Agro-ecological implications of change to the terrestrial water balance

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Location: Canberra

Principal investigator

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The need

The generic assumption among the natural resource management community is that, as the enhanced greenhouse effect warms the earth, the terrestrial surface should become more arid due to increases in atmospheric demand (often called potential evaporation) that are larger than any changes in rainfall. If true, this would have a negative impact on nearly all aspects of natural resource management in Australia—agricultural productivity, urban water supply, wetlands management, environmental flows etc. This view is prevalent in the media both in Australia and internationally. However, measurements from around the world show the reverse—evaporative demand (as measured by pan evaporation) has been steadily decreasing for the last 30-50 years. We have recently found the same general trend across Australia. In places where there has been no decline in rainfall, the terrestrial surface in Australia, like elsewhere, has become less arid over the last 30 years, despite warming. This project will investigate changes in annual pan evaporation and make a generic assessment of the ecological and hydrological changes we can expect due to decreasing evaporative demand.

How this project fits with MCV objectives

This project addresses climate change; specifically, how water availability has changed with warming over the past 30 years and how it might change in the future.

Project objectives

1. Document seasonal changes in rainfall and pan evaporation using data collected by the Bureau of Meteorology (BoM) across Australia since 1970.
2. Document seasonal changes in the underlying physical variables (solar radiation, vapour pressure deficit, windspeed) that determine pan evaporation at several pans where those data are available.
3. Using the trends from 1. and 2. above, make a generic ecological and hydrological assessment of how the surface water balance has changed over the last 30 years and the consequent implications of those changes for natural resource management.

Methods

For 66 sites with high quality pan evaporation records for 1975-2004, we compiled BoM data on solar radiation, air temperature, vapour pressure deficit (VPD) and windspeed.

Using these measurements with a physically based model, we calculated pan evaporation and compared this with the observations. In general, the observations and calculations agreed. Inverting the model, we decomposed the observed trends in pan evaporation into those due to changes in solar radiation, VPD and wind speed. The results show that, at the sites examined, declining pan evaporation is mostly due to declining wind speed, although there are regions where declining solar radiation (in north-west Australia) and declining VPD (SE Australia) have also been important.

Project: ANU49
Product code: PF061092

Desired outcomes

A rigorous scientific basis for assessing the impacts of climate change on water availability and natural resource management.

Achievements to date

The research has been completed. It has attracted widespread interest and has been presented at several national and international conferences and invited seminars[1].

What is left to do?

There is still a need for community education that warming does not necessarily mean drying. This project will help address that by demonstrating a more rigorous approach to assessing changes in what is arguably the nation's most important resource—water.

The attribution study has shown that the trends in Australian pan evaporation are consistent with trends in the underlying meteorological variables (solar radiation, VPD, windspeed). In terms of attribution, this analysis has found that declining windspeed is the most important factor, while declines in solar radiation are also important regionally. Exactly why the windspeed would have decreased so much awaits further investigation.

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[1] Gifford, R. M., Farquhar, G. D., Roderick, M. L., Nicholls, N. (2005) Pan evaporation: an example of the detection and attribution of trends in climate variables, Australian Academy of Science, May 2005, 81 pp.

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