

# Australian palaeoclimate, palaeohydrology, and archaeology of the Mid-Holocene: Trends in the human settlement of Australia's arid interior

Sophia A. Zamaria\*<sup>1</sup> & Sharon A. Cowling<sup>1</sup>

<sup>1</sup>Department of Earth Sciences, University of Toronto, 22 Russell St., Toronto ON, Canada, M5S 3B1

## \*CONNECT

✉ sophia.zamaria@mail.utoronto.ca (**she|her**)

🌐 sophiazamaria.com

🌐 linkedin.com/in/sophia-zamaria

🐦 @sophiazamaria

## 1. HIGHLIGHTS

1. There is evidence of human occupation of harsh desert environments in the Australian interior during the Mid-Holocene, but it isn't certain why or how these groups occupied these regions.
2. We compare archaeological evidence to palaeoclimate proxy data, reconstructed water table depths (WTDs) from a Mid-Holocene groundwater table depth model, and elevation to determine trends in human settlement patterns during the Mid-Holocene.
3. Our results show that WTD coupled with elevation were the strongest determinants of human settlement patterns of the Australian interior during the Mid-Holocene.

## 2. INTRODUCTION

- ▶ Archaeological evidence suggests humans first occupied the arid interior of Australia during the Mid-Holocene.
  - It isn't certain why or how humans could occupy harsh desert regions during this time.
  - Current theories include: 1) the amelioration of palaeoclimate due to the influence of the Mid-Holocene Climatic Optimum, and 2) the presence of ephemeral river networks
- ▶ The potential exploitation of permanent sources of shallow and accessible subsurface water is not discussed much in the literature.
  - Shallow WTDs in the arid interior may have sustained human populations during the Mid-Holocene.
  - Therefore, we use a Mid-Holocene WTD model to reconstruct WTDs across Australia. We compare archaeological evidence of human occupation to these WTDs as well as palaeoclimate proxy data and elevation to find the main determinants of broad-scale patterns of Mid-Holocene human settlement in the arid Australian interior.

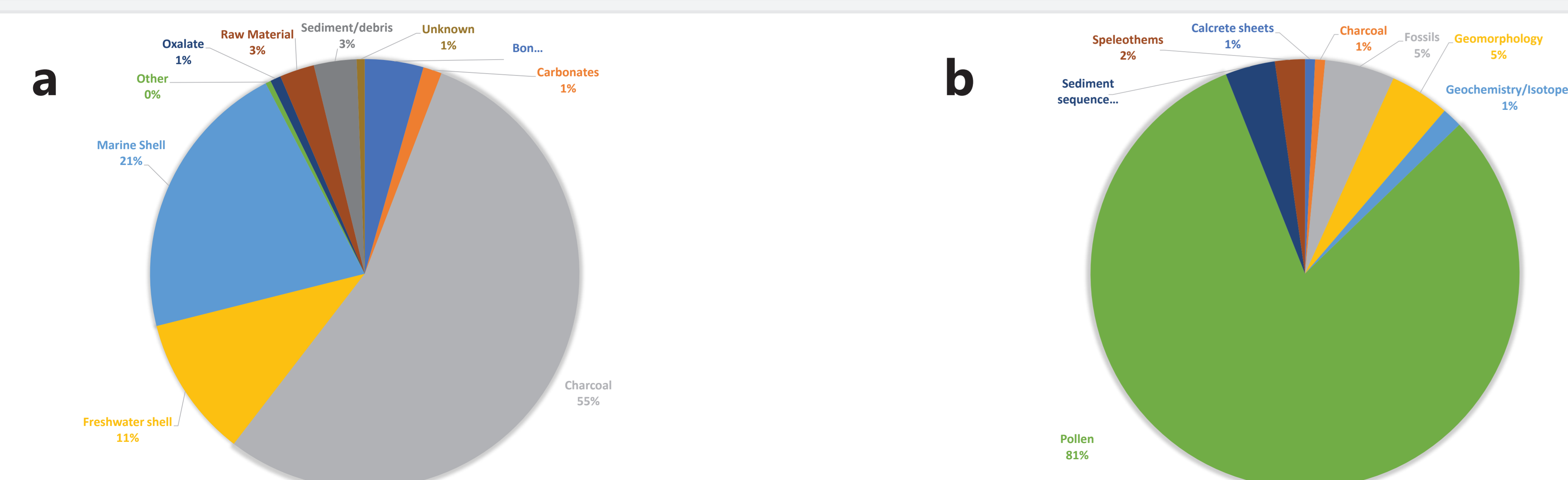
## 3. METHODS

### DATA

- ▶ Spatial data of archaeological evidence were retrieved from the AustArch database (Williams et al., 2014). (**Fig. 1a**)
- ▶ We compiled 133 Mid-Holocene palaeoclimate proxy data points indicating wetter or drier conditions from the relevant literature. (**Fig. 1b**)
- ▶ We used a WTD model developed by Fan et al. (2013) and Erb (2014) to reconstruct Mid-Holocene WTDs across Australia at a 30 arc-second resolution.
- ▶ Elevation data was retrieved from a digital elevation model (DEM) of Australia

### MODEL-PROXY-ARCHAEOLOGY COMPARISON

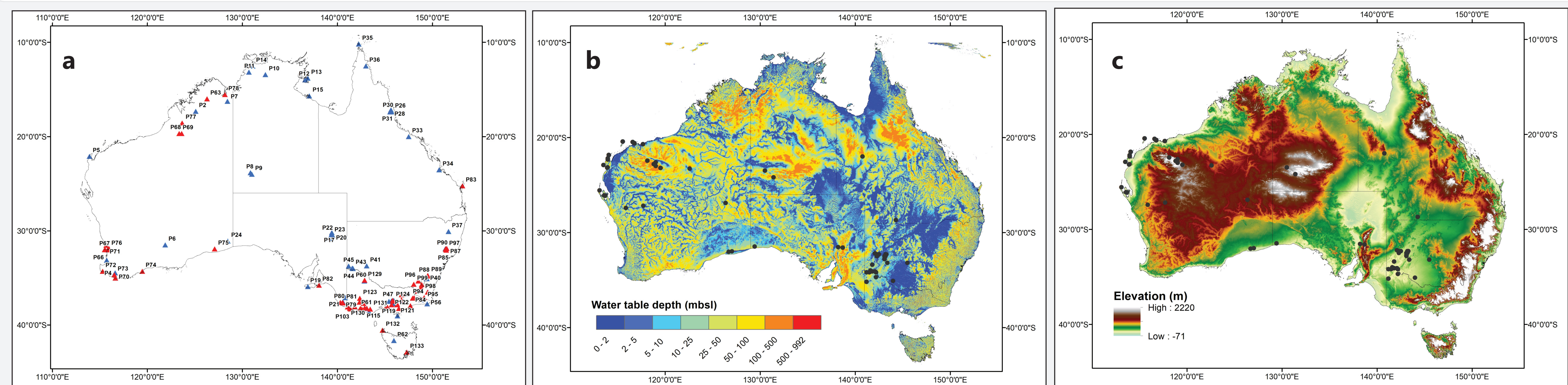
- ▶ We mapped the above data in ArcMap 10.6 to determine which factor(s) most influenced human settlement patterns in the interior.
- ▶ Broad, millennial-scale trends are considered here as the data span thousands of years across the Mid-Holocene.



**Fig. 1: a)** The proportion of the type of archaeological evidence considered in this study. **b)** The proportion of the type of palaeoenvironmental proxy data considered in this study. Note the high proportion of pollen proxy data.

## 4. RESULTS

1. Mid-Holocene palaeoclimate proxy data suggest a drier west coast, wetter northeast, and variable southeast. Data were limited in the interior of the continent. (**Fig. 2a**)
2. Shallow Mid-Holocene WTDs are predominantly found along the tropical northern shoreline and in the Lake Eyre and Murray-Darling Basins to the southeast. Deeper Mid-Holocene WTDs are found to the west and north (**Fig. 2b**). Broadly, WTDs correspond to the palaeoclimate signal, but elevation controls WTD on a localized scale.
3. Most archaeological data are found along coastlines or in highland regions within proximity to shallow and accessible WTDs (**Figs. 2b, 2c**).



**Fig. 2: a)** Palaeoclimate proxies indicating moisture conditions dated to the Mid-Holocene. Blue triangles represent palaeoclimate proxies that indicate wetter conditions; red triangles represent palaeoclimate proxies that indicate drier conditions. **b)** Mid-Holocene archaeological evidence overlaid onto a Mid-Holocene groundwater table depth reconstruction (Fan et al. (2013) and Erb (2014)); **c)** Mid-Holocene archaeological evidence overlaid onto a Digital Elevation Model. Archaeological data retrieved from Williams et al., (2014).

## 5. DISCUSSION AND CONCLUSIONS

- ▶ Our results suggest that groups preferentially settled upland regions with a nearby source of reliable and accessible surface and subsurface water (ie. piedmonts, springs and soakages).
  - Topography-driven lateral convergence of groundwater may have resulted in shallow sources of groundwater in otherwise arid regions.
  - Our results agree with Williams (2015) and Sutton (1990) who hypothesized that groups in the Mid-Holocene Australian interior would preferentially move from plains to hills to access more reliable sources of water.
- ▶ Our results show that WTD is an important factor to consider in archaeological studies.
  - Reconstructed WTDs may be able to inform the best regions for excavations, assuming that this trend is found globally.

### FUTURE RESEARCH

- ▶ We intend to conduct a least cost path analysis to further investigate the association between archaeological data and shallow WTDs.
- ▶ This study could be replicated in other regions globally and during different time periods to further investigate trends in human settlement patterns.

## 6. ACKNOWLEDGEMENTS

This research was supported by funding from the Natural Science and Engineering Research Council of Canada (NSERC). We thank Y. Fang and M. Erb for their groundwater table depth model data. Thank you to S. Finkelstein and M. Chazan for your guidance and support with this project.

## 7. REFERENCES

1. Williams, A. N., Ulm, S., Smith, M., & Reid, J. (2014). AustArch: A database of 14C and non-14C ages from archaeological sites in Australia - Composition, compilation and review (Data paper). *Internet Archaeology*, 36.
2. Fan, Y., Li, H., & Miguez-Macho, G. (2013). Global patterns of groundwater table depth. *Science*, 339(6122), 940-943.
3. Erb, M. P. (2014). The response of radiative feedbacks, equatorial pacific seasonality, and wetlands to orbital forcing in model simulations (Doctoral dissertation). Rutgers, the State University of New Jersey.
4. Williams, A. N., Veth, P., Steffen, W., Ulm, S., Turney, C. S. M., Reeves, J. M., ...Smith, M. (2015). A continental narrative: Human settlement patterns and Australian climate change over the last 35,000 years. *Quaternary Science Reviews*, 123(2015), 91-112.
5. Sutton, P. (1990). The pulsating heart: Large scale cultural and demographic processes in Aboriginal Australia. In B. Meehan and N. White (eds.), *Hunter-Gatherer demography: Past and present*