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Collection 1, Launch challenge

The impact of climate change on Australian Aboriginal hunter-gatherers and their response over the last 35,000 years.

By Alan N Williams, 24 August 2016

RESEARCH ARTICLE

In a recent article, I (and my colleagues) present models of population change for key regions across Australia over the last 35,000 years. We use these models to test an archaeological method (the use of numbers of radiocarbon dates as an indicator of human behaviour), explore the relationship of Aboriginal people and climate change, and to provide a status update for Australian archaeological research. We find that the archaeological technique is reliable, albeit with well-documented caveats that the user needs to be aware of. We find a close relationship between Aboriginal population and climate change for much of the last 35,000 years, with increasing divergence of the records in the last 6,000 years as numbers of people increase and techniques were developed to survive environmental shifts. We identify key areas of future research for the Australian archaeological community, including the need to fill spatial gaps across parts of the continent, and to focus on key temporal periods where significant change in society appears evident.

Introduction

Despite over 60 years of archaeological research in Australia, our understanding of the past populations and behaviour of Aboriginal society is still poorly understood. The broad narrative is widely known, including colonisation of the continent at about 50,000 years BP, abandonment, retraction and decline in populations through the Last Glacial Maximum (LGM) (24-18,000 years BP) – a particularly cold and arid period– and slow recovery followed by exponential growth and innovation in the last 5,000 years. However, the extremely large size of Australia (~7.7 million km^2) – a significant portion of which is hard to access – combined with the small number of researchers has severely limited the amount of archaeological and palaeoclimatic data available for interpretation, and this has checked the development of any narrative. Other issues have also played a role, including the lack of statistical and computational programs for the necessary analysis, and the siloing of researchers to their respective disciplines as two examples.

More recently, new methodological advancement and the publication of key palaeoclimatic and archaeological data have allowed us to further explore the Australian past. In [A. N. Williams et al., 2015], we use these new techniques and resources to provide a definitive account of past Aboriginal populations and behaviour across Australia over the last 35,000 years. In addition, we explore two other main themes: exploration and testing of an archaeological method using radiocarbon dates, which I elaborate on below; and much needed future direction for Australian archaeological research.

Methods

It is the role of the archaeologist to understand and interpret the behaviour of past societies. Traditionally, this has involved the careful excavation of sites known to have been inhabited by prehistoric people in the past. The changing number of stone tools, or other human created debris, recovered as one digs down provides an indication of whether there were more or less people at a given time, as well as other information on their behaviour. Such changes can be provided a chronology or timeframe through various dating methods of material recovered, most notably radiocarbon dating. Radiocarbon dating has been established since the 1950s, and represents a core tool of the archaeologist. Basically, all living organisms absorb carbon through inhalation or absorption of CO_2 (carbon dioxide) in the atmosphere, a proportion of this is slightly radioactive. When a living organism dies, the radioactive carbon that has been absorbed begins to decay, and we can measure this decay to work out the age of the organism at the time of its death. For archaeologists, it means a wide range of materials can be dated to work out how old a site, feature or layer is.

One of the key restrictions of excavation of a single site, however, is that it provides very localised information, producing a narrative for only a small spatial area, or group of people. In recent years, archaeologists have been exploring ways to combine information from a number of these sites to provide a larger picture of human behaviour. One of the more successful approaches to do this has been the accumulation and manipulation of the radiocarbon dates. By assuming each radiocarbon date recovered from an archaeological site reflects a prehistoric person at that location and point in time, by adding the number of dates together, we can produce a graph of increasing or decreasing people across the landscape. Since archaeologists have recovered relatively few dates compared with the world's population, it must be highlighted that the translation of dates to population is not a direct one, but rather a qualitative indication of the direction and amount of change through time, with more (less) dates suggest more (less) people, but not a specific value. (There are techniques that can convert this data to quantitative values and provide actual population numbers, but this was not part of this publication). This approach (known variously as 'dates as data', sum probability analysis or time-series analysis) was developed in the 1980s, but in the last few years has reached a zenith, and is now commonly found in the archaeological literature across the world. Of course, with all new archaeological techniques, there are questions about its reliability, and researchers that remain sceptical (see Williams and Ulm, 2016 for discussion) – and putting these concerns to rest is actually the main focus of our latest research.

We used some 5,000 radiocarbon dates recovered from 1,750 sites across Australia, and spanning 35,000 years ago to present, to test and verify the 'dates as data' approach. Our testing included: 1) the correlation of the radiocarbon dates with a recent synthesis of the past climate of Australia (Figure 1) – the assumption being that some form of human response would be evident with key climatic shifts, especially in more arid areas where Aboriginal populations would have been responsive to worsening conditions; and 2) the comparison of the data with some 90 records from archaeological sites across the continent – effectively the use of the traditional methods and records of people's behaviour from individual sites, and its relationship (or not) with the larger record produced by the radiocarbon dates.

The radiocarbon dates were divided into four regions that were comparable to the recent Australian climate synthesis, and encompassed the tropics, the arid centre, the temperate east coast, and Tasmania (Figure 2). Comparison of each of the dates as data graphs for these regions with the climate records for the last 35,000 showed a good and close relationship for the most part. This was especially the case during the LGM and Antarctic Climate Reversal (14-12,000 years BP), two periods of extremely cold and arid conditions, with data in all regions dropping to very low levels and suggesting Aboriginal people were almost wiped out. All records showed an increasing population after these events, and most notably during very warm and wet conditions between 9-6,000 years BP (an event known as the mid-Holocene climatic optimum). While there was disparity between the archaeological and palaeoclimatic records after this time (as outlined in the opening paragraphs above), comparison of the dates as data graphs with the 90 or so archaeological site records continue to show close similarity. Therefore, through the use of both testing approaches, we were able to conclude that the use of radiocarbon dates as a proxy for Aboriginal population was reliable. While I do not elaborate here, we do, however, include extensive discussion around the approach, and highlight a range of assumptions and limitations that the researcher needs to be aware of when using the technique, most notably site specific and regional sampling bias that result in artificial peaks in the data. An example of this is the Willandra Lakes system, where researchers have undertaken hundreds of dates on an area known to have been intensely occupied at the LGM, and thereby creating a large peak at around 21,000 years BP that is not reflected elsewhere in Australia.

Findings and Conclusions

[A. N. Williams et al., 2015], we compared behaviour and population size of past Aboriginal society in Australia with the climate record of the last 35,000 years. We found that Aboriginal society was strongly influenced by climate change for much of this time, with populations declining, or regions abandoned, in cold and dry periods, and the reverse when conditions improved. Importantly, we found that this human-climate relationship changed following a period of previously unseen wet and warm conditions between 9-6,000 years BP (before present), which allowed population to grow and reach a critical mass. After 6,000 years BP, we do not see populations mirror climatic events, but rather we see society adapt and weather change through the appearance of technological innovation (e.g. complex hunting equipment) and social complexity (e.g. evidence of ownership through rock art; and the formation of the Dreamtime religious system), resulting in continuous growth and expansion up until the settlement of Europeans in the late 18th Century.

While elements of the above story have long been known and understood in the Australian archaeological literature, this is perhaps the first time all the threads have been pulled together to weave a single narrative that explains how and why Aboriginal society has developed and thrived in one of the most arid countries in the world. For the modern day Australian, it presents an important part of the formative history of the nation, as well as highlighting some of the potential trials and tribulations that may need to be faced as climate changes into the future (e.g. areas likely prone to increased aridity and reduced fertility with climatic downturns). For the archaeologist, the paper provides a status update on Australian research, and presents regional models of population change through time, with which they can compare their records and identify areas of future investigation and research.

Finally, we identify future directions for Australian archaeological research. Through the 1950s – 1990s, there were large themes in Australian research, such as the origins of Aboriginal people, timing and location of initial colonisation of Australia, and human behaviour through the Last Glacial Maximum to name a few examples. More recently, however, research has become quite insular, and includes intense focus on individual sites or specific stone tool types, and revisiting previous sites and findings. There are a number of quite valid reasons for this shift. However, we highlight the need to re-consider the larger picture for Australian prehistory, and we propose a number of possible directions to do this. Specifically, we identify a number of regions that have yet to be investigated by archaeologists or researchers, and which are critical to understand how Aboriginal people moved and utilised the continent. These primarily include areas between the different regions, such as the Channel Country dividing the temperate coast and arid centre, where we should see evidence of Aboriginal people's response to even minor climate change; and the Murchison that divides the southwest corner of Australia (which contains some of the earliest evidence of Aboriginal people at Devil's Lair) and the arid core, similarly to understand the movement of people across this region. We also highlight a number of specific timeframes that more work is needed, most notably between 18-10,000 years BP, and 9-6,000 years BP – the former due to massive decline in population, to understand their recovery and survival through this period; and the latter to identify how and when the technological and social innovation outlined above was initiated and established, buffering populations from future climate deterioration.

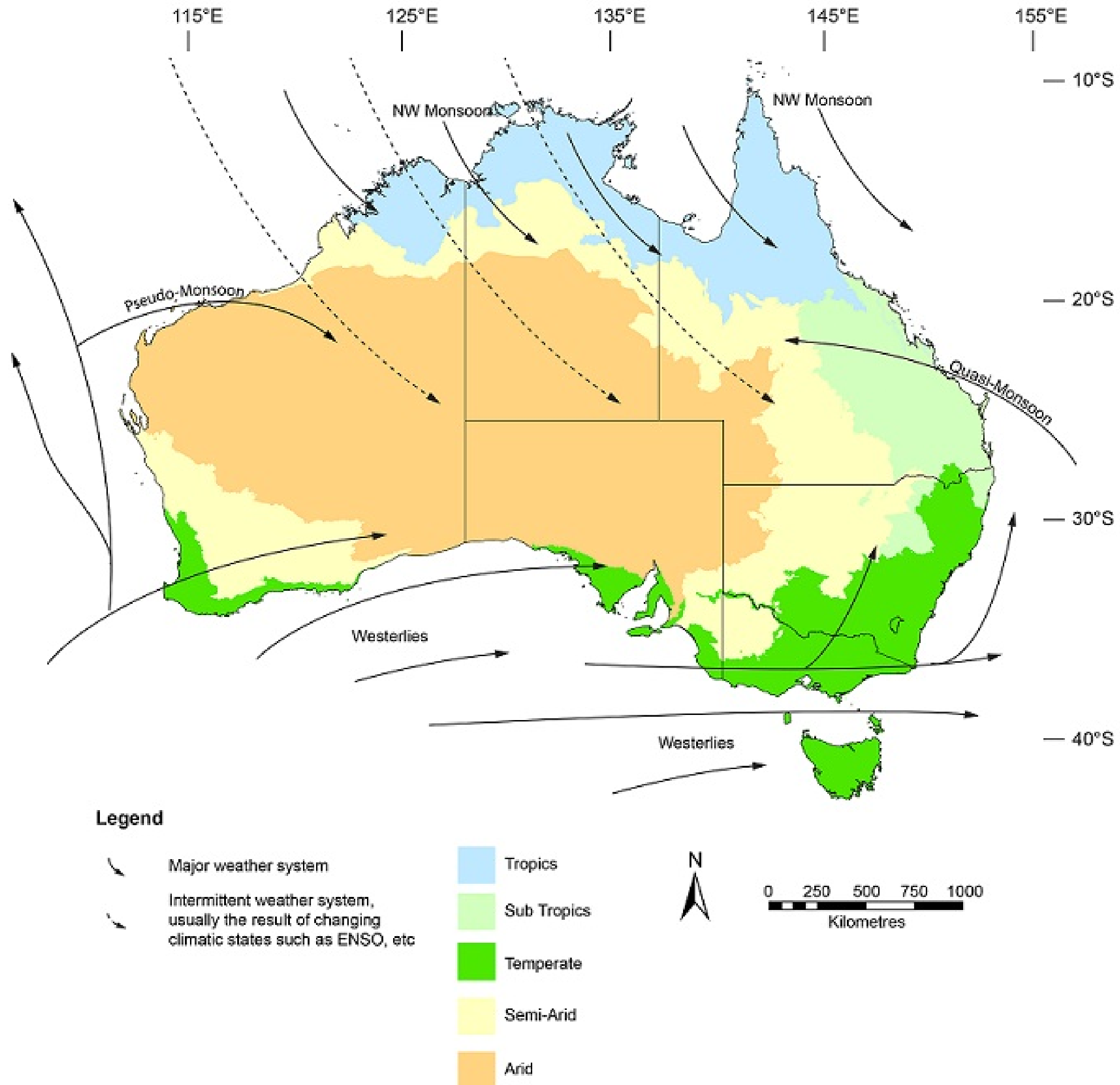

Figure 1: *A summary of the main weather systems in Australia. To the north, rainfall is driven by the movement of the summer monsoon across the top end and, in certain conditions, into*

the arid interior. To the south, rainfall is driven by the winter westerlies, which make incursions along the southern fringe and across the southeast corner. The interior of Australia receives rainfall through the interaction of these major systems, as well as other minor systems resulting from them. Figure reprinted from [A. N. Williams et al., 2015], Copyright (2015), with permission from Elsevier.

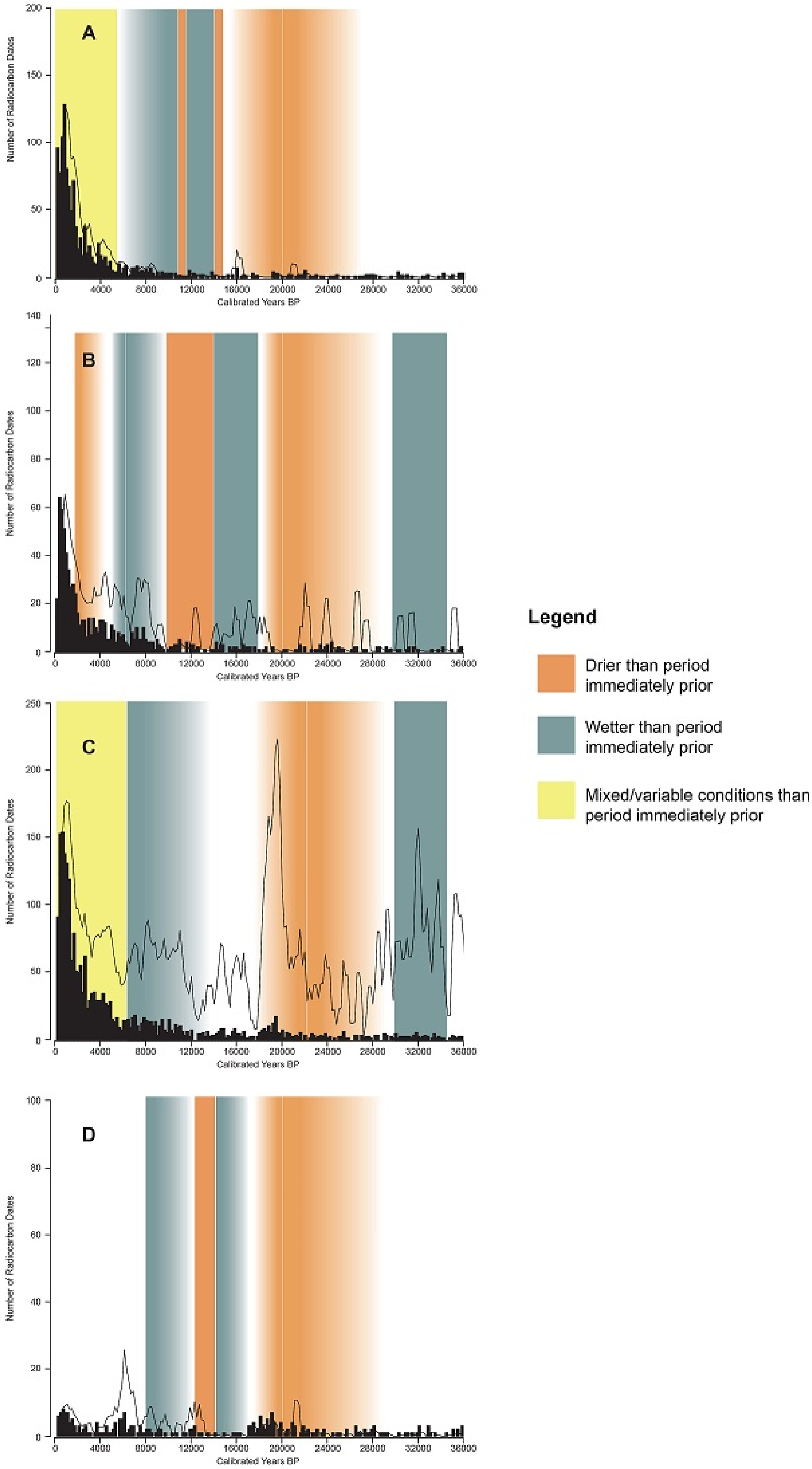
A
B
C
D
Number of Radiocarbon Dates
Calibrated Years BP
0
4000
8000
12000
16000
20000
24000
28000
32000
36000
Legend
Drier than period immediately prior
Wetter than period immediately prior
Mixed/variable conditions than period immediately prior

Figure 2: *The changing Aboriginal populations through time based on radiocarbon data in: A) the tropics; B) the arid interior; C) the temperate east coast; and D) Tasmania. The black bar chart represent the number of radiocarbon dates, and the black line is the same data statistically corrected for taphonomic loss of older sites through time (see [A. N. Williams, 2013] for further discussion). The data is interpreted as an increase (decrease) reflecting more (less) people. Please note that the graph should be read qualitatively, (rather than literally), with the number of radiocarbon dates at a particular point simply providing the trend in population change compared with other time periods, not actual numbers of people. The climatic conditions at each time period is presented as different colours. Figure reprinted from [A. N. Williams et al., 2015], Copyright (2015), with permission from Elsevier.*

Further Reading

[P. Hiscock, 2008]

[J. M. Reeves et al., 2013]

[M. A. Smith, 2013]

[P. M. Veth, 1993]

[A. N. Williams and S. Ulm, 2016]

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and M. Smith: A Continental Narrative: Human Settlement Patterns and Australian Climate Change over the last 35,000 Years, *Quaternary Science Reviews*, vol. 123, 91-112, https://doi.org/10.1016/j.quascirev.2015.06.018, 2015.

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Authors

Alan N Williams, Climate Change Research Centre, School of Biological, Earth and Environmental Sciences, University of New South Wales

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