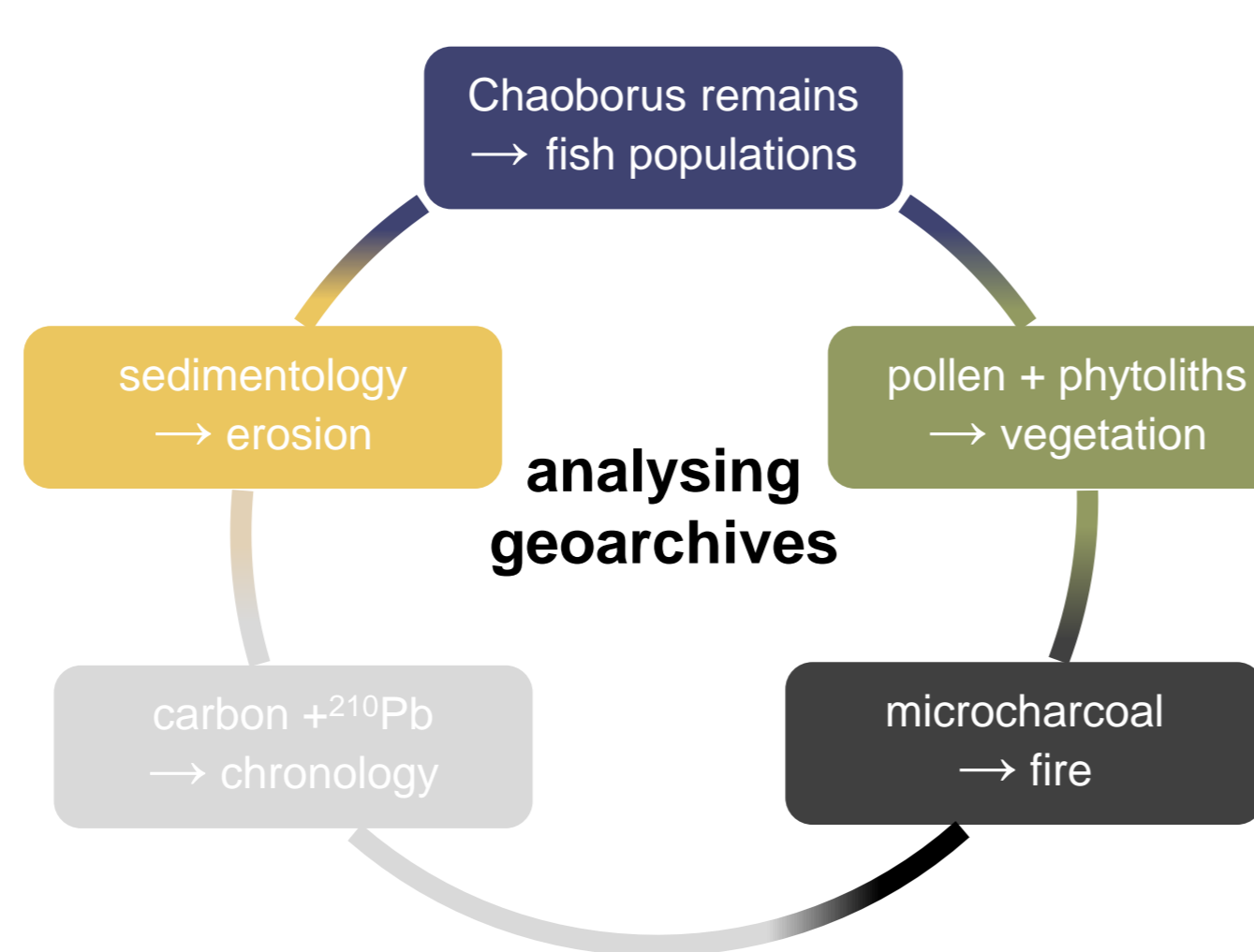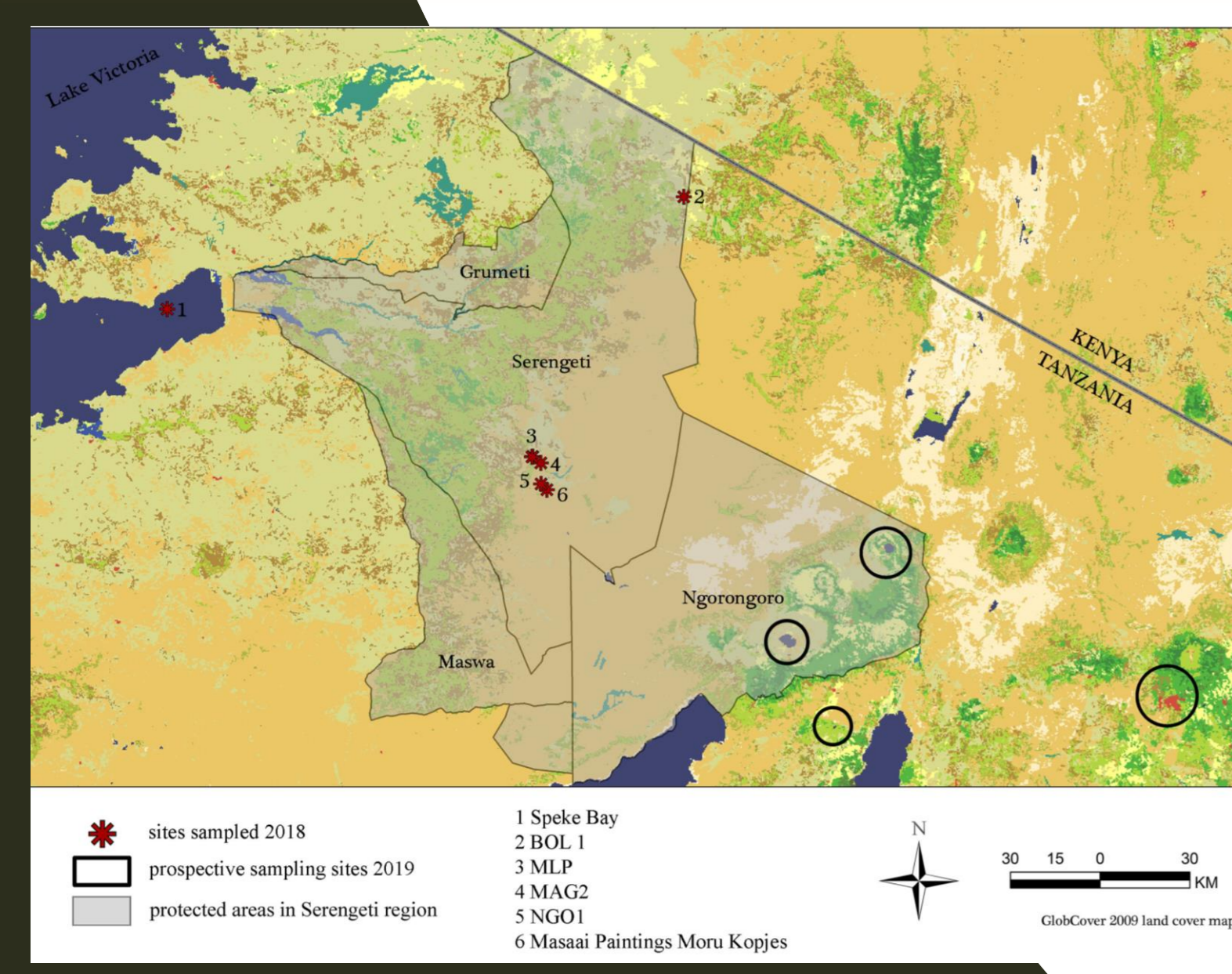# Adaptation & Resilience to Climate Change in eastern Africa project

Introducing ARCC

The occurrence of atypical weather extremes, linked to anthropogenic climate change, are increasing in frequency and magnitude. Unpredictable environmental conditions within and around the **Greater Serengeti Ecosystem** (GSE) in Tanzania present complications to future economic development, food security, socio-political functioning, human health and biodiversity. Adding to these complications is the fact that existing conservation and sustainable development policies are compromised by a lack of information on historic climate, land cover and land use dynamics. The ARCC project addresses this challenge by collating and generating new data on how people and landscapes in the GSE have responded to changes in socio-economic and environmental conditions over the last 300 years. Additionally, ARCC will combine local perspectives with the 'expert' data sets the project is producing to better assess how varied land use strategies will either lead to the realisation or dissolution of socio-economic development goals and sustainability targets. The ARCC project will apply a novel methodological approach called KESHO to analyse diverse future land use scenarios. Using the KESHO framework, qualitative, quantitative and spatial outputs of future land use in the GSE will be developed both *for* and *by* researchers, policy makers, and local stakeholders to improve the breadth of engagement and level of knowledge directed towards charting more resilient and adaptive paths to the future.

analysing geoarchives

- Chaoborus remains → fish populations
- pollen + phytoliths → vegetation
- microcharcoal → fire
- carbon +^{210}Pb → chronology
- sedimentology → erosion

The ARCC approach

ARCC aims to enhance understanding of the variable degrees of resilience among human and wildlife populations within and adjacent to a key Protected Area network in Tanzania, and to facilitate the transfer of this knowledge to diverse audiences including researchers, stakeholders, and policy makers at local, national and global levels. To achieve these ambitious scientific and training objectives the ARCC project takes a multi-disciplinary approach with a core team comprised of palaeoecologists, ecologists, archaeologists and scenario analysts.
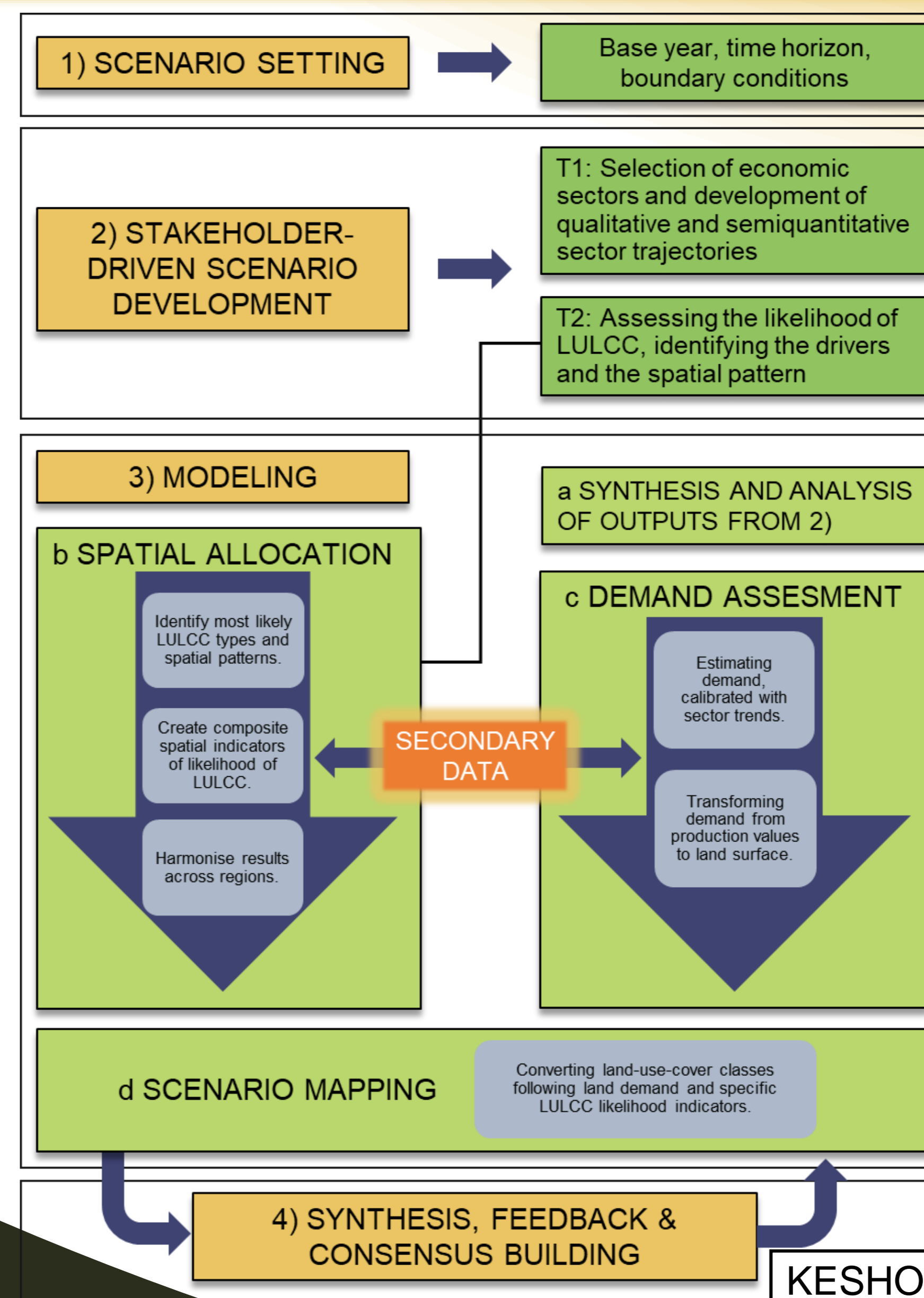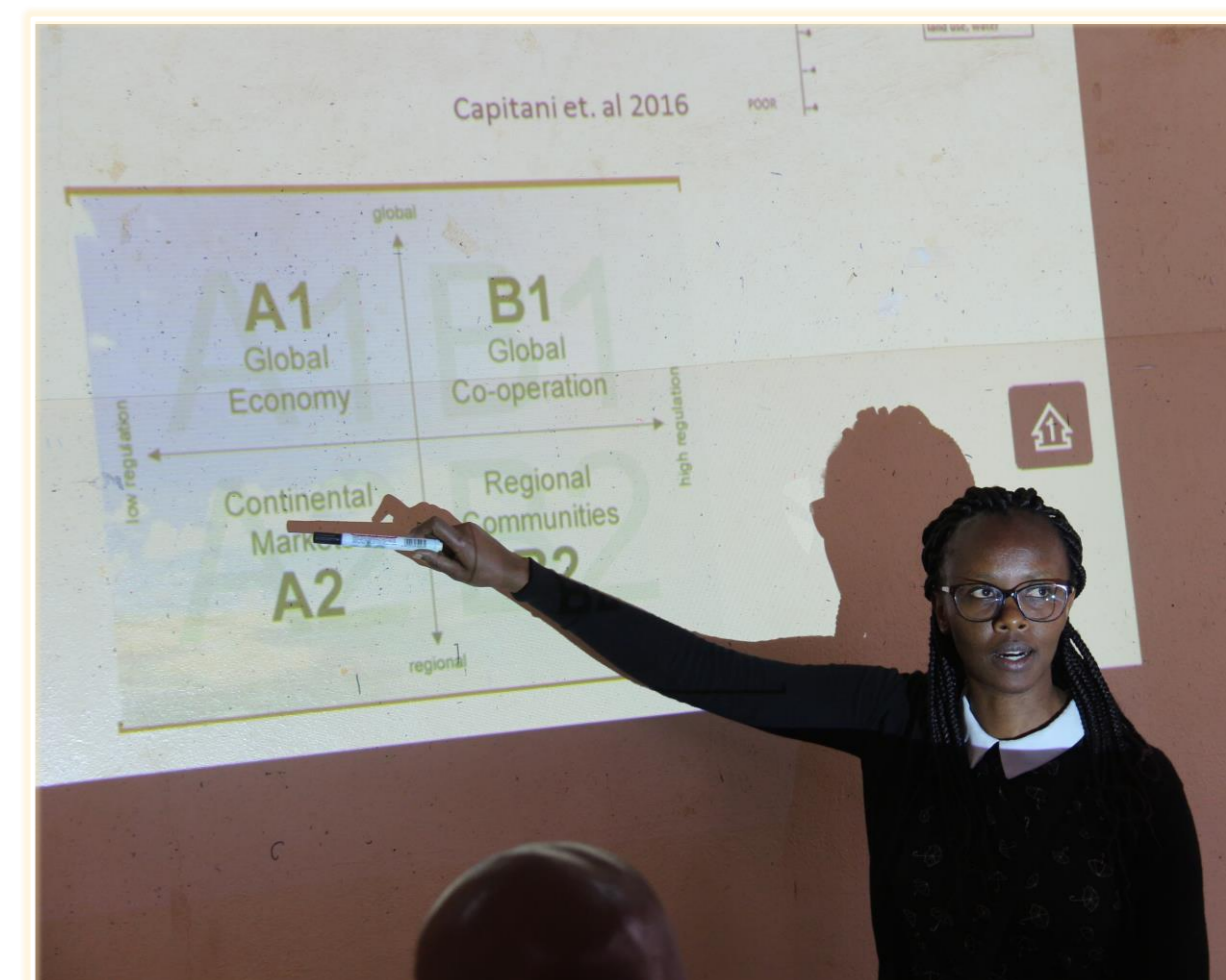
← Figure modified from Capitani, C. et al. 2016. From local scenarios to national maps: a participatory framework for envisioning the future of Tanzania. *Ecology and Society*. 21(3): 4.

1) SCENARIO SETTING → Base year, time horizon, boundary conditions

2) STAKEHOLDER-DRIVEN SCENARIO DEVELOPMENT → T1: Selection of economic sectors and development of qualitative and semiquantitative sector trajectories / T2: Assessing the likelihood of LULCC, identifying the drivers and the spatial pattern

3) MODELING
- a SYNTHESIS AND ANALYSIS OF OUTPUTS FROM 2)
- b SPATIAL ALLOCATION: Identify most likely LULCC types and spatial patterns / Create composite spatial indicators of likelihood of LULCC / Harmonise results across regions
- SECONDARY DATA
- c DEMAND ASSESMENT: Estimating demand, calibrated with sector trends / Transforming demand from production values to land surface
- d SCENARIO MAPPING: Converting land-use-cover classes following land demand and specific LULCC likelihood indicators

4) SYNTHESIS, FEEDBACK & CONSENSUS BUILDING

KESHO framework

discussing scenarios and land use trajectories

Palaeoecology

Environmental dynamics operate on a range of scales, including those that extend far beyond the temporal limits of ecological field studies, documentary sources and oral histories. The ARCC project is thus heavily invested in sampling geoarchives from across the GSE, focusing especially on understudied yet ecologically and culturally relevant landscape features. Analysing stratified sediment deposits for pollen, phytoliths, microcharcoal, invertebrate fossils and chemical elements will provide a better understanding of change and continuity in vegetation, hydrology, biodiversity and fire regimes across central northern Tanzania on decadal, centennial and millennial time scales.

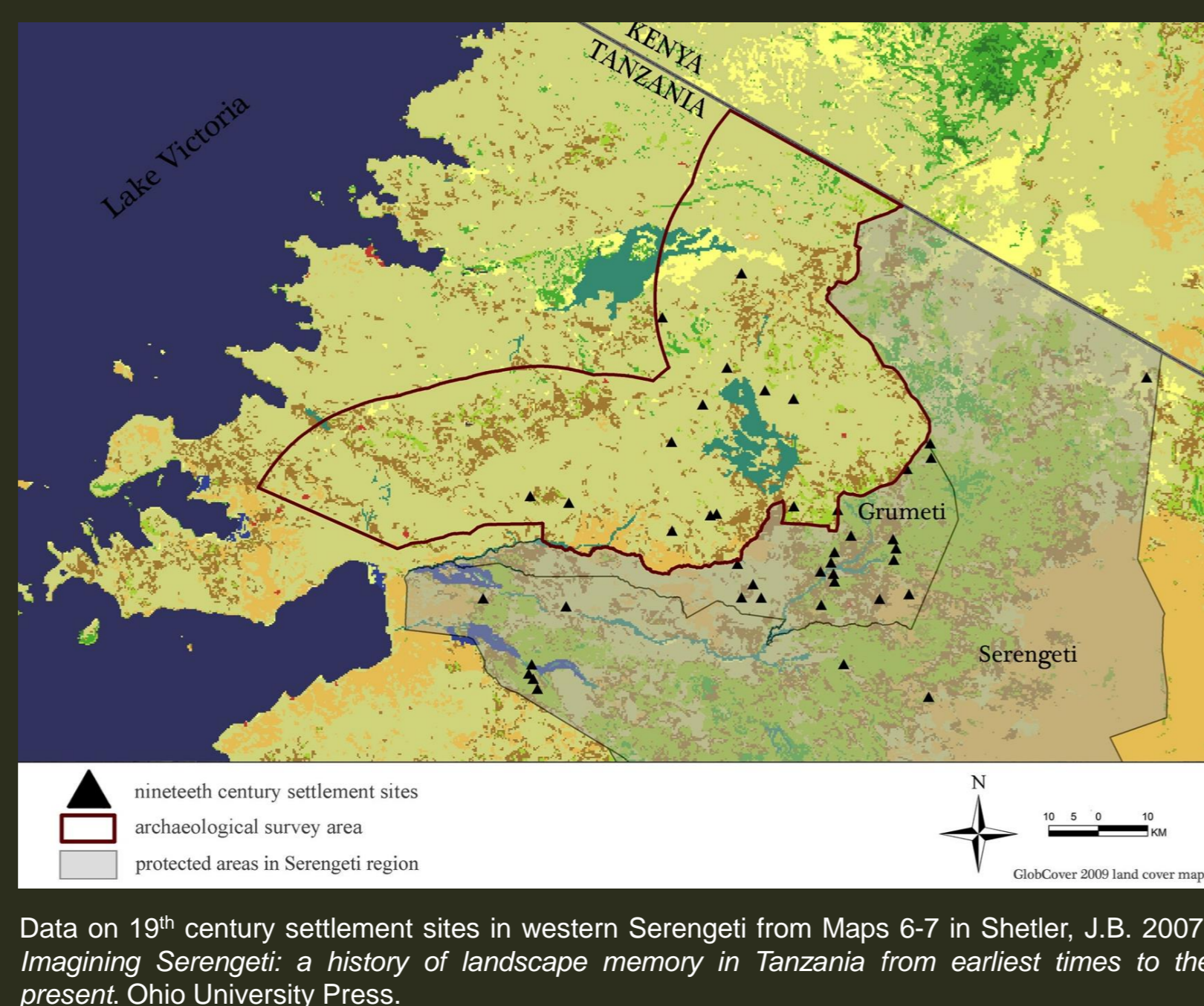exploratory sampling of colluvial sediments in arid lands of Serengeti National Park

collecting palaeoenvironmental samples in Serengeti

Archaeology

To varying degrees of success, people play a key role in transforming the landscapes they inhabit and societies are likewise ever adapting to their changing environments. To better understand the long-term settlement and land use history of the GSE, the ARCC project is conducting systematic archaeological surveys. This fieldwork will entail identifying and characterising material culture, anthropogenic landscape features and test-excavating promising sites in areas that have been devoid of archaeological exploration to date, such as the western Serengeti. Our archaeological results, in combination with archival and oral historical sources will be used to elucidate the changing nature of land use during the late Iron Age and into the colonial period. Ultimately, this research aims to reconstruct the long-term ecological footprints of varied land use strategies and reframe older narratives that portray 'baseline' pre-colonial ecological conditions as essentially devoid of human influence.

locating archaeological remains

Learning about the outcomes and implications of land use change

workshop participants in Karatu

stone tools

aerial historical photos

Data on 19th century settlement sites in western Serengeti from Maps 6-7 in Shetler, J.B. 2007, *Imagining Serengeti: a history of landscape memory in Tanzania from earliest times to the present*. Ohio University Press.

- nineteenth century settlement sites
- archaeological survey area
- protected areas in Serengeti region

Scenario Analysis

Researchers are challenged with exploring and understanding the future of social-ecological systems while addressing their inherent uncertainty. Consequently, scenarios are widely used to explore consistent and realistic narratives of possible future land cover/use patterns, to disseminate co-produced land cover/use change information, to inform policy, and enact positive change. The ARCC project incorporates the KESHO framework for the participatory modelling of 'land use change scenarios'. Insights generated from a series of workshops held in Karatu, Maswa, Mugumo and Amboseli are being used in combination with existing climate projections and ecological data to model potential future land use change trajectories at 2030 and 2063. These date were selected as they connect to the UN Sustainable Development Goals and the African Union Development agendas. The iterative process in which these model outputs are created, which includes their presentation to workshop participants for feedback and recalibration, is facilitating deep consideration of the implications and outcomes of land use change on biodiversity, ecosystem services and human well-being.

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