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Long-range impact-based forecasts for agricultural drought early warning in Australia

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Abstract: Early warning of drought is critical for national water security, farm business outcomes and government planning. The Drought Early Warning System (DEWS) project is developing indicators to measure and forecast the extent and severity of drought impacts in the Australian agricultural sector with a focus on accessing economic risks. Through a multi-disciplinary approach, long-range climate forecasts are combined with biophysical and agro-economic models to generate impact-based drought indicators, translating climate data into specific impacts such as crop yields, pasture growth and farm profits.

In this work, we develop a high-resolution spatial forecasting system to generate forecasts of rainfall, temperature, solar radiation, vapour pressure and evaporation on a 5km grid across Australia, at a daily time step out to 18 months ahead. Forecasts are derived from the Bureau of Meteorology's ACCESS-S2 climate model. Forecast calibration and downscaling are implemented using Bayesian joint probability modelling and an empirical disaggregation approach, which seamlessly extends forecasts beyond the 7-month range of the climate model. The ensemble forecasts are targeted at multiple observational datasets to drive a suite of models including APSIM, Grassgro, AussieGRASS and farmpredict.

The climate inputs are fed into the suite of DEWS models, the outputs of which become indicators that will be presented as percentiles for a defined historical reference period. The definition of an appropriate reference period is a challenging problem given significant changes in both temperature and rainfall patterns across Australia over the last century and decadal scale climate variability. Assuming recent farm practices are adapting to climate trends, the recent 30–40 year period is adopted as the baseline, a period which also corresponds to historical ABARES farm survey data. To maximise the interpretability of the products, key users have been engaged in a co-design process.

The DEWS software platform has been developed as a real-time forecasting system hosted within Senaps, a cloud-based scientific workflow orchestration platform and secure data service. The drought indicator products are being prototyped and will be published online via the prototype Climate Services for Agriculture (CSA) platform, which is currently under development. We discuss the potential impacts of the forecasting system and the future work required to undertake rigorous forecast validation and verification.

Keywords: *Drought, forecasting, biophysical modelling, economic modelling, climate extremes*