Adaptive capacity of farming communities to climate change in the Peruvian Andes: past, present and future. *Rev. Glaciares Ecosistemas Montaña* 8, 51–67.
- Buckley, B. M., Anchukaitis, K. J., Penny, D., Fletcher, R., Cook, E. R., Sano, M., et al. (2010). Climate as a contributing factor in the demise of Angkor, Cambodia. *Proc. Natl. Acad. Sci. U. S. A.* 107 (15), 6748–6752. doi:10.1073/pnas.0910827107
- Carter, A. K., Klassen, S., Stark, M. T., Polkinghorne, M., Heng, P., Evans, D., et al. (2021). The evolution of agro-urbanism: a case study from Angkor, Cambodia. *J. Anthropol. Archaeol.* 63, 101323. doi:10.1016/j.jaa.2021.101323
- Chakraborty, R., and Sherpa, P. Y. (2021). From climate adaptation to climate justice: critical reflections on the IPCC and himalayan climate knowledges. *Clim. Change* 167 (3–4), 49. doi:10.1007/s10584-021-03158-1
- Coe, M. D. (2003). *Angkor and the Khmer civilization*. London, England, United Kingdom: Thames and Hudson.
- Coldham, S. (1979). Colonial policy and the highlands of Kenya, 1934–1944. *J. Afr. Law* 23 (1), 65–83. doi:10.1017/S0021855300010317
- Cusicanqui, S. R. (2015). Strategic ethnicity, nation, and (Neo)colonialism in Latin America. *Alternautas* 2 (2). doi:10.31273/alternautas.v2i2.1018
- Diepart, J. (2015). The fragmentation of land tenure systems in Cambodia: peasants and the formalization of land rights. *GRET Aurore Mansion Land Tenure Dev.*
- Douglass, K., and Cooper, J. (2020). Archaeology, environmental justice, and climate change on islands of the Caribbean and southwestern Indian Ocean. *Proc. Natl. Acad. Sci. U. S. A.* 117 (15), 8254–8262. doi:10.1073/pnas.1914211117
- Dunning, N. P., Jones, J. G., Duncan, N. A., Pearsall, D. M., and Siegel, P. (2018). “Curaçao,” in *Island historical ecology: socio-natural landscapes of the eastern and southern caribbean*. Editor P. E. Siegel (NYC, NY, United States: Berghahn Books), 155–181.
- Erickson, C., and Walker, J. (2009). “Pre-columbian causeways and canals as landesque capital,” in *Landscapes of movement: trails, paths, and roads in anthropological perspective*. Editors J. E. Snead, C. L. Erickson, and J. A. Darling (University of Pennsylvania Press), 235–252.
- Estenssoro, F. (2021). Who is destroying life on the planet? The confrontation of the Anthropocene and Capitalocene concepts in the environmental debate. *Universum* 36, 661–681. doi:10.4067/s0718-23762021000200661
- Fitzpatrick, S. M., and Keegan, W. F. (2007). Human impacts and adaptations in the Caribbean Islands: an historical ecology approach. *Earth Environ. Sci. Trans. R. Soc. Edinb.* 98 (1), 29–45. doi:10.1017/S1755691007000096
- Fletcher, R., Buckley, B. M., Pottier, C., and Wang, S. Y. (2017). “Fourteenth to sixteenth centuries AD: the case of Angkor and monsoon extremes in mainland Southeast Asia,” in *Megadrought and collapse: from early agriculture to angkor*. Editor H. Weiss (Oxford University Press).
- Fletcher, R., Penny, D., Evans, D., Pottier, C., Barbeti, M., Kumm, M., et al. (2008). The water management network of Angkor, Cambodia. *Antiquity* 82 (317), 658–670. doi:10.1017/S0003598X00097295
- Fletcher, R., White, K., and Penny, D. (2024). Risk and low-density dispersed urbanism. *Front. Hum. Dyn.* 6, 1347157. doi:10.3389/feart.2024.1347157
- Fratkin, E. (2001). East african pastoralism in transition: Maasai, boran, and rendille cases. *Afr. Stud. Rev.* 44 (3), 1–25. doi:10.2307/525591

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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- Galaty, J. (2021). "Pastoralism in eastern Africa," in *Oxford research encyclopedia of african history* (Oxford University Press). doi:10.1093/acrefore/9780190277734.013.1046
- Gifford-Gonzalez, D. P., and Kimengich, J. (1984). "Faunal evidence for early stock-keeping in the Central Rift of Kenya: preliminary findings," in *Origin and early development of food-producing cultures in north-eastern Africa*. Kobusiewicz. Editors L. Krzyzaniak, and M. and (Poznań, Poland: Poznan: Polish Academy of Sciences and Poznan Archaeological Museum), 457–471.
- Griggs, G., and Reguero, B. G. (2021). Coastal adaptation to climate change and sea-level rise. *Water* 13 (16), 2151. doi:10.3390/w13162151
- Grillo, K. M., Dunne, J., Marshall, F., Prendergast, M. E., Casanova, E., Gidna, A. O., et al. (2020). Molecular and isotopic evidence for milk, meat, and plants in prehistoric eastern African herder food systems. *Proc. Natl. Acad. Sci. U. S. A.* 117 (18), 9793–9799. doi:10.1073/pnas.1920309117
- Grogan, K., Pflugmacher, D., Hostert, P., Mertz, O., and Fensholt, R. (2019). Unravelling the link between global rubber price and tropical deforestation in Cambodia. *Nat. Plants* 5 (1), 47–53. doi:10.1038/s41477-018-0325-4
- Håkansson, N. T., and Widgren, M. (2016). *Landesque capital: the historical ecology of enduring landscape modifications*. Oxfordshire, England, United Kingdom: Routledge.
- Hall, D. (2011). Land grabs, land control, and southeast asian crop booms. *J. Peasant Stud.* 38 (4), 837–857. doi:10.1080/03066150.2011.607706
- Haraway, D. J. (2016). *Staying with the trouble: making kin in the chthulucene*. Durham, NC, United States: Duke University Press. doi:10.1215/9780822373780
- Hofman, C. L., Stancioff, C. E., Richards, A., Nanichi Auguiste, I., Sutherland, A., and Hoogland, M. L. P. (2021). Resilient caribbean communities: a long-term perspective on sustainability and social adaptability to natural hazards in the lesser antilles. *Sustain. Sci. Pract. Policy* 13 (17), 9807. doi:10.3390/su13179807
- Hun, S., Isoda, H., Amekaw, Y., and Ito, S. (2017). Factors influencing members' perceptions of success in agricultural cooperatives in Cambodia: a case study in tram kak district, takeo province. *J. Econ. Sustain. Dev.* 8 (6), 1–6.
- IPFCC and CIEL (2020). "Indigenous peoples and traditional knowledge in the context of the UN framework convention on climate change," in *Compilation of Decisions and conclusions Adopted by the Parties to the convention - 2020 update, (the center for international environmental Law)*, 1–15.
- IPCC (2007). *Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II*. NYC, NY, United States: Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 1–22.
- IPCC (2013). "Climate change 2013: the physical science basis. Contribution of working group I," in *Fifth assessment report of the intergovernmental Panel on climate change*. Editors Stocker, T., Qin, D., Plattner, Q.-K., Tignor, M. M. B., Allen, S. K., and Boschung, J. (Cambridge University Press), 1523.
- Kirkbride, M., and Grahn, R. (2008). *Survival of the fittest: pastoralism and climate change in east Africa*. Nairobi, Kenya: Oxfam International.
- Klassen, S., and Evans, D. (2020). Top-down and bottom-up water management: a diachronic model of changing water management strategies at Angkor, Cambodia. *J. Anthropol. Archaeol.* 58, 101166. doi:10.1016/j.jaa.2020.101166
- Klier, G., and Folguera, G. (2017). ¿Caras de una misma moneda? Conservación de la biodiversidad y extractivismo en América Latina. *Let. Verdes Rev. Latinoam. Estud. Socioambientales* 22, 182–204. doi:10.17141/LETRASVERDES.22.2017.2704
- Kohler, T. A., and Rockman, M. (2020). The IPCC: a primer for archaeologists. *Am. Antiq.* 85 (4), 627–651. doi:10.1017/aaq.2020.68
- Kong, R., Diepart, J.-C., Castella, J.-C., Lestrelin, G., Tivet, F., Belmain, E., et al. (2019). Understanding the drivers of deforestation and agricultural transformations in the Northwestern uplands of Cambodia. *Appl. Geogr.* 102, 84–98. doi:10.1016/j.apgeog.2018.12.006
- Kopenawa, D., and Albert, B. (2013). *The falling sky: words of a yanomami shaman*. Harvard University Press. doi:10.4159/harvard.9780674726116
- Lane, P. (2013a). "The archaeology of pastoralism and stock-keeping in east Africa," in *The oxford handbook of african archaeology*. Editors P. Mitchell, and P. Lane (Oxford University Press), 585–601. doi:10.1093/oxfordhb/9780199569885.013.0040
- Lane, P. (2013b). "Trajectories of pastoralism in northern and Central Kenya: an overview of the archaeological and environmental evidence," in *Pastoralism in Africa: past, present and future*. Editors M. Bollig, and H. P. Wotzka (NYC, NY, United States: Berghahn Books), 104–144. doi:10.1515/9780857459091-007
- Lankester, F., and Davis, A. (2016). Pastoralism and wildlife: historical and current perspectives in the East African rangelands of Kenya and Tanzania. *Revue Sci. Tech.* 35 (2), 473–484. doi:10.20506/rst.35.2.2536
- Leakey, M. D., Leakey, L. S. B., Game, P. M., and Goodwin, A. J. H. (1943). Report on the excavations at hyrax hill, nakuru, Kenya colony, 1937–1938. *Trans. R. Soc. S. Afr.* 30 (4), 271–409. doi:10.1080/00359194309519847
- Levis, C., Flores, B. M., Campos-Silva, J. V., Peroni, N., Staal, A., Padgurschi, M. C. G., et al. (2024). Contributions of human cultures to biodiversity and ecosystem conservation. *Nat. Ecol. and Evol.* 8 (5), 866–879. doi:10.1038/s41559-024-02356-1
- Lind, J., Sabates-Wheeler, R., Caravani, M., Kuol, L. B. D., and Nightingale, D. M. (2020). Newly evolving pastoral and post-pastoral rangelands of Eastern Africa. *Pastoralism* 10 (1), 24. doi:10.1186/s13570-020-00179-w
- Lucero, L. J., Fletcher, R., and Coningham, R. (2015). From 'Collapse' to urban diaspora: the transformation of low-density, dispersed agrarian urbanism. *Antiquity* 89, 1139–1154. doi:10.15184/aqy.2015.51
- MAFF (2015). Annual report for agriculture, forestry and fisheries 2014–2015 and direction 2015–2016. Phnom Penh.
- Marshall, F., Reid, R. E. B., Goldstein, S., Storozum, M., Wreschnig, A., Hu, L., et al. (2018). Ancient herders enriched and restructured African grasslands. *Nature* 561 (7723), 387–390. doi:10.1038/s41586-018-0456-9
- Moore, J. W. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *J. Peasant Stud.* 44 (3), 594–630. doi:10.1080/03066150.2016.1235036
- Morgan, W. T. W. (1963). The "white highlands" of Kenya. *Geogr. J.* 129 (2), 140–155. doi:10.2307/1792632
- Muchiru, A. N., Western, D. J., and Reid, R. S. (2008). The role of abandoned pastoral settlements in the dynamics of african large herbivore communities. *J. Arid. Environ.* 72 (6), 940–952. doi:10.1016/j.jaridenv.2007.11.012
- Mutundu, K. K. (2010). An ethnoarchaeological framework for the identification and distinction of Late Holocene archaeological sites in East Africa. *Azania Archaeol. Res. Afr.* 45 (1), 6–23. doi:10.1080/00672700903291724
- Notenbaert, A. M. O., Davies, J., De Leeuw, J., Said, M., Herrero, M., Manzano, P., et al. (2012). Policies in support of pastoralism and biodiversity in the heterogeneous drylands of East Africa. *Pastor. Res. Policy Pract.* 2 (1), 14. doi:10.1186/2041-7136-2-14
- Olivier, M. (1954) "Le régime domanial et foncier," in *Phnom Penh: Missions Francaises aupres des Juridictions Judiciaires Khmères*.
- Orlove, B., Dawson, N., Sherpa, P., Adelekan, I. O., Alangu, W., Carmona, R., et al. (2022) "Intangible cultural heritage, diverse knowledge systems and climate change," in *International Co-sponsored meeting on culture, heritage and climate change*, 108.
- Penny, D., Hall, T., Evans, D., and Polkinghorne, M. (2019). Geoarchaeological evidence from Angkor, Cambodia, reveals a gradual decline rather than a catastrophic 15th-century collapse. *Proc. Natl. Acad. Sci. U. S. A.* 116 (11), 4871–4876. doi:10.1073/pnas.1821460116
- Pohl Schnake, V., and Coppiarolo, L. (2019). Proyectos REDD y conflictos socio-ambientales: contribuciones para su análisis desde la Geografía Crítica y Ecología Política. *Actas Univ. Nac. La Plata. Fac. Humanidades Ciencias la Educ.*, Available at: [https://www.memoria.fahce.unlp.edu.ar/trab\\_eventos/ev.13626/ev.13626.pdf](https://www.memoria.fahce.unlp.edu.ar/trab_eventos/ev.13626/ev.13626.pdf).
- Porensky, L. M., and Veblen, K. E. (2015). Generation of ecosystem hotspots using short-term cattle corrals in an african savanna. *Rangel. Ecol. and Manag.* 68 (2), 131–141. doi:10.1016/j.rama.2015.01.002
- Prendergast, M. (2011). "Hunters and herders at the periphery: the spread of herding in eastern Africa," in *People and animals in Holocene Africa: recent advances in archaeozoology*. Editors H. Jousse, and J. Lesur (Frankfurt: Africa Magna Verlag), 43–58.
- Roberts, P., Kaplan, J. O., Findley, D. M., Hamilton, R., Caetano-Andrade, V. L., Amano, N., et al. (2023). Mapping our reliance on the tropics can reveal the roots of the Anthropocene. *Nat. Ecol. and Evol.* 7 (5), 632–636. doi:10.1038/s41559-023-01998-x
- Saunders, N. J. (2005). *The peoples of the caribbean: an encyclopedia of archaeology and traditional culture*. NYC, NY, United States: Bloomsbury Publishing USA.
- Shahack-Gross, R., Simons, A., and Ambrose, S. H. (2008). Identification of pastoral sites using stable nitrogen and carbon isotopes from bulk sediment samples: a case study in modern and archaeological pastoral settlements in Kenya. *J. Archaeol. Sci.* 35 (4), 983–990. doi:10.1016/j.jas.2007.07.002
- Stephens, T. (2023). The kunming–montreal global biodiversity framework. *Int. Leg. Mater.* 62, 868–887. doi:10.1017/ilm.2023.16
- Stephenson, T. S., and Jones, J. J. (2017). Impacts of climate and extreme events in the coastal and marine environments of caribbean small island developing States (SIDS). *Caribb. Clim. Change Rep. Card Sci. Rev.* 2017, 10–22.
- Storozum, M. J., Goldstein, S. T., Contreras, D. A., Gidna, A. O., Mabulla, A. Z. P., Grillo, K. M., et al. (2021). The influence of ancient herders on soil development at Luxmanda, Mbulu Plateau, Tanzania. *CATENA* 204, 105376. doi:10.1016/j.catena.2021.105376
- Sutton, J. (1998). Hyrax hill and the later archaeology of the central Rift Valley of Kenya. *Azania Archaeol. Res. Afr.* 33, 73–112. Available at: <https://www.africabib.org/rec.php?RID=P00054538>. doi:10.1080/00672709809511465
- Svampa, M. (2019) "Neo-extractivism in Latin America: socio-environmental conflicts, the territorial turn, and new political narratives," Cambridge University Press. *Elements in Politics and Society in Latin America*. doi:10.1017/9781108752589

Thomas, F. (1999). Histoire du régime et des services forestiers français en Indochine de 1862 à 1945.

UNFCCC (2017) "Local communities and indigenous peoples Platform: decision 2/CP.23," in *The conference of Parties: UN climate change conference*. Available at: <https://unfccc.int/documents/65126>.

UNFCCC (2022a). Global Stocktake secretariat synthesis reports and addendas. *U. N. Framew. Convention Clim. Change*. Available at: <https://unfccc.int/global-stocktake-secretariat-synthesis-reports-and-addendas>.

UNFCCC (2022b) "Sharm el-sheikh implementation plan: decision 1/CP.27," in *The conference of Parties*. Available at: <https://unfccc.int/documents/624444>.

United Nations (1993). Convening of a global conference on the sustainable development of small island developing States. 47th session of the general assembly.

Ventresca Miller, A. R., Spengler, R., Haruda, A., Miller, B., Wilkin, S., Robinson, S., et al. (2020). Ecosystem engineering among ancient pastoralists in northern central Asia. *Front. Earth Sci.* 8. doi:10.3389/feart.2020.00168

Whittlesey, D. (1953). Kenya, the land and mau mau. *Foreign Aff.* 32 (1), 80–90. doi:10.2307/20031009

Zhou, D. (2007). in *A record of Cambodia: the land and its people*. Editor P. Harris doi:10.5860/choice.45-6950Silkworm Books.