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FORUM

Geospatial Science

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Geographic information system (GIS) applications have grown from being the prime tool of early, computational archaeological minds to an essential component of standard recording, archiving, and modeling spatial data in archaeology. Recently, GIS has supported the expansion of airborne photography, satellite imagery, multidimensional visualization, and modeling applications, amplifying the reach and scope of geospatial approaches in African archaeology —a trend also manifested in this journal (Gokee & Klehm, 2022). Much has been achieved. I do wonder, and occasionally worry, about the spatiotemporal specificity of correlating archaeological records to present-day environmental conditions (and the ever-present specter of equifinality), as well as the drivers and ethics of creating and managing spatial data.

Pioneering spatial analysis in southern Africa, Sinclair (1987) demonstrated how different environmental factors usually considered influential in the location of sites/monuments, such as geology, climate, and vegetation, can have different magnitudes of effect. Not only do different environmental factors shape biotic and abiotic processes across varying cycles, but there is also the question of human choice and preference, the *ukama* (or relatedness, cf. Le Grange, 2012) of ecological and cultural factors, and how these are accounted for when using spatial data to explain past developments (cf. Chami, 2015). If environmental parameters can influence record distribution, socio-cultural factors might shape the space between records and their internal organization (e.g., Sinclair, 1987, 2004). The relation between archaeological records and environmental conditions is neither linear nor causative: some environmental parameters are more clearly differentiated at large scale (e.g., geology), and others might exert greater influence on human needs and choices at local or micro-scale (e.g., slope). Which present-day environmental parameters correlate to past records?

While we grapple with the complexities of past spaces, we must cherish the growth of teaching and training in geospatial methods across African universities, with GIS featuring in archaeology curricula for decades now, often via combined degrees in Archaeology and Geography/Environmental Sciences. Reflecting on geospatial education and applications in archaeology and heritage, I sense (with some frustration) an oversight of the growth and innovation of geospatial technologies across environmental, computational, economic, and social sciences in Africa and for Africa. Geospatial intelligence seems to be driving a revolution in how African researchers and institutions address global challenges (e.g., AfricaGeoPortal, Digital Earth Africa, EIS-Africa). This is producing a literature that does not seem to have much traction in archaeology, and the absence of archaeological/heritage contributions in Africa's geospatial fora (e.g., AfricaGIS) is concerning, to say the least. These fora connect and inform development agendas,

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policy, and decision-making across institutional, governmental, and international spheres.

Echoing this journal editor's inaugural remarks, I think geospatial approaches to African heritages share the mandate to "…be attentive to the kinds of archaeology [and other disciplines] that African institutions are developing" (Ogundiran, 2019). Much geospatial archaeological work remains focused on questions about the past, and those applications that engage with present-day issues seldom move beyond descriptive contributions: e.g., this site is being destroyed by erosion; urban expansion is threatening this monument, etc. Can geospatial archaeological data and approaches do more? Can they inform practices for monitoring, preserving, and expanding cultural and environmental resources? There is some *inertia*, I think, in agenda setting rather than analytical or resource constraints. The pioneering approaches developed since the 1960s, together with new applications, have shown the effectiveness and versatility of geospatial archaeological tools to reach beyond mapping human footprints on African soil to capture energy regimes and resource uses (Harrower et al., 2020; Kabora et al., 2020; Pikirayi et al., 2022; Sinclair, 2004), enable predictive modeling (Klehm et al., 2019; Thabeng et al., 2019) , and unlock biocultural heritages (Ochungo et al., 2022).

Developing digital databases and archives is now a priority for national heritage institutions across the continent. Geospatial archaeological tools are key to the efforts of African heritage institutions in handling, creating, and preserving national records. Digitization of survey and excavation records and museum holdings is still very limited, though advancing on a country-scale level (e.g., Katsamudanga, 2021). At an interregional scale, three digital mapping programs led by European institutions are collaborating with national institutions to document sites and monuments across different African countries. These include *Endangered Archaeology in the Middle East and North Africa* (EAMENA) and its partner project *Maritime Endangered Archaeology in the Middle East and North Africa* (MarEA), as well as *Mapping Africa's Endangered Archaeological Sites and Monuments* (MAESaM) in sub-Saharan Africa.

Do local communities dwelling in landscapes, regions, and sites have a stake in mapping, documenting, and modeling archaeological and heritage records? Who owns geospatial data? Who can access it? These remain open questions in emerging discussions on the ethics of collecting and handling spatial data across disciplines within and beyond Africa (e.g., Davis & Sanger, 2021; Gokee & Klehm, 2022). I like to think archaeology in Africa can make a transformative impact by bridging its own camps and reaching out beyond its trenches. GIS participatory mapping, for example, has proven to be a powerful tool to engage local communities and knowledge systems for building community heritages (Kleinitz & Merlo, 2014; see also Ichumbaki et al., 2023). Among other promising geospatial tools, digital curations and story maps remain limited to pioneering work on Tswana towns (http://www.metsemegologolo.org.za)—to the best of my knowledge. In the first story map of an ancient African town, the biography of Seoke unfolds through mapping, 3D modeling, and visual and textual records that make material culture and oral traditions speak, alluring visitors without compromising on archaeological accuracy. With mobile broadband coverage expanding (already outpacing mobile usage), story mapping can connect and disseminate local pasts and knowledge systems across and beyond Africa.

With these developments, geospatial science might drive the contribution of archaeology to Agenda 2063's aim to optimize the use of Africa's cultural and environmental resources for the benefit of all.

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