

Climate change: basic science and background

Climate change is one of the great issues of our time. According to Sir David King, the UK Government's chief scientific adviser, "climate change is the most severe problem that we are facing today". Science broadcaster, Sir David Attenborough, has recently said: "I was sceptical about climate change. I was cautious about crying wolf. But I'm no longer sceptical. Now I do not have any doubt at all. I think climate change is the major challenge facing the world." Prominent scientist James Lovelock has been even more outspoken, stating that the world and human society face a disaster to a greater extent and on a faster timescale than almost anyone realises, adding that the consequences for humanity are likely to be far worse than any war.

Climate change refers to the variation in the weather occurring through natural processes (climate variability) and human-induced (anthropogenic) activities. While the Earth's climate is constantly changing, in recent times there have been rapid and unprecedented rises in surface air and water temperatures, also referred to as 'global warming'. In 2007, the United Nations Intergovernmental Panel on Climate Change (IPCC), made up of the world's leading atmospheric researchers, released its latest report concluding that the average surface temperature has increased by at least 0.7°C over the twentieth century. Global warming has contributed to retreating alpine and continental glaciers, receding ice sheets, rising sea levels, as well as regional changes in rainfall, cloud cover and floods, droughts, hurricanes and heat waves. Climate records reveal that the past two decades have been the warmest of the last thousand years. The IPCC's 2007 Fourth Assessment report paints a gloomy picture. IPCC reports have the agreement of all member governments.

The Australian Commonwealth Scientific and Research Organisation (CSIRO) estimates that Australia has warmed by an average of 0.7°C over the past century. The Bureau of Meteorology (BOM) recently announced that 2005 was the hottest year on record in Australia's

history. Rising temperatures have resulted in increases in extreme rainfall events and increased frequency and severity of droughts and fires in many parts of the world.

The enhanced greenhouse effect

Global warming is caused by increasing concentrations of so called 'greenhouse gases' in the atmosphere, including carbon dioxide (from burning fossil fuels such as coal, oil and gas), methane, nitrous oxide, water vapour and several other artificial chemicals such as chlorofluorocarbons (CFCs). The natural greenhouse gas effect is the process by which the atmosphere warms the planet. Energy from the sun enters the atmosphere and is absorbed by the surface of the Earth. This energy radiates from the Earth's surface into the atmosphere. Heat then becomes trapped in the atmosphere, which in turn causes a net warming effect.

Scientists now broadly agree that most of the global warming observed over the last 50 years has been caused by human activity. This is known as the 'enhanced greenhouse effect'. Since pre-industrial times, levels of carbon dioxide have increased by approximately 73 per cent: from 278 parts per million (ppm) to 379 ppm in 2005. The United Nations World Meteorological Organization (WMO) in March 2006 announced that globally averaged concentrations of carbon dioxide, methane and nitrous oxide in the Earth's atmosphere reached their highest ever levels in 2004, although methane concentrations have levelled off. The IPCC's most recent 2007 report states that concentrations of carbon dioxide are at their highest levels for at least 650,000 years.

At approximately 27 tonnes of greenhouse pollution per person, emissions by Australians are higher than New Zealand (13 tonnes), Japan (10 tonnes), the United States (21 tonnes) and more than double the average per person for industrialised countries. Every time we drive a car, use electricity from coal-fired power plants, or heat our homes with oil or natural gas, we release carbon dioxide, the main greenhouse pollutant, into the air. Another major

source of greenhouse gas emissions is the destruction of forests and carbon rich soil. Not only does this cause a serious loss of biodiversity (species and ecosystems), but millions of tonnes of carbon dioxide are released into the atmosphere adding to the greenhouse effect.

How much warmer is the Earth likely to become? Due to the slow rate in which carbon dioxide can be absorbed back into carbon reservoirs in the earth and oceans, climate change is predicted to continue long after the stabilisation of greenhouse gas concentrations. Using six different scenarios, the IPCC projects that Earth's surface temperature could increase between 1.1°C to 6.4°C by 2090-2099 relative to surface temperatures in the period 1980-1999. Sea levels are also projected to rise as the oceans warm up and glaciers and ice sheets melt. Between 1961-2003, the sea level rate rose by 1.8mm per year. This rate has almost doubled to 3.1mm per year between 1993-2003. The IPCC projects that by 2100 sea levels increases over the century could be as high as 59cm or more. Many scientists now believe that they are likely to be much greater. It will take centuries to stabilise the current concentration of greenhouse gas emissions.

Projected Australian impacts

Of all developed countries, Australia is the most vulnerable to climate change. Climate change will affect all Australian environments, human health, cities and towns and key sectors of the economy, such as agricultural production, international trade and tourism.

Climate change will in many areas reduce the supply of water which will in turn aggravate existing problems (such as salting of drylands and rivers, eutrophication and toxic algal blooms). By 2030, the water supply in the Murray-Darling Basin could be 20 per cent less than its current levels due to climate change. Rainfall changes and increased evaporation could cause a decrease in available soil moisture which in turn could intensify the severity of droughts. The National Farmers Federation has described climate change and the associated droughts as potentially the greatest challenge facing Australian farmers this century. Increasing demands from the cities accentuate the problems associated with water scarcity.

The \$32 billion tourism industry will also be substantially affected by climate change. A sea level rise of 10 to 30cm, combined with rainfall changes, will cause massive dam-

age to the Kakadu National Park's freshwater ecosystems. A 1°C temperature increase could cause the loss of high-land rainforest habitat for particular species in the World Heritage listed tropical rain forests of North Queensland. Global temperature increases of as little of 1°C could cause extensive coral bleaching. The death of corals would strike a massive blow to the Australian tourism industry. The impact of tropical cyclones and storm surges represents another major concern for tourism, habitat destruction, health and the economy in general.

Climate change could have a dramatic influence on health and living conditions in Australia. Heat-related deaths could increase substantially with up to 2,500 deaths per annum in 2020 and up to 6,500 deaths in 2050. Many mosquito-borne diseases, such as Dengue fever and Ross River virus, could be found as far south as Brisbane and even Sydney.

Poor communities will experience the greatest impact of altered health and living conditions caused by global warming. Tens of thousands of refugees from South-Pacific islands threatened by sea-level rise might also need to be looked after. Even closer to home, over the past two years, the Torres Strait Islander population have been affected by unprecedented tidal flooding and may in future be forced to seek refuge on the Australian mainland.

The Australian Government's response

In 1997, Australia signed the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), an international agreement designed to limit global greenhouse emissions. Former Prime Minister John Howard, however, refused to ratify the Protocol during his term in office. In 2005, Australia, China, India, Japan, the Republic of Korea and the United States formed the Asia-Pacific Partnership (APP) on Clean Development and Climate partly as an alternative arrangement. Canada joined the Partnership in October 2007. It is notable that of these seven countries only Australia and the US had not ratified the Kyoto Protocol. The member countries aim to "meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction." The Partnership arrangements do not, however, include targets for greenhouse gas reductions. Furthermore, while the APP scenarios modeled by ABARE (the Australian Bureau of Agriculture and Resource Economics) show

a 20 per cent reduction in emissions relative to business as usual, this would still lead to a doubling of emissions relative to the year 2000 by 2050.

Following the election of the new Government led by Kevin Rudd in November 2007, the Government's first official act was to ratify the Kyoto Protocol. When Prime Minister Rudd announced his Government's commitment at the United Nations Climate Change Conference in Bali in December 2007, it was met with widespread international applause. The conference, in which Australia played an active part, culminated in the adoption of the Bali Roadmap, setting out the various tracks essential for reaching a secure climate future. The Bali Roadmap includes the Bali Action Plan, which charts the course for a new negotiating process designed to tackle climate change. It also includes the launch of the Adaptation Fund, and the scope and content of the Article 9 review of the Kyoto Protocol, as well as decisions on technology transfer and on reducing emissions from deforestation.

Australia is working towards its Kyoto target of limiting emissions to 108 per cent of 1990 levels between 2008-2012. Australia may be able to meet its target - a very generous one compared to those of other nations - because mass clearing of native vegetation has largely been stopped. Other greenhouse gas emissions have, however, continued to spiral upwards.

Future directions

To slow down global warming, energy conservation is of paramount importance. This will require a contribution from the whole of Australian society. According to leading climate researcher Dr Barrie Pittock, emissions of carbon dioxide from burning oil, coal and gas and destroying forests will have to be reduced eventually by 80 to 100 percent relative to present emissions. To stabilise greenhouse pollution, Australian governments must make a commitment to reductions of 20 to 30 percent by 2020 and of 60 to 80 percent by 2050. This means a 4-5 percent reduction per annum relative to business as usual. The smaller the initial reductions the greater the subsequent ones will need to be and the more costly it will be to make them. Serious measures need to be taken to create incentives for a switch to low carbon technologies and carbon pricing. The Climate Institute argues that Australia is the least prepared of any developed country to deal with global warming (www.climateinstitute.org.au).

Useful sources

Flannery, T. (2006). *The Weather Makers: The History and Future Impact of Climate Change*, Melbourne: Text Publishing. This book, by an internationally acclaimed scientist and explorer, is an examination of the history, science and politics of global warming and climate change.

Lowe, I. (2005). *Living in the Hothouse: How Global Warming Affects Australia*, Carlton North, Victoria: Scribe Publications. Ian Lowe, eminent scientist with expertise on climate change, provides a comprehensive review of current scientific knowledge of global warming and its impact on Australia.

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Pittock, A.B. (2005). *Climate Change: Turning up the Heat*, Melbourne: CSIRO Publishing. Written by one of the world's leading climate researchers, this book makes a comprehensive analysis of climate change, covering past assessments, projections for the future and suggestions for major adaptations.

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Woodruff, R., Hales, A., Butler, C., & McMichael, A. (2005). *Climate Change Health Impacts in Australia*, Report for the Australian Conservation Foundation (ACF) and Australian Medical Association (AMA), http://www.acfonline.org.au:80/uploads/res/res_ama_acf_full_report.pdf

This report was prepared by four of Australia's leading epidemiologists for the ACF and AMA.

See also Australian Conservation Foundation – <http://www.acfonline.org.au>

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