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Modelling hydroclimatic variability for water resources management

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Climate is always changing over various time scales. The management of land and water resources involves designing and operating systems to cope with hydroclimatic variability. For example, all water resources projects take into account seasonal and inter-annual variability, some farming enterprises and water agencies use medium-term hydroclimate forecasts to help make operational management decisions, and most are concerned with the potential impacts of climate change on land and water resources.

This paper discusses some of the challenges and opportunities that hydroclimatic variability presents to the management of water resources in Australia. Australia is an interesting example because it is drier and less of its rainfall becomes runoff compared to most parts of the world, the inter-annual variability of streamflow in Australia (and southern Africa) is about twice that of rivers elsewhere in the world, and the hydroclimate-ENSO teleconnection in Australia (and western South America and Central America) is amongst the strongest in the world.

The first part of this paper demonstrates the use of the empirical mode decomposition (EMD) method to identify oscillations and trends in rainfall and streamflow time series data. The EMD analysis allows for an adaptive and unsupervised decomposition of a time series into a finite number of time series components (which can have varying amplitude and frequency) based purely on the properties of the data. The analysis indicates that many hydroclimate datasets exhibit inter-decadal variability, where some inter-decadal periods are considerably drier or wetter than others. These wet and dry cycles have significant implications for the management of land and water resources systems, where several decades of sufficient water are followed by droughts clustered

over the following decades.

The second part of this paper describes methods for forecasting streamflow several months/seasons ahead. The paper focuses on statistical nonparametric methods that forecasts exceedance probabilities of streamflow based on the lag streamflow-ENSO relationship and streamflow serial correlation. The statistical forecasting methods are generally more accurate for small to medium size catchments compared to climate models. However, climate models, particularly as they continue to improve, may provide more reliable forecasts for large regions and for longer lead times.

The third part of this paper discusses issues relating to the modelling of climate change as a result of anthropogenic enhancement of greenhouse gas concentrations, and the modelling of climate change impact on water resources in Australia. The paper highlights the uncertainties in climate change projections as well as most studies pointing towards drier conditions but with higher rainfall intensities in southern Australia.