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Planning for the impacts of Hadley cell expansion on water supply in Victoria, Australia

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South-eastern Australia has recently experienced the worst drought of the instrumental record; the so-called Millennium drought (1997–2009). This drought was primarily a cool season phenomenon, with large reductions in rainfall observed during the Austral winter (April to October). This reduction in winter rainfall, combined with an absence of wet years and very wet months led to a reduction in streamflow across the region far greater than would be anticipated based on the 12 percent reduction in mean annual rainfall alone. These conditions have proven particularly challenging for water management and planning processes. Our research has linked the extent, duration and severity of this drought to the ongoing observed expansion of the Southern Hemisphere Hadley cell of 0.5 degrees per decade. This expansion has intensified the sub-tropical ridge over southern Australia, pushing cool season mid-latitude storm tracks further south, leading to a reduction in winter rainfall over the region.

Modelling has shown that the expansion of the Hadley cell can only be reproduced if anthropogenic influences (greenhouse gases, aerosols and stratospheric ozone) are included in the models, thus providing evidence that the Millennium drought was at least partly attributable to climate change. Climate model projections also indicate that the expansion of the Hadley Cell is likely to continue. This means that the traditional winter "filling season" for water supply systems in Victoria may be less reliable in the future. However, in the light of the expansion of tropical influences, the cool season rainfall deficit may be offset to some extent by increased rainfall in the warmer months of the year.

Given that the Millennium drought has been shown to be at least partly attributable to climate change and the considerable uncertainties associated with projected future changes, water planning and management processes in Victoria have been modified to be more robust, adaptive and flexible. Short-term operational decisions are typically based on consideration of a range of future inflow scenarios which are informed not only by seasonal climate forecasts but also by the possibility of a return to the conditions experienced during the Millennium drought (that is, a continuing cool season rainfall deficit). In terms of longer term planning, water corporations are required to develop Water Supply-Demand Strategies with a view to balancing supply and demand over the next 50 years. In developing these strategies, water corporations have been asked to consider a range of plausible water availability futures, including climate change projections, as well as the possibility of an immediate return to the conditions experienced during the Millennium drought. These Water Supply-Demand Strategies include a range of options for reducing demand and augmenting supplies both on a short-term and long-term basis, including further investments in large scale water infrastructure.

Improved understanding of the links between changes in the climate system and their impacts on water availability will allow refinement of the range of plausible future flow scenarios and thus greater confidence in the decision making process.