



Climate Scientists Australia Luncheon – Briefing Notes

1:00–2:30 pm, 28 October 2010, Premiers' Hall, Queensland Parliament House

Plan for the briefing

This briefing on climate change science by some of Australia's top climate scientists has been organised by Climate Scientists Australia in conjunction with the Queensland Climate Change Centre of Excellence (QCCCE) and the Environment and Resources Committee (ERC).

Given the considerable coverage and often conflicting information on climate change presented in the media, the aim of the briefing is to brief MPs on climate change science and recent controversies, as well as on the relevance of climate change and its impacts to Queensland. There will also be ample time for questions and discussion.

The plan for the briefing is as follows:

1. **About Climate Scientists Australia (Prof. Dave Griggs)**
2. **Update on climate change science (Prof. Will Steffen)**
3. **Physical climate change in Queensland (Prof. Matt England)**
4. **Observed and potential impacts of climate change in Queensland (Prof. Lesley Hughes)**
5. **Climate change and the Great Barrier Reef (Prof. Ove Hoegh-Guldberg)**
6. **Q&A**

1. About Climate Scientists Australia

Climate Scientists Australia is an independent group of senior and highly respected climate scientists who, because of their extensive research experience and familiarity with the scientific literature on climate change, became deeply concerned about climate change and its potential impacts.

The group formed in mid-2009 to provide a credible source and a strong and unified voice on the scientific information on climate and climate change, in order to promote the use of scientifically-based information in decisions related to these issues. All outputs from the group are based on science or the policy implications clearly deducible from the science. The group is not affiliated with or represented by any other organisation, and does not advocate for any specific policies.

So far the group has made two visits to Parliament House in Canberra and one visit to the Victorian Parliament House, as well as provided two briefings for business leaders. In addition, the group has developed a website and fact sheets to make climate science information more accessible to the general public.

www.climatescientistsaustralia.org.au

2. Update on climate change science

The basics of climate change science

- There is very strong scientific evidence that emissions of carbon dioxide and other greenhouse gases from human activities are already causing the Earth to warm and that unchecked emissions are likely to lead to further and potentially dangerous climate changes in the future.
- The basic mechanisms of climate change are well established and studied. As far back as 1859, British scientist John Tyndall discovered that carbon dioxide absorbs heat and suggested that it may have a role in changing the Earth's temperature.
- Since then, thousands of scientists, using multiple data sets and research approaches, have shown that the rate and pattern of warming is consistent with the effects of human-related greenhouse gas emissions, and cannot be explained by natural factors alone.

Recent observations of the climate system

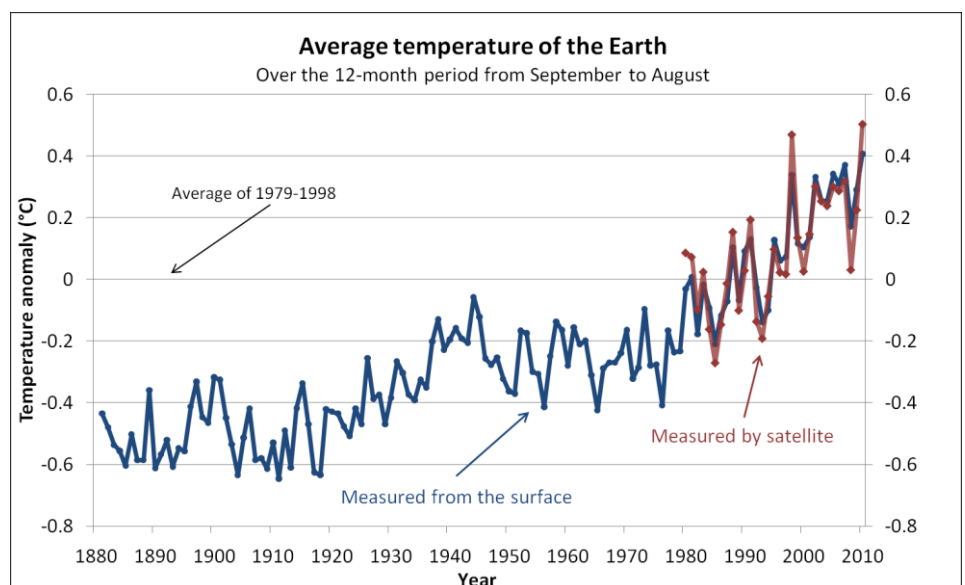
- There are normally large weather and climate variations from year to year and between regions. The clearest evidence of global climate change is found by considering the whole globe and variations from one decade to the next.

- The chart below shows that the Earth's average surface temperature has increased by about 0.7°C over the last 130 years. This warming is unusual in at least the previous 1800 years.
- Despite assertions often repeated in the media, the Earth has continued to warm since 1998. The last 12 months are the hottest recorded in the last 130 years, and 2010 is on track to being in the top two hottest years.

Criticisms of climate change science

- Although many claims have been levelled against climate change science, that either the science was wrong or that scientists have been covering up contrary evidence, none of these claims have undermined the scientific evidence that climate change is caused by human activity.
- This is because the claims have been shown to be either wrong or immaterial; and several official inquiries have cleared climate scientists and climate science organisations from any wrongdoing.
- While there are many uncertainties in the details of climate science, more than 97 out of every 100 climate scientists agree that the link between human activities and climate change is solid.

Figure: Global average temperatures over the 12-month period September to August from two data sets: (blue) surface records from the NASA Goddard Institute for Space Studies dataset, and (red) satellites measurements from the Spencer-Christy lower atmospheric temperature dataset.



3. Climate & physical changes relevant to Queensland

Sea Level

- Sea level rise is an inevitable consequence of global warming for two main reasons: ocean water expands as it heats up, and additional water flows into the oceans from the ice that melts on land.
- Globally, satellite measurements show that sea level has risen by 3.4 millimetres per year since these records began in 1993. This is 80% faster than what scientists predicted in 2001. Accounting for ice-sheet mass loss, sea level rise until 2100 is likely to be at least twice as large as the predictions available in 2007; that is somewhere in the range 0.4–1.2 m. While values of over 1.2 m sea level rise by 2100 cannot be excluded, there is likely an upper limit of approximately 2 metres rise by 2100 based on new ice-sheet understanding. Well beyond 2100, global sea level could eventually rise by many metres due to polar ice sheet melt.
- While sea level around Australia has risen by about 17 centimetres between 1842 and 2002, this magnitude of change is not always obvious. This is because most beaches are keeping up with the increase due to natural sand-deposition processes. However, as sea levels continue to rise these processes will not be able to keep up, leading to greater damage along sandy coastlines.
- However, even small rises in sea level can significantly magnify the impact of storm surges, and high tides.
- Even if emissions are curtailed in the next few decades, sea levels will continue to rise for hundreds of years, requiring a very long-term planning approach for coastal areas.

Tropical cyclones

- It has been known for many decades that formation of a tropical cyclone requires very warm ocean temperatures. So, there has been concern that global warming, by warming the ocean, might increase the frequency and/or intensity of tropical cyclones and allow them to penetrate further away from the tropics.
- Most recent research, however, has indicated that the factors affecting tropical cyclones are more complex. As well, there are concerns about the fidelity of tropical cyclone data

needed to assess possible changes in cyclone activity (because of changes in observing systems over the years). Also, our ability to model tropical cyclones is inadequate.

- Bearing in mind these caveats, current research indicates that it is likely that the global numbers of tropical cyclones will decrease or remain unchanged in the future, but that an increase in the maximum wind speeds and rainfall rates of tropical cyclones is likely.

Tropical lows & monsoon

- The monsoon is one of the important factors that affect rainfall in Queensland. While the monsoon system is likely to be affected by climate change, with many models projecting an increase in monsoon intensity over parts of northern Australia, it remains difficult to predict the localised nature of this change.

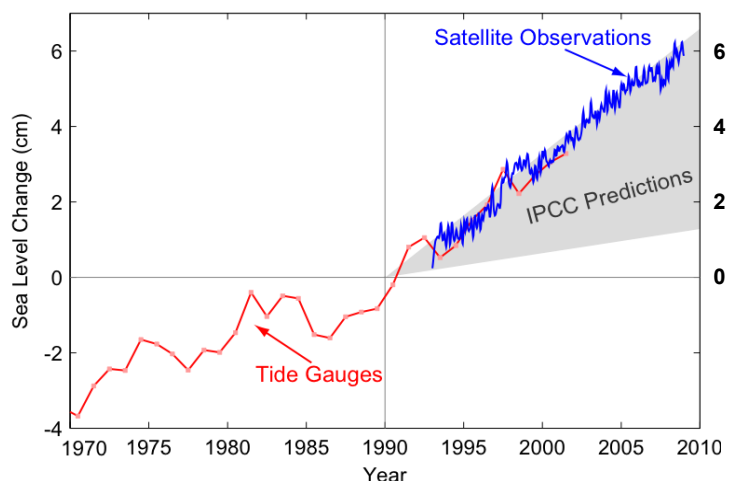
References and further information

Climate Change Risks to Australia's Coast. Australian Government Department of Climate Change and Energy Efficiency, Nov 2009.

(www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx)

The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science. The University of New South Wales Climate Change Research Centre (CCRC). (www.copenhagendiagnosis.org/)

Climate Change 2007 (AR4). Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). (www.ipcc.ch)



4. Observed and potential impacts of climate change in Queensland

Coasts and infrastructure

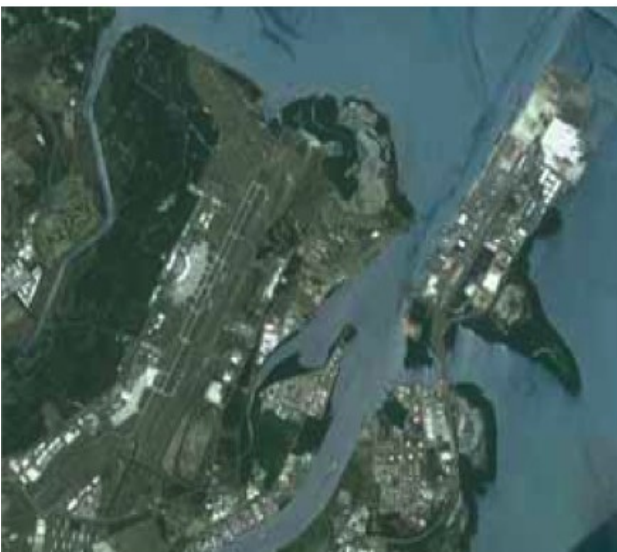
Nearly 88% of Queensland's population lives within 50 km of the coast and is consequently vulnerable to the impacts of storm surges coupled with sea level rise.

- 35,900-56,900 residential buildings in QLD may be at risk of inundation from a sea-level rise of 1.1 m. Based on this analysis, QLD has the second highest number of residential buildings at risk in Australia. This analysis, however, does not include storm tide associated with a 1-in-100 year storm, which would increase the area of exposure.
- The current replacement value of the residential buildings at risk is \$10-\$16 billion.
- LGAs of Moreton Bay, Mackay, the Gold Coast, Fraser Coast, Bundaberg and the Sunshine Coast have the highest risk, representing almost 85% of residential buildings.
- There are approximately 15,200 residential buildings located within 110 m of 'soft', erodible shorelines, of which approximately 5,400 are located within 55 m of 'soft' coast.
- There is also very likely to be increasing loss of high-value land including airports; road and transmission line deterioration; disrupted rail transport; degraded beaches, floodplain protection, drainage & sewerage systems; and loss of items of cultural significance.

- Coastal population centres such as Cairns will be particularly vulnerable to any increases in the frequency and/or intensity of tropical cyclones.
- Torres Strait Islands and isolated indigenous communities in North QLD are vulnerable to saltwater intrusion and flooding as sea levels rise.

Agriculture

- Changing rainfall patterns are expected to result in mismatches between water availability and the existing locations and types of agriculture.
- Increasing heat stress of livestock and risk for increased disease incidence.
- Declining pasture and crop quality expected to result from physiological impacts of increasing atmospheric CO₂ concentrations and changes in rainfall.
- Horticulture will be at risk from changing water availability, heat stress and pests.



Brisbane Airport today (left) and in 2100 (right) with a 1.1 m sea level rise above 1990 levels coupled with a high tide (Climate Change Risks to Australia's Coasts: A First Pass National Assessment (2009) Department of Climate Change).

Natural Ecosystems

Queensland is Australia's most naturally diverse state, with around 1350 ecosystems supporting 70% of Australia's mammals, 80% of its native birds and more than 50% of its native reptiles, frogs and plant species.

Over the next century the resilience of many species and ecosystems is likely to be exceeded by an unprecedented change in climate, combined with increased disturbances (fires, floods, sea level rise, ocean acidification) and other global change drivers, especially land use change, changes to fire regimes, water diversion, and exotic species introductions.

The climatic changes that Australia has experienced over the past few decades have already had observable impacts on plants and animals including shifts in species distributions, advances in species life cycles and population changes. Impacts are projected to include:

- Population changes and species loss, especially amongst restricted and rare endemic species in areas such as the north QLD Wet Tropics World Heritage Area.
- Increased intensity and frequency of coral bleaching in the Great Barrier Reef (GBR). When coupled with increasing ocean acidity, potential increases in tropical cyclones, and rising sea levels, potentially devastating impacts on the GBR may occur.

Health

- Increases in extreme high temperatures are associated with increases in hospitalisations and deaths. Annual temperature-related deaths in Queensland, in a scenario without climate change mitigation, is expected to rise to over 5800 deaths by 2100.
- Fire: Increasing severity and frequency of bushfires will lead to increased deaths and respiratory illness.
- Increased microbial food poisoning and diarrhoeal diseases, in association with warming and, in rural and remote regions, flooding and possible contamination of water supplies.
- Increased aeroallergens and air pollutants with associated impacts on respiratory conditions such as asthma.

- Changes in distributions of mosquito vectors, particularly in northern and coastal regions, will potentially expose more people to dengue fever, Japanese encephalitis, perhaps Ross River virus, and possibly (if introduced back into northern Australia) malaria.
- Mental health problems due to climate stress in rural communities, where declines in productivity and livelihoods, as well as community contraction, are also likely to increase.
- Health problems disproportionately affect lower socio-economic communities, including remote indigenous communities and the elderly.

Summary: Key messages on impacts

1. Climate change is already affecting both human and natural systems in Australia. Climate change is beginning to affect essential life-support systems and will increasingly affect our health and our economy.
2. The major impacts will not come from average trends but from increases in extreme events. We already know that these events can have serious, non-reversible impacts, and can hit multiple sectors simultaneously.
3. Some sectors such as agriculture have significant capacity to adapt, but natural ecosystems do not. Changes in ecosystem health may affect important industries such as tourism and fisheries.
4. We are confident that the magnitude of these risks will increase exponentially unless significant reductions in greenhouse gas emissions occur.

References and further information

Climate Change Risks to Australia's Coast. Australian Government Department of Climate Change and Energy Efficiency, Nov 2009.

www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx

5. Climate change and the Great Barrier Reef

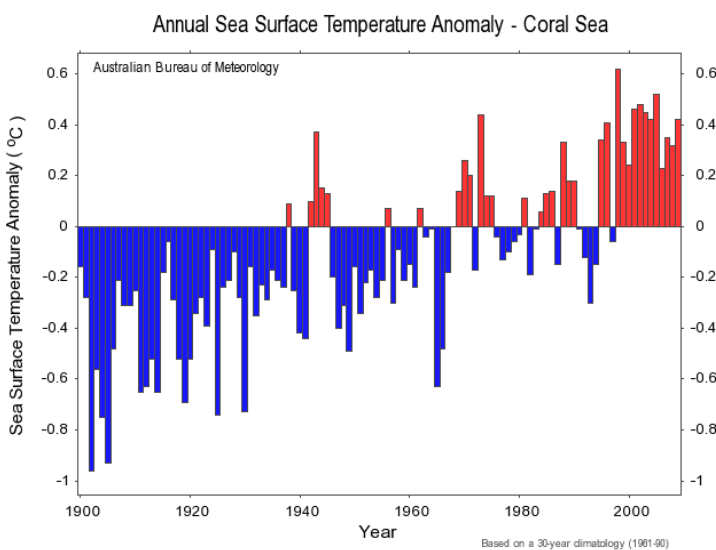
- The Great Barrier Reef (GBR) brings in over \$5 billion each year in tourist and fishing revenue. It is the world's largest continuous coral reef and was World Heritage listed in 1981.
- The GBR is currently in good condition relative to other coral reef systems. However, it faces serious threats from local factors, such as declining water quality along the Queensland coastline, shipping, and over-fishing of some areas. Recent evidence suggests that coral cover (a measure of reef health) is now around half of what it was in the early 1980s. Increasing atmospheric CO₂ has placed additional threats on the GBR through its impact on water temperature and acidity.
- In the warm conditions of 1998, for example, around 16% of the world's corals died. The GBR has been relatively lucky so far, with 7 moderate to severe bleaching events since 1979. So far, we have not experienced extreme thermal stress seen in 1998 in places like the Western Indian Ocean. There, an estimated 46% of coral died as a result.
- There is no evidence that mass bleaching occurred on coral reefs such as the GBR prior to 1979.
- However, sea temperatures in the Coral Sea have been increasing steadily over the past century (see below left). They are pushing coral reefs closer to or above their thermal limit.

Water temperature

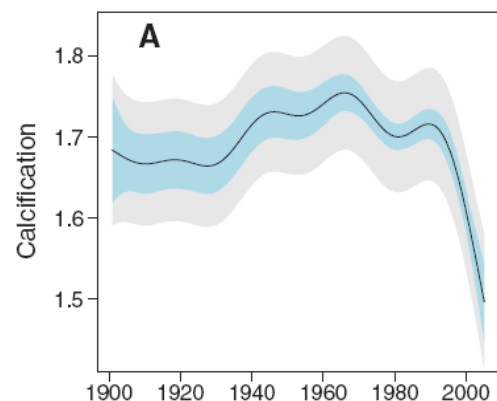
- Elevated water temperatures cause corals to 'bleach'. Bleaching occurs when the all-important symbiosis between corals and tiny brown plant-like symbionts called zooxanthellae breaks down. This results in the brown symbionts leaving the coral and causing it to look bleached.
- Small increases in water temperature (1°C above the long-term average) trigger mass coral bleaching. At low levels of bleaching, coral may recover. When conditions are warmer for longer, increasing numbers of corals become starved or diseased and die.

Ocean acidification

- An increased amount of atmospheric CO₂ causes a greater amount of CO₂ to enter the ocean, where it reacts with ocean water to form carbonic acid. Since industrialisation, about 40% of human-produced CO₂ has entered the world's oceans, increasing the acidity of ocean water by 0.1 pH units and decreasing the concentration of carbonate ions by around 15–20%.
- Carbonate ions are crucial to reef calcification. Experiments with corals have shown that calcification and reef building decrease as the concentration of carbonate ion decreases.



This graph from the Bureau of Meteorology (www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi) shows sea surface temperatures in the Coral Sea as a difference from a long-term average ('anomaly'). It shows that 2009 was the eighth warmest year on record for the Coral Sea.



This panel from Figure 2 in De'ath et al. (2009) shows the decline in calcification (in grams per square centimetre per year) since 1990, based on 1900–2005 coral data in the Great Barrier Reef.

Prognosis for the Great Barrier Reef?

- A recent study by the Australian Institute of Marine Science found that long-lived corals in the GBR are now calcifying 15% less than they were before 1990 (see left). They also found that this was unprecedented in the 400 years of records they inspected. Similar results have been found by several other studies for other regions.
- The decrease in coral calcification is likely to have resulted from a combination of increasing water temperatures and acidities – it is not yet possible to say which factor is more important.
- Further decreases in coral calcification as observed in the GBR are likely to cause coral reefs to stop growing or even to start disintegrating. This is because there is a fine balance between calcification (reef growth) and physical or biological erosion. Currently around 90% of what is laid down during calcification is removed by erosion.
- Under current trajectories of human-related greenhouse gas emissions, atmospheric concentrations of CO₂ will reach 450 ppm within 35 years. Most studies indicate that under these conditions, ocean temperatures and acidities will reach such levels that carbonate coral reefs (like the GBR) will be severely degraded, and are likely to eventually disappear.
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As a result, the GBR will be a vastly changed place. Given corals create the habitat for approximately one million species, the deterioration of the coral structure of the GBR will lead to major reductions in its biodiversity and productivity – as well as the ecosystem services that it currently provides (tourism, fishing, coastal protection).

References and further information

- Bruno JF, Selig ER (2007): Regional decline of coral cover in the Indo-Pacific: Timing, extent, and subregional comparisons. *PLoS ONE* 2(8): e711
- De'ath G et al. (2009): Declining coral calcification on the Great Barrier Reef. *Science* 323:116-119
- Hoegh-Guldberg O et al. (2007): Coral reefs under rapid climate change and ocean acidification. *Science* 318(5857):1737-42
- Hoegh-Guldberg O & Hoegh-Guldberg H (2008): The impact of climate change and ocean acidification on the Great Barrier Reef and its tourist industry. *Garnaut Climate Change Review*.
- Ocean Studies Board (2010): Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean. National Academies Press, Washington, DC, USA.



Where the GBR might be heading: On the left is a healthy coral reef at Heron island, on the right is Kelso Reef off Townsville (which was largely destroyed by a combination of Crown of Thorns starfish and thermal stress related bleaching).

Members



Professor Nathan Bindoff

Nathan is Professor of Physical Oceanography at the University of Tasmania, and CSIRO Marine Research Laboratories, Director of the Tasmanian Partnership for Advanced Computing, and Project Leader of the Antarctic Climate and Ecosystems Cooperative Research Centre's Modelling Program.



Professor Matthew England

Matt is a Federation Fellow and joint Director of the University of New South Wales Climate Change Research Centre. He specialises in the physics of the ocean and climate system. He is a former Fulbright Scholar and CSIRO Flagship Fellow, winner of several national prizes for his scientific work.



Professor Dave Griggs

Dave is CEO ClimateWorks Australia, Director Monash Sustainability Institute and Professor at Monash University. He is currently the vice-chair of the World Climate Research Programme and is a member of the Victorian Ministerial Reference Council on Climate Change Adaptation.



Professor Ann Henderson-Sellers

Ann is an Australian Research Council Professorial Fellow at Macquarie University. Previously she was Director of the United Nations' World Climate Research Programme and Deputy Vice-Chancellor of RMIT. She was awarded the Centenary Medal of Australia in 2003.



Professor Ove Hoegh-Guldberg

Ove is Professor and Director of the Centre for Marine Studies at the University of Queensland. He specialises in the impact of climate change on coral reefs. He is a Queensland Smart State Premier's Fellow, and is chair of the World Bank/GEF working group on coral reefs and climate change.



Professor Lesley Hughes

Lesley is an ecologist at Macquarie University researching the ecosystem impacts of climate change. She is a former Chair of the NSW Scientific Committee and sits on the Ad Hoc Technical Advisory Group on biodiversity and climate change for the United Nations Convention on Biological Diversity.



Professor Roger Jones

Roger is a professorial research fellow at the Centre for Strategic Economic Studies at Victoria University. He is recognised internationally for his work on climate risk and decision making. He was a Coordinating Lead Author for the IPCC Fourth Assessment Report.



Professor David Karoly

David is a Federation Fellow and Professor of Meteorology at the University of Melbourne. He is an expert in climate change and climate variability. He is a member of the Wentworth Group of Concerned Scientists and was Chair of the Premier of Victoria's Climate Change Reference Group.



Professor Amanda Lynch

Amanda is a Federation Fellow and Professor at Monash University. Her research applies climate science to problems of policy relevance. She holds numerous leadership positions in Australia and internationally, including chair of a climate reference group for the Office of the Chief Scientist.



Professor Tony McMichael

Tony is an NHMRC Australia Fellow and epidemiologist at the Australian National University. He is Honorary Professor of Climate Change and Health at the University of Copenhagen and a senior advisor to the World Health Organization on climate change and health.



Professor Neville Nicholls

Neville is an ARC Professorial Fellow at Monash University. His research has included predicting climate variations, examining climate and weather impacts, and developing data sets for monitoring climate. He is President of the Australian Meteorological and Oceanographic Society.



Professor Andy Pitman

Andy is the Director of the ARC Centre of Excellence for Climate System Science and co-lead of the UNSW Climate Change Research Centre. He is a member of the Academy of Science's National Committee for Earth System Science and of the NSW Ministerial Council on Climate Change.



Professor Will Steffen

Will is Executive Director of the Climate Change Institute and Professor at the Australian National University (ANU). He is also Science Adviser, Department of Climate Change, Australian Government. Previously he was Executive Director of the International Geosphere-Biosphere Programme.