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Identifying remote paleoclimate proxies with potential for inferring long-term hydroclimatic variability

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Recent advances in the collection and analysis of paleoclimate information have allowed insights into historical environmental events and processes prior to the availability of instrumental records, enabling greater understanding of long-term environmental change and associated hydroclimatic risks. However, there is still currently a lack of paleoclimate information in many areas where such insights and long-term data are crucial (Gell et al., 2009). The Murray-Darling Basin (MDB), Australia's 'food bowl', is a prime example of this, where currently there is very limited in situ proxy data available. To date, only three studies have attempted to incorporate paleoclimate archives in the investigation of long-term hydroclimatic variability in the MDB (Gallant and Gergis, 2011, Verdon and Franks, 2007, McGowan et al., 2009). These studies utilized existing remote paleoclimate proxies of large-scale climate mechanisms (such as the El Niño/Southern Oscillation and the Interdecadal Pacific Oscillation) to infer MDB hydroclimatic variability, but there is a lack of studies that identify key land-based Australian regions that could be used to inform pre-instrumental MDB hydroclimatic reconstructions.

This study highlights key regions where paleoclimate information that currently exists within Australia is most useful for expanding long-term knowledge of MDB hydroclimatology. Regions where the future collection and interpretation of as yet unrealized paleoclimate archives that are of greatest value are also identified. To pinpoint the crucial existing or potential paleoclimate proxy locations, rainfall relationships between the MDB and remote locations within Australia have been explored through correlations and principal component analysis (Jolliffe, 2002) using both the Australian High Quality gauged rainfall network (Lavery et al., 1997) and the Australian Water Availability Project interpolated gridded dataset (Jones et al., 2007). The rainfall-rainfall relationship fields were then overlain by locations of known proxy records in order to assess each record's contribution to the overall variability of MDB rainfall, as well as highlight regions where strong relationships exist and paleoclimate sources have yet to be explored. An objective analysis using optimal interpolation (Evans et al., 1998) is used to identify the most strategic locations and quantify the benefit of obtaining and analyzing additional paleoclimate information.

While this study focuses on the MDB and Australian paleoclimate archives, the techniques used could be applied to any region that currently lacks extensive instrumental records, paleoclimate proxy records or both. This would enable improved assessments of long-term interannual to multidecadal hydroclimatic risks.