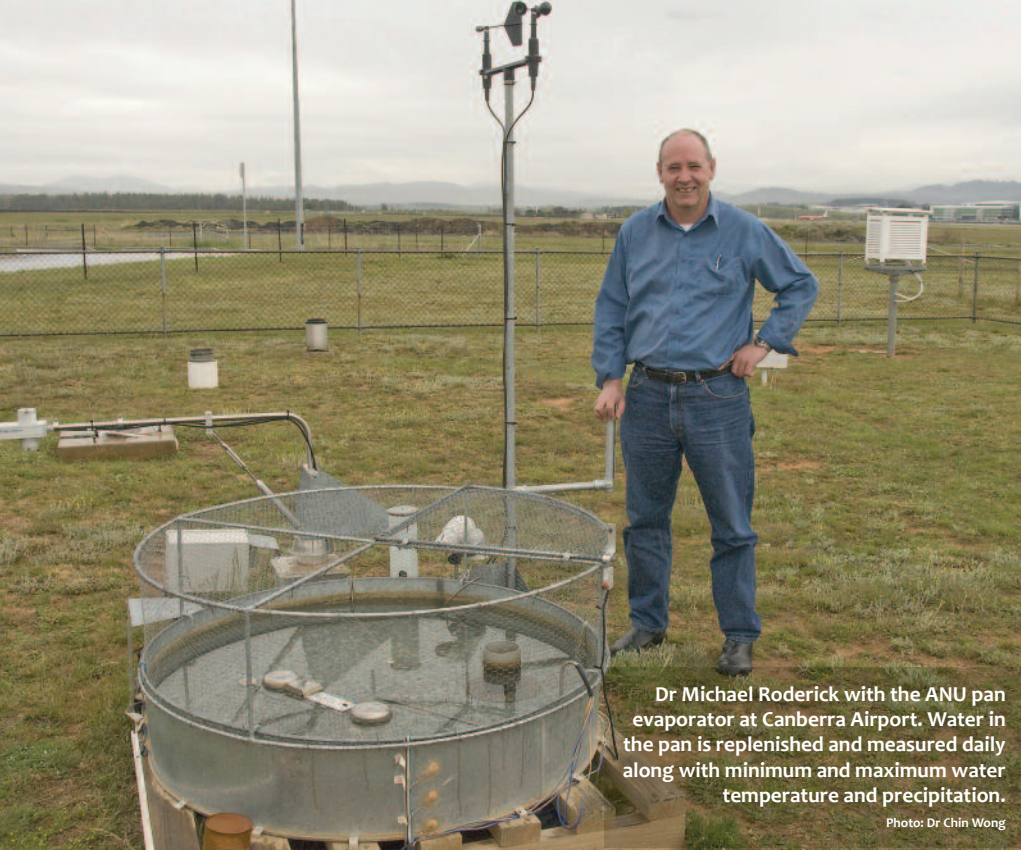


Dr Michael Roderick with the ANU pan evaporator at Canberra Airport. Water in the pan is replenished and measured daily along with minimum and maximum water temperature and precipitation.

Photo: Dr Chin Wong

The Evaporation Paradox

BY PETER POCKLEY

A "scientist's scientist" has won the 2009 *Australasian Science* Prize for research that overturns assumptions of the impacts of climate change on water availability.

Research that has overturned assumptions about the effects of climate change on evaporation rates and on changes in water availability has won the *Australasian Science* Prize 2009 for Dr Michael Roderick, a joint Fellow in the Research Schools of Earth Sciences and Biology of the Australian National University. Now in its tenth year, the Prize is "priceless recognition" of world-class science by Australasia's most inspiring minds.

While the mainstream media has placed advocates in the climate change "debate" into one "camp" or another – either strongly for or against global warming, Roderick has clearly stated the evidence and the degrees of certainty (or uncertainty) in predictions made by climate models. "This is a very different approach to popular coverage," he declares. "I am pro-science and evaluate the evidence with an open mind. I show there are no absolutes."

Roderick's prize-winning research, published in several peer-reviewed journals in the past 12 months, is based on a deceptively simple experiment that measures the rates of water evaporation from about 300 standardised pans distributed around Australia (maintained by the Bureau of Meteorology) and more overseas. His conclusions were surprising.

"London receives about 600 mm of rainfall every year and the surrounding landscape is green and wet. On average, Canberra also receives around 600 mm each year but the surrounding landscape is much drier and largely brown. The landscape differences are largely due to the different rates of evaporation. Evaporation is much higher in Canberra than London.

"Needless to say, there has been a widespread expectation that evaporation would increase as air temperature rises. It has been anticipated, for example, that wet and green places like London would become more like Canberra should global temperatures rise. This expectation has fuelled a perception – both in the media and in the scientific literature – that terrestrial surfaces will dry out in the future as a consequence of global warming.

"There was surprise amongst the global scientific community when confronted with observations showing that the evaporation of water from pans has been, on average, declining over the last 30–50 years just as global temperatures have been rising. Surely this must be a hoax!

"As it turns out, though, it is not a hoax. Instead, it is one of those unexpected observations that stimulate the very best science. Understanding and unravelling the 'pan evaporation paradox' underpins the whole question of how water availability has changed and might change."

Roderick's analysis of radiation, temperature, humidity and wind speed measurements has been comprehensive. He has shown that several factors are at work simultaneously, with declining wind speed and/or declining radiation being the major global factors behind declining evaporation. All these must be taken into account with errors declared clearly.

Global and Local Variability

Earlier in the year Roderick and PhD researcher Wee Ho Lim released the *Atlas of the Global Water Cycle*. These maps, averaged from a number of climate models, showed the history of rainfall in regions of Australia and overseas and outlined the best rainfall projections, with uncertainties stated.

A further effort to place localised observations into "the big picture, and getting this right", was a study this year with Prof

Graham Farquhar (a plant physiologist at the ANU and a Fellow of The Royal Society of London) of the water-stressed Murray–Darling Basin (MDB). This work, released exclusively to *Australasian Science* to accompany this announcement, found "fundamental differences" between public perceptions and scientific observations.

Roderick explains: "As the air temperature increases [due to global warming] and water evaporates faster, the public perception is that it will get drier, whereas the scientific basis is that it will rain more on a global average basis. However, locally – in, say, Sydney, Melbourne or the MDB – it will not necessarily rain more. It might or might not. It could rain less... When averaged across all models, a robust prediction is for global precipitation to increase annually by 17 mm for every 1°C of warming."

The study finds that the increased rainfall globally is not spread evenly. Some regions will become wetter while others will become drier.

"We should not give up on agriculture and water resources in the MDB and other once-productive regions," Roderick concludes. "The future is not necessarily as bleak as appears from the recent and continuing drought. These projections and the models producing them are now widely accessible, and public commentators should heed them seriously."

Independent Reviews

Dr Thomas Barlow, a research policy specialist, comments on the big picture painted by Roderick: "He has done some absolutely fascinating work looking at the real (and sometimes counter-intuitive) impacts of climate change. In a field where most of the public debate centres on computer models and new energy solutions, the importance of his work cannot be overstated.

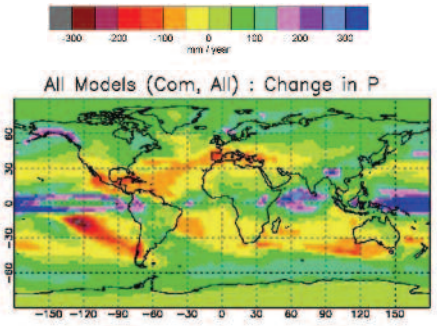
"This is curiosity-led science that has raised questions of global significance. He starts with very simple but important questions and answers them with extraordinary rigour and originality. In my mind this is truly inspirational stuff – science at its best."

Dr Roger Gifford, Chief Research Scientist in CSIRO's Plant Industry, also puts Roderick's work in the global context: "Observations and conclusions like Roderick's, when accepted and absorbed widely, will do great things for improving the representation of the science in algorithms that form global climate models, thereby improving the climate change predictions. They will also lead to more realistic assumptions about the details of the nature of human-induced climate change that sit behind a great deal of climate change impacts and adaptation research.

"Roderick's work in this area is truly groundbreaking, with widespread implications not only for other research that depends on the ideas that he has toppled, but also for very real policies and decisions relating to climate change that depend on them. He is a scientist's scientist."

Farquhar also rates Roderick's work highly. "I am confident his current efforts will have a broad public impact, as well as the obvious deep scientific impact with recent invited reviews," he said. "With his student Randall Donohue and colleagues, he has shown from satellite monitoring that Australia is generally greening up, particularly in northern areas where rainfall has increased, and with browning off in areas that have been drying. The picture that emerges is important as it gives reference data for, and context to, the various claims and counter-claims in the public arena.

"Communication is something he obviously takes very seriously. In regard to rainfall scenarios, it has been a rather difficult message – one that communicators don't much like. That is, the regional forecasts of future rainfall in the agricultural areas of Australia are very uncertain, and we don't know what is going to happen. But he emphasises the need to work as hard as we can to find out."



Change in mean annual precipitation over the next 100 years (2070-2099 less 1970-1999) projected by climate models. The change, an average of 20 global climate models, is for a global increase of 55 mm/year.

Source: Lim W.H. & Roderick M.L. (2009) *An Atlas of the Global Water Cycle: Based on the IPCC AR4 models*. ANU E Press, Canberra.

PAST WINNERS OF THE *AUSTRALASIAN SCIENCE* PRIZE

2008 Dr John Long (Melbourne Museum) for discovering three embryos and an umbilical cord in a Placoderm fossil – the earliest example of live birth on record.

2007 Prof Paul Fisher (La Trobe University) for discovering that an alarm protein in slime mould could be used to model cellular damage observed in human mitochondrial diseases.

2006 A/Prof Alex Hamilton and the Quantum Electronic Devices Group (University of NSW) for developing quantum semiconductor devices that use holes instead of electrons.

2005 Alexander Argyros, Dr Martijn van Eijkelenborg and Dr Maryanne Large (University of Sydney) for developing polymer optical fibres that perform competitively with silica fibres.

2004 Prof Levon Khachigian (University of NSW) for developing DNA drugs with potential in cancer treatment.

2003 Prof Mark Rowe (University of NSW) for determining how sensations are processed and transmitted in the brains of mammals.

2002 Dr Mark Hindell (University of Tasmania) for research on the behaviour of southern elephant seals and other marine predators.

2001 Prof Mandyam Srinivasan, Dr Shaowu Zhang & Dr Javaan Chahl (Australian National University) for extending knowledge of the behaviour and intelligence of bees to artificial intelligence.

2000 Dr Charlie Veron & Dr Mary Stafford-Smith (Australian Institute of Marine Science) for the discovery of 169 species of corals and documenting all known species in *Corals of the World*.