Modelling the Pleistocene Peopling of Cyprus

Theodora Moutsiou[i], Athos Agapiou[ii], Christian Reepmeyer[i,iii], Vasiliki Kassianidou[i], Stella Demesticha[i]

Zomenia Zomeni[iv], Corey J. A. Bradshaw[v]

[i]Archaeological Research Unit, University of Cyprus, Cyprus

[ii]Earth Observation Cultural Heritage Research Lab, Department of Civil Engineering and Geomatics and Eratosthenes Centre of Excellence, Cyprus University of Technology, Lemesos, Cyprus

[iii]Commission for Archaeology of Non-European Cultures (KAAK), German Archaeological Institute, Germany

[iv]Geological Survey Department, Ministry of Agriculture, Rural Development and the Environment of the Republic of Cyprus, Cyprus

[v]Global Ecology, College of Science and Engineering, Flinders University, Australia

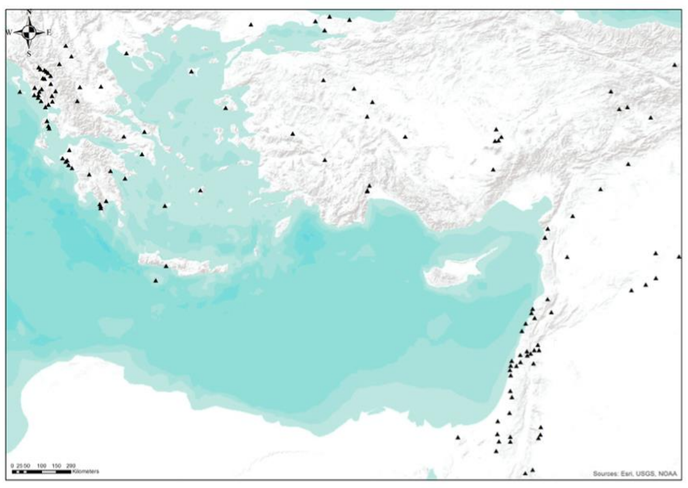
Part of project MIGRATE in connection with projects PLEICY and PLACe. MIGRATE is implemented under "Excellence Hubs" Programme (contract EXCELLENCE/0421/0050) of the RESTART 2016-2020 Programmes for Research, Technological Development and Innovation, administered by the Research and Innovation Foundation of Cyprus.

Introduction

A pre-Neolithic peopling of Cyprus is often dismissed on the argument that the Mediterranean Sea was a barrier to early human movement and that islands in the region were too impoverished to have sustained non-agricultural societies[1]. The technological capacity of early humans for maritime crossings is now demonstrated globally (e.g.,[2]). Although Cyprus was never connected to the mainland, sea crossings from the neighbouring Levantine coast would have involved navigating distances as little as 30–70 km depending on episode of marine regression. Visible from many continental regions, Cyprus was also a direct, and potentially, attractive target for the populations occupying coasts to move to and explore[3]. Considering that the continental regions of the Eastern Mediterranean were populated by hunter-gatherer groups adapted to coastal living and maritime travel, and with direct access to Cyprus during the Late Pleistocene (45–12 kya), it is important to investigate the timing and nature of the initial peopling of Cyprus to determine the context of Eastern Mediterranean island colonisation, ecological niche creation, and coastal adaptation.

Pleistocene record of Cyprus

Recent advances in the study of island peopling showing the scale of hunter-gatherer interactions with maritime resources and island landscapes (**Fig. 1**), require revisiting the question of a potential Pleistocene human presence on Cyprus. Unequivocal evidence of material culture of this period in Cyprus is so far largely absent (**Fig. 2 & 3**), but recent research concluded that an earlier colonisation of the island is plausible[3] (and references therein).



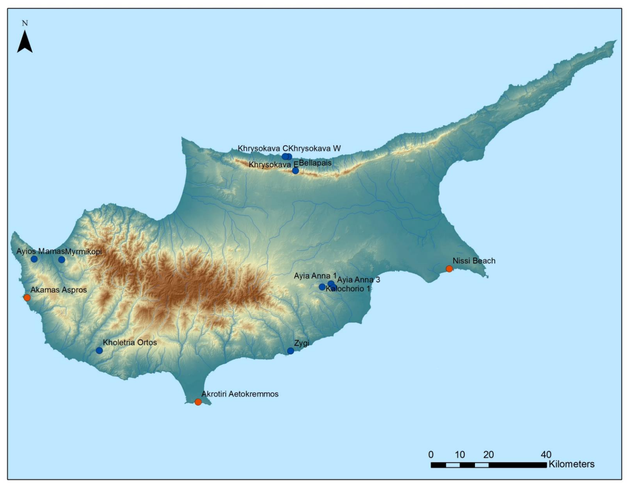


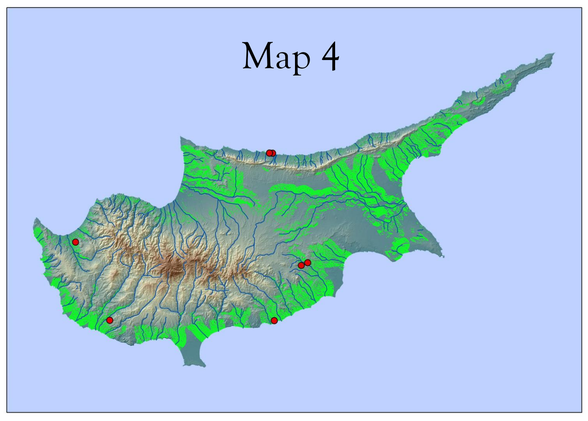
Figure 3. Lithic artefacts from Cyprus of a potential Pleistocene age.

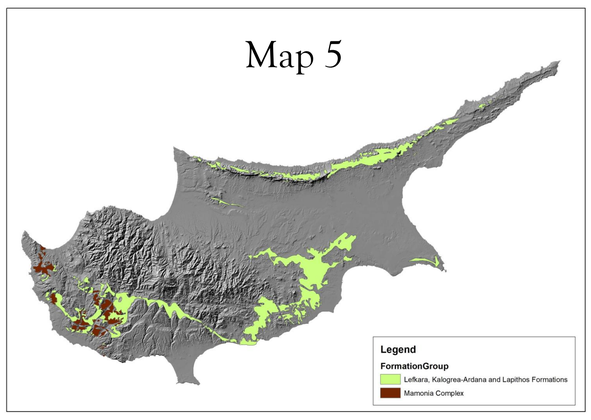
Figure 1 (left). Pleistocene archaeological sites in the circum-Cyprus Eastern Mediterranean region (detailed list of sites[4]).

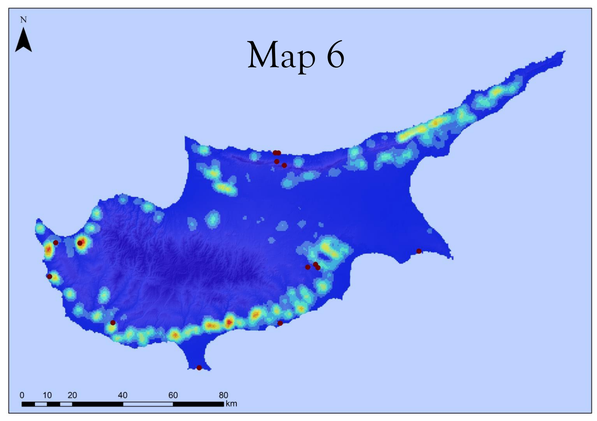
Figure 2 (right). Terminal Pleistocene sites and legacy Palaeolithic surface lithic assemblages from Cyprus. Compiled in ArcGIS with digital elevation model data from the Land and Surveys Department of the Republic of Cyprus[4].

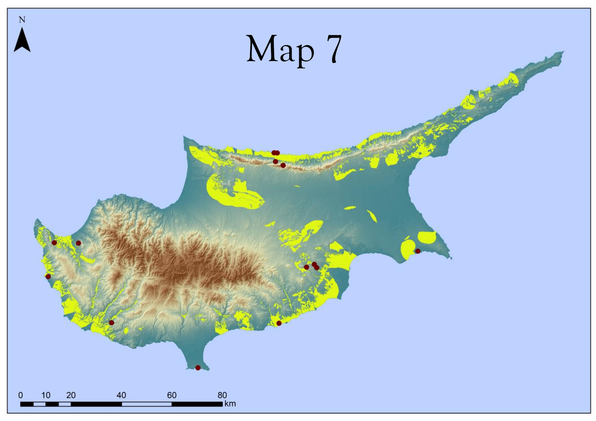
Suitability model

We modelled the surface probability of potential Pleistocene archaeological locales on the island of Cyprus using Boolean geometry, proximity estimation, and similarity analysis. The models include landscape characteristics that denote areas with high potential to unearth Pleistocene archaeology. Characteristics of the Cypriot landscape that would have been attractive to early humans include proximity to freshwater sources (rivers, springs), availability of raw material sources (lithology, Quaternary geology), and topographical features such as slope, aspect, low elevation, and short distances to coasts. We did spatial analyses at two main scales: local and regional. Our analyses show that distance from water and raw material sources would have been important parameters for site selection (**Fig. 4–7**).









Figures 4–7. Map (**4**): location of rivers and high-probability areas (green) for the preservation of Pleistocene archaeology. Map (**5**): location of chert-bearing formations (geology parameter). Map (**6**): probability of sharing similar attributes with those of the fifteen earliest-known archaeological sites of Cyprus based on single-class classification analysis using the spectral angle mapper classifier. Map (**7**): final prediction of potential site probability taking into account slope, elevation, aspect, distance from coast, and rivers, as well as Pleistocene terrestrial geology and availability of raw materials (green zone). Dark red dots indicate locations of known early archaeological sites[4].

Field survey

We did a preliminary research-based field survey as a spatially explicit island-scale assessment of the opportunities for Pleistocene human occupation of Cyprus. Reconnaissance surveys targeted both the coastal zone and island interior, while also focusing on specific topographic features, including rockshelters, rivers, and Pleistocene-aged deposits. We identified and recorded surface lithic scatters and isolated finds in various localities (**Fig. 8**), confirming the expectations of the spatial model. Based on a preliminary study of their morphological-typological characteristics, these chert stone tools likely range chronologically from at least the Terminal Pleistocene to the Early Holocene (**Fig. 9–11**).

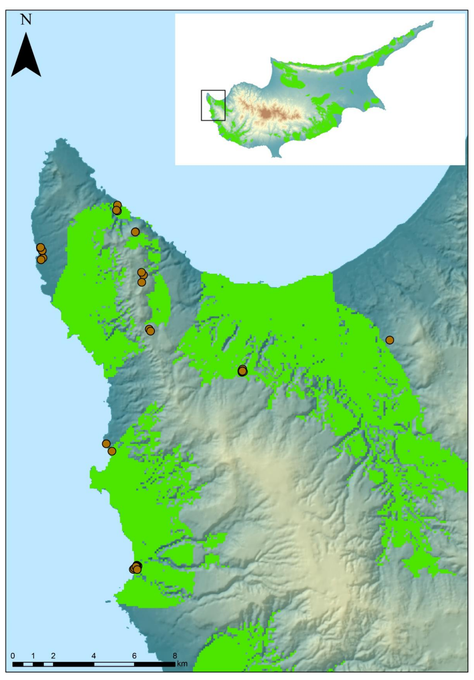
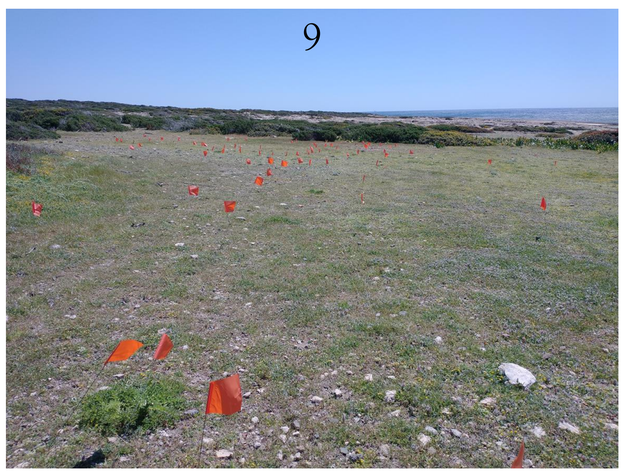


Figure 8. Archaeological localities identified during field surveys in the region of Akamas based on model predictions. Archaeological localities identified during field surveys superimposed over predictive map (green area). Insert shows location of surveyed region.



Figures 9–11. Surface lithic scatters and examples of Terminal Pleistocene–Early Holocene lithic artefacts recorded on Cyprus.

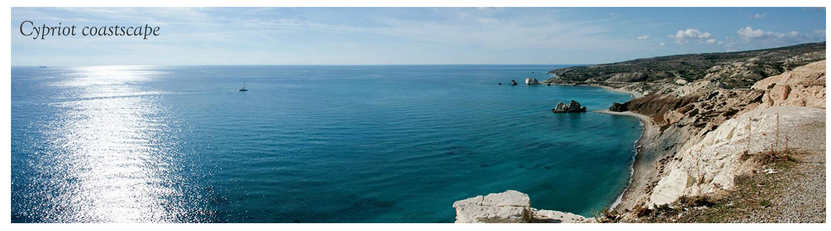
Human demography

Project MIGRATE will expand this preliminary work by (a) including modelled population dynamics and range shifts that likely produced dispersals from the Eastern Mediterranean mainland to the island of Cyprus during the Late Pleistocene (i.e., 45–12 kya), and (b) modelling* the plausible demographic context (minimum viable population size) of the founding populations that would have been necessary for the persistence of hunter-gatherer populations on Cyprus. MIGRATE will test hypotheses regarding entry points, sequence and timing of entry, and the relationship to carrying capacity for the first anatomically modern humans to people the island of Cyprus by constructing a cellular-automaton model in R[5]. The model will simulate population dynamics by including estimated carrying capacity, plausible emigration and immigration rates, long-distance dispersal, distance-to-water limitation, and catastrophic mortality events. **Climate**[6,7]**, carrying capacity**[8] **and sea-level** are hindcasted; we will analyse anthropological relationships for dispersal, permanent water distribution, landscape ruggedness, and **archaeological data** as a comparison/validation[8–10].

*datasets: (i) ***archaeological*** *from relevant published literature, focusing on* Homo sapiens *archaeological sites from the mainland with good dating and stratigraphy ranging from 45–12 kya. (ii)* ***Geophysical and bathymetry*** *from Dep Land & Surveys, Geological Survey Dep Rep Cyprus, Eur Mar Obs Data Netw (EMODnet) portal (emodnet.eu/en), and Nat Cent Environ Info (NOAA) ETOPO1 Global Relief Model*[11]*, (iii)* ***climate–environmental*** *from LOVECLIM*[6] *and HadCM3*[7]

Conclusions

The true density of mobile hunter-gatherer sites on Cyprus is seriously underestimated in current narratives. Determining palaeo-demographic rates and relative carrying capacity on early Cyprus is an exciting opportunity to investigate the pre-Neolithic exploitation of insular environments in the Mediterranean and elucidate patterns of early human mobility and migration, maritime connectivity, cognition, and adaptation.



Cypriot coastscape

References

[1]**Dawson, H.** 2014. *Mediterranean Voyages: The Archaeology of Island Colonisation and Abandonment*. Left Coast Press, Inc., California

[2]**Kealy, S., et al.** 2017. Reconstructing palaeogeography and Inter-island Visibility in the Wallacean Archipelago During the Likely Period of Sahul Colonization, 65–45000 Years Ago. *Archaeol Prosp* 24, 259–272

[3]**Moutsiou, T.** 2021. Climate, environment and cognition in the colonisation of the Eastern Mediterranean islands during the Pleistocene. *Quat Int* 577, 1-14

[4]**Moutsiou, T. Reepmeyer, C., Zomeni, Z., Kassianidou, V., Agapiou, A.** 2021. Modeling the Pleistocene colonisation of Cyprus, Eastern Mediterranean. *PLoS ONE* 16, e0258370

[5]www.R-project.org

[6]**Goosse, H., et al.** 2010. Description of the Earth system model of intermediate complexity LOVECLIM version 1.2. *Geosci Mod Dev* 3, 603–633

[7]**Krapp, M., et al.** 2021. A statistics-based reconstruction of high-resolution global terrestrial climate for the last 800,000 years. *Sci Dat* 8, 228

[8]**Tallavaara, M., et al.** 2015. Human population dynamics in Europe over the Last Glacial Maximum. *PNAS* 112, 8232-8237

[9]**Bradshaw, C.J.A., et al.** 2019. Minimum founding populations for the first peopling of Sahul. *Nat Ecol Evol* 3, 1057–1063

[10]**Bradshaw, C.J.A., et al.** 2021. Stochastic models support rapid peopling of Late Pleistocene Sahul. *Nat Commun* 12, 2440

[11]**NOAA National Geophysical Data Center**. 2009. ETOPO1 1 Arc-Minute Global Relief Model. NOAA Nat Cent Environ Info. doi:10.7289/V5C8276M (accessed 2022)

contact: tmouts01@ucy.ac.cy
UNIVERSITY OF CYPRUS
P.O. Box 20537. CY-1678
Nicosia, CYPRUS
tel. +357 2289357