GLOBAL WARMING CONTRIBUTES TO AUSTRALIA'S WORST DROUGHT

CLIMATE CHANGE

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14 January 2003

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New research has found that human-induced global warming is a key reason why the Australian drought of 2002 has been so severe.

OVERVIEW

During 2002, Australia experienced its worst drought since reliable records began in 1910. The average Australian rainfall for the 9 months March-November 2002 was the lowest ever during this period. The drought was concentrated in eastern Australia with the Murray-Darling Basin, the nation's agricultural heartland, receiving its lowest ever March-November rainfall in 2002.

This drought has had a more severe impact than any other drought since at least 1950, because the temperatures in 2002 have also been significantly higher than in other drought years (see Table 1 and 2). The higher temperatures caused a marked increase in evaporation rates, which sped up the loss of soil moisture and the drying of vegetation and watercourses. This is the first drought in Australia where the impact of human-induced global warming can be clearly observed.

Barry Trail, The Wilderness Society

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THE 2002 DROUGHT – HIGHER TEMPERATURES THAN ANY PREVIOUS DROUGHT

Australia experienced its lowest March-November[4] rainfall for more than 50 years in 2002, less than 50% of normal, as much of the country was gripped by severe drought (see Figure 1).

The drought was associated with El Niño, the irregular warming of the equatorial Pacific Ocean that occurs about once every three to seven years. Most major Australian droughts over the last 100 years are associated with El Niño (Nicholls 1983, 1985).

In 2002, Australia also recorded its highest-ever average annual daytime maximum temperatures following a warming trend that has intensified over the past two decades. The temperature across Australia was 1.6ºC higher than the long-term average and 0.8ºC higher than the previous record.

While higher temperatures are expected during El Niño triggered droughts (Jones and Trewin 2000), the 2002 drought temperatures are extraordinary when compared to the five major droughts since 1950, with average maximum temperatures more than 1.0ºC higher than these other droughts (see Table 1).

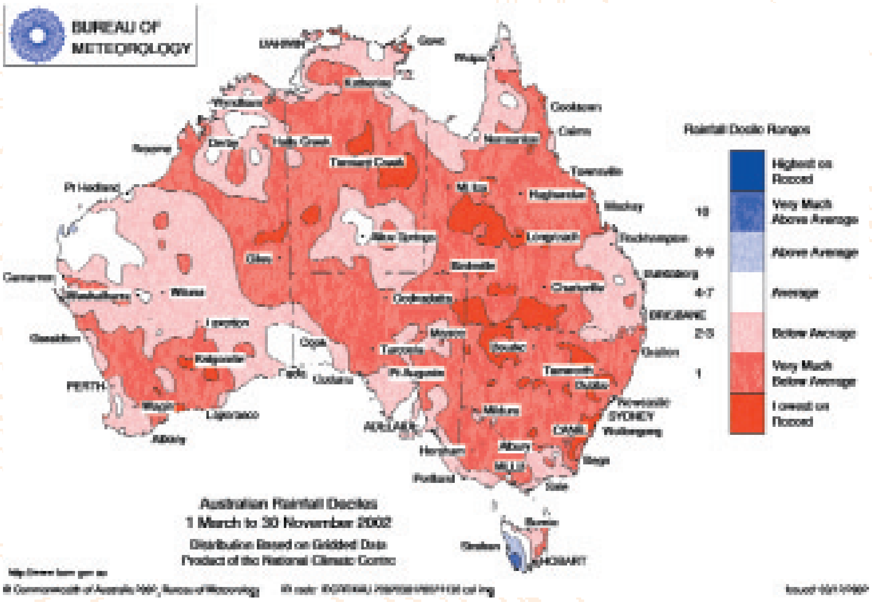


Figure 1: Profile of the 2002 drought

Average rainfall anomalies in March-November 2002 shown as deciles. Decile 1 (red) indicates rainfall amounts that are very much below average and have occurred in less than one year in ten. From the Bureau of Meteorology

Table 1: The 2002 drought compared to other droughts since 1950

Year	Rainfall (mm/month)	Maximum temperature anomaly (ºC)
2002	**14.1**	**1.65ºC higher than average**
1994	16.5	0.69ºC higher than average
1982	22.4	0.12ºC higher than average
1965	25.0	0.24ºC higher than average
1957	21.8	0.50ºC higher than average

Average conditions over Australia for the 9 months March-November of major drought years since 1950. Shown are the average monthly rainfall and the average daily maximum temperature anomalies (relative to the 1961-1990 long-term average of 29.1 mm/month and 26.6ºC). Data from the Bureau of Meteorology.

[4] March-November rainfall has been used, rather than the calendar year, as droughts are often more intense in this period, when there is a stronger influence from El Niño.

HIGHER TEMPERATURES IN THE MURRAY DARLING INTENSIFY THE DROUGHT'S IMPACT

The Murray-Darling Basin was at the centre of the Australian drought in 2002.

The basin received its lowest ever March-November rainfall in 2002, only 45% of normal rainfall. This key agricultural region makes up one-seventh of the total area of Australia and 75% of NSW. The Basin, that produces 40% of Australia's agricultural product, covers towns north to Toowoomba, west to Broken Hill and south to Victoria and South Australia.

During 2002, the Murray-Darling Basin experienced average maximum temperatures more than 1.2ºC higher than in any previous drought since 1950 (Table 2). The higher temperatures led to greater evaporation of water, exacerbating the drought. Higher evaporation rates make it difficult to sow crops, place existing crops under stress, and take water from rivers and reservoirs. The higher maximum temperatures and drier conditions have also created greater bushfire danger than in previous droughts (Williams, Karoly, and Tapper 2001).

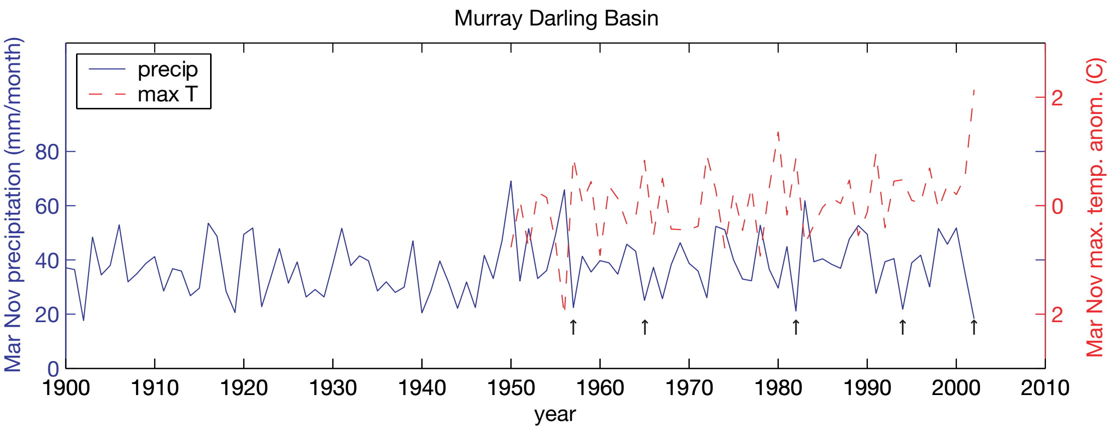
Table 2:
The 2002 drought in the Murray-Darling Basin compared with other droughts

Year	Rainfall (mm/month)	Maximum temperature anomaly (ºC)
2002	**18.3**	**2.14ºC higher than average**
1994	21.8	0.48ºC higher than average
1982	21.2	0.87ºC higher than average
1965	25.2	0.83ºC higher than average
1957	22.5	0.89ºC higher than average

Average conditions in the Murray Darling Basin for the 9 months March-November of major drought years since 1950. Shown are the average monthly rainfall and the average daily maximum temperature anomalies (relative to the 1961-1990 long-term average). Data from the Bureau of Meteorology

Figure 2:
Drought severity in the Murray Darling is increasing with global warming

The time series in Figure 2 shows that each drought is associated with higher maximum temperatures, but 2002 was extraordinary because of the record high temperatures.



Interannual variations of March-November average monthly rainfall (solid blue line) and average daily maximum temperature (dashed red line) for the Murray-Darling Basin. Small arrows indicate the 5 major drought years; 1957, 1965, 1982, 1994, and 2002, since 1950.

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WHY HUMAN-INDUCED GLOBAL WARMING INCREASED THE SEVERITY OF THE 2002 DROUGHT

The drought in 2002 was due to natural climate variations associated with El Niño. However, the higher temperatures this year are not attributable to the natural variations of Australian climate alone.

The higher temperatures in this year's drought are part of the overall warming trend in Australian temperatures over the last 50 years (Figure 3). Australian average surface temperature increased by more than 0.7ºC between 1950 and 2001.

In 2001, the Intergovernmental Panel on Climate Change concluded *"most of the observed (global) warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations"* (IPCC 2001). The warming trend over the last 50 years in Australia also cannot be explained by natural climate variability and most of this warming is likely due to the increase in greenhouse gases in the atmosphere (Figure 4, Karoly 2001). This figure shows that the actual trend in Australian temperatures since 1950 is now matching the climate models of how temperatures respond to increased greenhouse gases in the atmosphere. These greenhouse gas increases occurring today are due to human activity; burning fossil fuels for electricity and transport, and land clearing.

Figure 3.
Warming trend in Australia

Trends in average daily maximum temperature over Australia over the period 1950-2001.

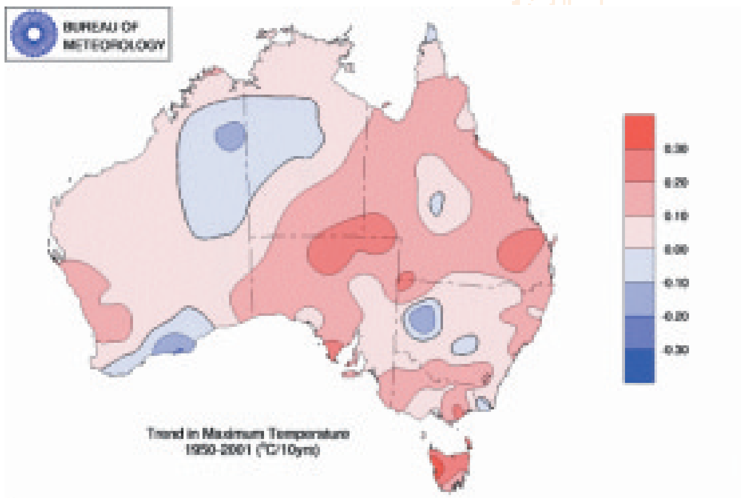
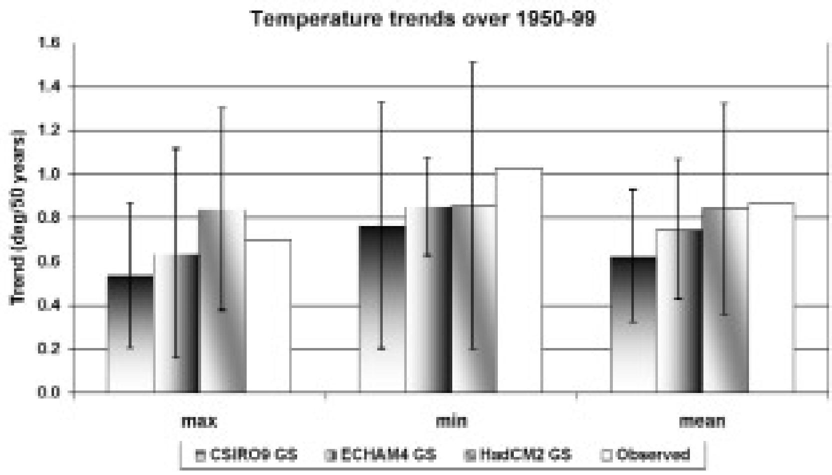


Figure 4:
Australian temperatures are now matching the global warming models



Observed trends in Australian average daily maximum (max), minimum (min), and mean temperatures over the period 1950-1999 compared with simulated trends from three different global climate models forced by observed increases in greenhouse gases and aerosols. The three climate models have been develop by CSIRO Australia, the Max Planck Institute for Meteorology in Germany, and the Hadley Centre in the UK. The error bar on each of the simulated warming trends is the uncertainty (90% confidence interval) in the 50-year trend associated with internal climate variability simulated by that model (Karoly 2001).

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GLOBAL WARMING INCREASES EVAPORATION RATES AND DRYING OF VEGETATION

A one-degree average temperature increase may appear to be a relatively small increase but it can have a major impact on the severity of drought.

Higher temperatures lead to higher evaporation of water from the soil, plants, lakes, and rivers. This places stress on water supplies and has a detrimental impact on agricultural productivity and vegetation health.

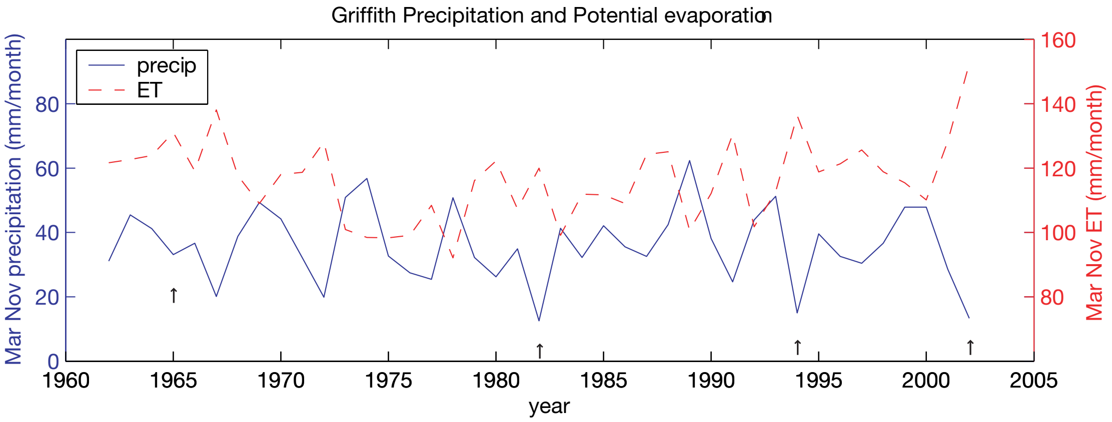
Under normal conditions evaporation rates in Australia are high, with almost 90 per cent of the precipitation that falls on the Australian continent returned through evapotranspiration to the atmosphere. As a result of the higher maximum temperatures, the evaporation rates in the Murray-Darling Basin in 2002 were significantly higher. Evaporation at Griffith, in the centre of the Murray-Darling Basin, in March-November 2002 was the highest on record and 10% higher than in other droughts, associated with the record high temperatures (Table 3, Figure 5).

Table 3:
Evaporation at Griffith in 2002 compared with other droughts

Year	Potential evaporation (mm/month)	Rainfall (mm/month)
2002	**152**	**13.3**
1994	136	15.0
1982	120	12.6
1965	131	33.1

Average potential evaporation and rainfall at Griffith in the Murray-Darling Basin for the 9 months March-November of major drought years since 1960. Potential evaporation is the evaporation expected from an open water surface, such as a reservoir. Data from CSIRO Land and Water, Griffith, available from 1960 only.

Figure 5.
Tracking evaporation in the Murray-Darling Basin



Interannual variations of March-November average monthly rainfall (solid blue line) and potential evaporation (dashed red line) for Griffith, in the Murray-Darling Basin. Small arrows indicate the 4 major drought years; 1965, 1982, 1994, and 2002, since 1960. Data from CSIRO Land and Water, Griffith.

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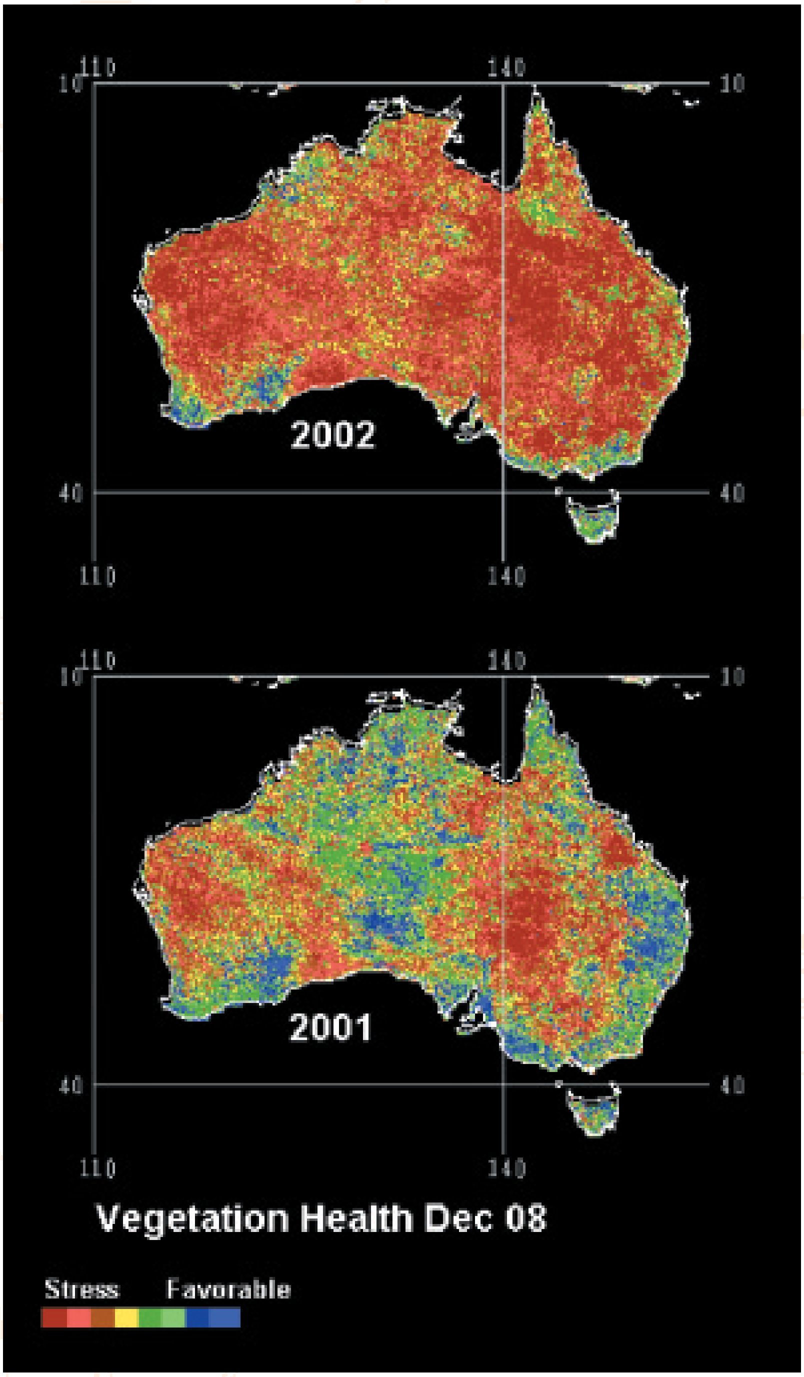
GLOBAL WARMING INCREASES EVAPORATION RATES AND DRYING OF VEGETATION

The higher temperatures have also placed Australian vegetation under severe stress, as captured by satellite data processed in the USA (Figure 6).

Figure 6. Vegetation stress in December 2002 compared with 2001



Vegetation health (condition) due to water availability and temperatures, based on satellite data. Drought regions with vegetation under stress are shown in red. (Kogan, 1997) Obtained from NOAA, USA from http://orbit35i.nesdis.noaa.gov/crad/sat/surf/vci/aus.html

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THE ECONOMIC IMPACT OF THE DROUGHT

Lower crop production due to the current drought will lead to lower export earnings for wheat, barley, cotton and canola in 2002 - 03 according to a recent forecast from the Australian Bureau of Agricultural Resource Economics (ABARE). Production of Australia's four major winter crops - wheat, barley, canola and lupins - is set to fall by 14.8 million tonnes in 2003.

Substantial reduction of irrigation water is also likely to result in major cuts in areas sown to irrigated summer crops such as rice and cotton in 2002-03. ABARE's Australian Crop Report estimates the area sown to cotton will be down 45 per cent from last season, while the rice area faces a slump of almost 70 per cent.

ABARE has forecast the area sown to summer crops will drop by 41 per cent in 2002-03, with grain production forecast to be down 59 per cent - this would make it Australia's smallest summer crop since the drought of 1982-83.

Australia's export earnings from crops are forecast to be down 19 per cent to $12.9 billion. ABARE has also forecast a drop of 3.7 per cent in the overall value of Australia's commodity exports due to the impact of the drought on agricultural performance.

The gross value of farm production is forecast to fall by 21 per cent to $30.4 billion in 2002-03 with earning from farm exports expected to drop by 13 per cent. The drought will reduce the rate of economic growth in Australia during 2002-03 by 0.75 per cent, reducing it to 3.1 per cent.

FUTURE DROUGHTS AND IMPLICATIONS FOR GOVERNMENTS

Global warming is a reality that is with us today. We can expect that the impact of drought in Australia will get worse as global warming accelerates. CSIRO (2001) has projected increases in Australian temperatures of between 1ºC and 6ºC by 2070, much greater than the increases over the last 50 years. These temperature increases would lead to even greater evaporation and water stress during future droughts, much worse than in 2002. CSIRO (2001) has projected up to a 45% decrease in stream flow in the Murray-Darling Basin by 2070. Climate models have projected a marked increase in the frequency of extreme droughts under global warming conditions (IPCC, 2001).

It is possible to slow global warming, keep temperature increases to the lower end of the scale and therefore reduce the severity of future droughts. Coordinated international action by governments is required to address the impacts of global warming. The Kyoto Protocol is the first international agreement with targets for reducing greenhouse gas emissions. It is the first step in slowing global warming. However, the Australian government has decided not to ratify the Kyoto Protocol. Mr Howard, the Australian Prime Minister, said in Parliament *"It is not in Australia's interest to ratify the Kyoto Protocol"* (Hansard, 5 June 2002). Any delay in greenhouse gas emission reductions will increase the likelihood of drought having worsening environmental and economic impacts, which is also not in Australia's interest.

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