Themes in Contemporary Archaeology

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Samuel Seuru • Benjamin Albouy Editors

Modelling Human-Environment Interactions in and beyond Prehistoric Europe





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Foreword

Conveying a sense of place and measuring the importance of environmental services for people in the past are difficult tasks. Understanding the relationship between prehistoric and proto historic human populations and the world around them requires the ability to reconstruct key aspects of the palaeoenvironment - from large-scale drivers of environmental conditions, such as climate, to more regional variables such as vegetation cover and faunal communities. Computational archaeology is leading the way in the study of past human-environment interactions across spatial and chronological scales. With the increased availability of highresolution climate models, agent-based modelling, palaeoecological proxies and the mature use of Geographic Information System (GIS) in ecological modelling, archaeologists working in interdisciplinary settings are well-positioned to explore the intersection of human systems and environmental affordances and constraints. These methodological advancements provide a better understanding of the role humans played in past ecosystems - both in terms of their impact upon the environment and, in return, the impact of environmental conditions on human systems. They may also allow us to infer past ecological knowledge and land-use patterns that are historically contingent, rather than environmentally determined. This volume presents contributions that combine reconstructions of past environments and archaeological data with a view to exploring their complex interactions at different scales. We invited scholars from varying disciplines and backgrounds to present and compare different modelling approaches to better grasp the human-environment interactions.

Preface

Interactions between humans and environments are one of the major issues in archaeology. Throughout the past, these relationships may have played a crucial role in population dynamics, dispersals, social organization of groups, or even extinctions. Thanks to advances in computer sciences and the ever-increasing accumulation of environmental data, it is now possible to question these relations with more precise scales.

It is in this context that Ariane Burke and Felix Riede proposed the session "Modelling complexity: past interactions between people, climate and environment" at the Annual Meeting of the European Association of Archaeologists (EAA) in 2021 in Kiel, entitled "Widening Horizons". Due to pandemic restrictions, this session (#297) was also held online. Nevertheless, participants manifested a great interest and initiated very stimulating debates on the suggested topics.

Having contributed to this session as PhD candidates, it seemed important to us that the content of this session goes beyond this virtual event, by proposing to the participants to publish their different contributions in this present volume. This book constitutes a necessary and updated synthesis to address past human-environment interactions in and beyond prehistoric Europe. In this chrono-cultural context, we also decided to integrate contributions of the neighboring session #487 – "A network for agent-based modelling of socio-ecological systems in Archaeology" organized by Philip Verhagen, Dries Daems, and Iza Romanowska. The main objective of the volume is to illustrate the importance of a multidisciplinary approach, bringing together archaeologists', palaeontologists', geographers', geologists', and computational scientists' expertise to address the complex issue of past human-environment interactions. At a time when climate change is a major societal issue, all these contributions demonstrate the role that specific environment variables played on human decision-making but also the impact that human actions may have had on the environment.

The results presented in this volume will be of interest to the scientific community, working on Europe, but also to any reader wishing to adapt these approaches to other chrono-cultural and environmental contexts. It can also be used more widely as educational and illustrative material for undergraduate student interested in European contexts or in these current research dynamics.

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Introduction

Current trends towards a substantial improvement of computer technologies and software suggest that new technological possibilities in archaeology are likely to make significant changes in methodology and theoretical frameworks. Through these new technological possibilities, as recent advances in palaeoclimatic reconstruction using proxy data, advances in climate modelling or modelling methods using machine learning, archaeologists are now able to explore human-environment interactions at an unprecedented resolution in time and space.

Historiographically, archaeology maintains a close relationship with climate and environmental sciences. Throughout human history, environmental change has played a significant role in shaping the course of Hominin evolution, affecting patterns of dispersal, subsistence strategies and cultural transformations. In the meantime, actions of human populations are also recognized as a key factor of environmental transformation. In this volume, we understand the environment in a broad sense as the whole of elements which surrounds an individual or a species and of which some contribute directly to provide its needs. Because of environmental diversity, scientists developed and applied different approaches to study past humanenvironment interactions. With the development of computer technologies during the last two decades, archaeology has benefited from theoretical and methodological advances made in the field of complex system science. Complex systems offer a coherent theoretical framework in which archaeologists can explore interactions between heterogenous or homogenous entities – such as humans and ecological variables. It also allows short- and long-term interactions to be studied.

Hence, we decided to edit a volume which brings together archaeologists using a range of modelling approaches to tackle past human-environment interactions, particularly in and beyond prehistoric Europe. We divided the book in two main sections to clearly explore the diversity of approaches. Indeed, we emphasize two main strategies of modelling which differ from each other in considering and processing the data, known as "top-down" and "bottom-up" approaches. The first section is focused on the "top-down" approach that includes ecological modelling, such as species distribution or habitat suitability models. The second section explores the "bottom-up" approach, and particularly agent-based models.

The "top-down" perspective considers the general observation of a system, dividing it into a maximum of simpler elements, called predictors, in order to understand the influence of each element on the system. In the specific case of ecological modelling, predictors that potentially affect spatial behaviour of a target species are identified. Each of these predictors are then tested to understand their influence on the distribution of the species in question and thus its population's structure. This approach has proven to be particularly useful to study human interactions with the palaeoenvironment. Part I of this volume presents several contributions illustrating the relevance of this perspective to explore a broad diversity of questions related to human-environment relationships in the European domain and its margins. A main step is to define a palaeogeographical framework. Chapter "Refloating the Aegean Lost Dryland: An Affordance-based GIS Approach to Explore the Interaction Between Hominins and the Palaeolandscape" (Tsakanikou and McNabb) perfectly illustrates the importance of palaeogeographical reconstructions considering sea-level variations influenced by tectonic evolution and glacial/interglacial cycles. At the crossroads between Africa, Europe and Asia, the Aegean region offers an opportunity to the authors to present GIS-based (Geographic Information System) suitability analysis and predictive modelling of human biogeography dynamics in Pleistocene and discuss their importance in terms of early human settlement patterns. Another method considered in this volume is habitat suitability modelling. Environmental predictors are tested to understand their influence on species distribution and then its population's structure. Chapter "The Last of Them: Investigating the Palaeogeography of the Last Neanderthals in Europe (Marine Isotopic Stage 3)" (Albouy et al.) addresses the application of such an approach in Middle Palaeolithic to investigate last Neanderthal palaeogeography in Europe during Marine Isotopic 3 (MIS 3: 60-27 ky BP), a period of high climatic instability, coinciding with their extinction. The authors propose a methodology combining chronometric and palaeoenvironmental data to classify the occupations of the territory between cold and warm phases within this period. As a conclusion, the authors highlight the importance of data selection preceding the process of modelling. Applying the same methodology, Chapter "Going New Places: Dispersal and Establishment of the Aurignacian Technocomplex in Europe During the Marine Isotopic Stage 3 (MIS 3)" (Paquin et al.) explores on the contrary the impact of the specific climatic changes of MIS 3 on the anatomical modern humans first dispersal in Europe, through Protoaurignacian and Early Aurignacian technocomplexes. The results allow new diachronic observations on demography and population dynamics in relation to the drastic environmental changes taking place in Europe at this time. Chapter "The Impact of Magdalenian Hunter-Gatherers on Their Environment" (Gravel-Miguel) investigates the possibility that hunter-gatherers impacted the environment and the resources on which they relied. The author reconstructs prehistoric biomes of Southwest Europe in which Magdalenian hunter-gatherers may have lived. Then, the main goal is to compare the results with archaeological pollen records. It is fundamental to not forget that all these new computational methods are mainly used to test and challenge narratives and hypotheses. Finally, Chapter "Modeling the Cultural Landscape of Early Farmers on the Fringe of the Great Eurasian Steppe: A Case Study from the Middle Southern Buh River Basin in the 6th–5th Millennium BC" (Kiosak and Radchenko) focuses on a more recent period, investigating how the climatic zone of the North Pontic Steppe in Eastern Europe influenced the configuration of new sites that emerged during the spread of agriculture into this region. The authors illustrate the necessity to consider a multiproxies approach for exploring human palaeogeography. Altogether, these chapters demonstrate the importance of "top-down" modelling techniques as tools for contextualizing past human-environment interactions in both ways.

Part II explores the potential of "bottom-up" approaches to decipher the complex processes that shaped our ancestors' behaviour. One definition lying behind this approach is that population-level patterns will emerge from actions and interactions of heterogeneous agents (e.g., hunter-gatherers, mammals, dwellings). Emergent patterns may be non-intuitive and may also have a retroaction on agents' behaviours and interactions. One type of computer simulation that uses this strategy to test hypotheses about complex phenomena is called agent-based modelling (ABM). Therefore, ABM offers a powerful tool to comprehend dynamics of a system that can be better understood by focusing on known low-level individuals' behaviour. Before exploring how ABM can be a useful tool for past human-environment interactions, it is fundamental to begin with a discussion about agency, as proposed by Ertsen et al. in Chapter "Modelling Gaia: Towards an Actor-Network Modelling Framework in Archaeology". Agent activities are the core in such models. These activities may be the result of too much pre-

structuring, however. Discussing examples on the Ancient Near East and Netherlands, this contribution explores how the Gaia approach as provided by the French scholar Latour allows the comparison between cases with different spatial and temporal scales. In Chapter "Why Were Rabbits Hunted in the Past? Insights from an Agent-Based Model of Human Diet Breadth in Iberia During the Last Glacial Maximum", Seuru et al. use ABM to test specific archaeological hypotheses about human foraging behaviour based on behavioural ecology theory. The authors seek to reconstruct key aspects of hunting behaviour, such as small game hunting, for past human populations living in Iberia around the Last Glacial Maximum. The theoretical core of this chapter, which is derived from optimal foraging theory, i.e., the Diet-Breadth Model, is used to build the model. Although ABM is perfectly adapted to analyse huntergatherer societies during Prehistory, it is also a useful tool to study more recent and sedentary societies. Chapter "Modeling the Landscape Evolution and Land-Use in Early Bronze Age at Hacılar Büyük Höyük, in Southwest Anatolia" (Bülent and Özdoğru) explores long-term patterns of socio-economic and demographic changes on the site of Hacılar (Burdur region, Turkey) in Southwest Anatolia, a major settlement during the Early Bronze Age I (ca. 3100– 2900 BC). Combining palaeoenvironmental regional data with ABM, the authors discuss how dry farming, ovicaprid-based and site-tethered pastoralism affected the immediate landscape around the site. Another example of exploring the impact of more recent societies upon environment through ABM is shown in Chapter "The Power of Emergence: The Effects of Bottom-Up Decision-Making in Resource Exploitation Strategies on Community Sustainability in Iron Age to Hellenistic Anatolia" (Daems and Boogers). The authors test the hypothesis that Iron Age populations were the main drivers of environmental change between 900 and 200 BC in Sagalassos (Southwest Turkey). The combination of a GIS and ABM offers the opportunity to simulate different resource exploitation strategies regarding raw material such as agricultural product, clay or wood. The simulations are compared with regional environmental data, allowing further discussion of the historical trajectory of human impact on the environment. Finally, and still in this line of research, Chapter "Exploring Environmental Determinism with Agent-Based Simulation of Settlement Choice" (Sikk et al.) clearly details environmental determinism. A significant component of archaeological interpretations is the influence of environment on social processes. Thanks to ABM, the author investigates possible spatial and systemic effects from environmental influence on settlement choice. It is argued that environmental determinism is a valuable information that can be used as an indication of systemic properties in the past.

This volume demonstrates the benefits of multidisciplinary perspectives and modelling approaches in archaeology to contextualize social, technological and economic evolution within the environment. We argue it is the necessary step to better decipher the black box of complex interactions between people, climate and environment at an unprecedented temporal and spatial resolution. Besides, it explores how archaeologists can test hypotheses through "top-down" and "bottom-up" approaches that analyse the role of climate change and environmental transformations in shaping past human behaviour and vice versa. Nevertheless, results obtained in the different chapters show that these two main approaches should not be considered as antithetical but as ways to mobilize several types of evidence to test a set of hypotheses about human-environment interactions in the past. More importantly, as these two perspectives are mutually compatible, they should be used as complementary and retroactive tools to improve their possibilities of exploring archaeological and anthropological issues. We consider this complementarity as the next major step for future studies focused on modelling past human-environment interactions.

Finally, reasons to focus on human-environment interactions are two-fold. On the one hand, these issues have always been a central focus in archaeology providing a context for understanding long-term and short-term evolutionary processes in the human past. On the other hand, environment and climate are omnipresent in contemporary public discourse. We hope this volume provides new insights about how human decisions interfere with environment, especially during the current climate crisis we are facing.

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