

Climate Variability & Social Vulnerability

A brief statement of the issues

**Commissioned by
Disability Services Commission
for the
LONG TERM COMMUNITY PLAN REFERENCE GROUP**

Socially, climate change raises profound questions of justice and equity: between generations, between the developing and developed worlds; between rich and poor within each country. The challenge is to find an equitable distribution of responsibilities and rights.
David Miliband, (Foreign Secretary, United Kingdom) 2006ⁱⁱⁱ

April, 2008.

Abbreviations

AGO	Australian Greenhouse Office
BOM	Bureau of Meteorology
BTE	Bureau of Transport Economics
CSIRO	Australian Commonwealth Scientific Research Laboratories
DOE	W.A. Department of Environment
FAO	Food & Agriculture Organisation (United Nations)
IOCI	Indian Ocean Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
NIEIR	The National Institute of Economic and Industry Research
UNFCC	United Nations Framework Convention on Climate Change

Authors

Professor Daniela Stehlik is Director and Dr Diane Costello is Research Fellow at the Alcoa Research Centre for Stronger Communities at Curtin University of Technology, Perth.

More information about the Centre and the authors can be found at:
www.strongercommunities.curtin.edu.au

Contents

Abstract	4
1. Introduction	1
2. Conceptual framework	6
3. Climate change, vulnerability and social impacts	6
4. National impacts	7
5. Impacts on Western Australia	8
6. Vulnerability and mitigation	9
7. Adaptation as social policy	10
8. Signposts to a future	11
9. Conclusion	12
10. References and brief bibliography	14

Abstract

To date, any determination of the impacts of climate variability on vulnerable populations have tended to focus on environmental and economic, rather than on the social impacts, and on these in the developing world, rather than here in Australia. There is currently a lack of available scientific information about the potential for adaptive capacity and need for mitigation among vulnerable groups within developed countries, although there is increasing appreciation about the public health impacts.

In the past decade, Western Australia has experienced enough climate variability and extreme events to become increasingly aware of potential future impacts. Evidence that is available highlights that these impacts will be differently experienced both in terms of geographic place, and within society, as those with resources will be able to prepare for them and manage them with greater resilience, than those without.

Vulnerable groups – such as people with a disability and their families – will tend to rely on government intervention and mitigation to cope with change. Therefore any future planning for people with a disability and their families in the Western Australian context needs to take these issues into account.

This paper provides a brief context from existing literature to these issues to assist in dialogue and discussion.

1. Introduction

The Intergovernmental Panel for Climate Change (IPCC) has argued that human activity is responsible for many observed climate changes, particularly the warming temperatures of the last several decades¹. The serious economic and environmental consequences of global climate variability are widely acknowledgedⁱⁱⁱ as has been symbolised in current negotiations focussing on the Kyoto Protocol. To reduce vulnerability to future climate change, the IPCC has advocated action towards more extensive adaptation strategies.

However, in highlighting these physical impacts climate change discourses have largely ignored the significance of the *social* impacts. In advocating a just and effective response to climate change, the Australian Greenhouse Office (AGO) Report endorsed that social and environmental impacts be given *equal weight* along with any economic considerations^{iv}. It has been recognised that the consequence of failing to integrate all three implications would further disadvantage people with the least capacity to pay which can then result in compromising any adaptation measures to reduce greenhouse gas emissions.

A demand for recognition of the social inequities associated with climate change means ensuring that vulnerable population groups are given assistance to adapt to relevant policies, some of which could be seen as having quite draconian impacts.

Promoting an integrated approach to public policy is essential, as climate change is only one aspect of a complex arena, (which also includes alternatives to oil-based energy and reduction in water resources) and it is therefore vital to frame it within the context of other issues affecting the same decision strategies^v. Such an integrated decision-making framework not only requires a wider understanding of natural and human systems, but consultation with stakeholders is imperative to identify and negotiate the most effective and socially just strategies to be adopted.

This paper takes up this challenge of integration by focussing on the impact of climate variability on vulnerable groups, specifically on people with disabilities and their families in Western Australia.

The paper is structured as follows:

- (1) a conceptual framework for identifying impacts is developed
- (2) a brief contextual review of essential literature then enables
- (3) the emergence several key issues relating to impact of climate variability on vulnerable groups and finally
- (4) some signposts to the future are developed.

In the paper, we use climate 'change' in the context of the literature reviewed and the associated predictions being made and climate 'variability' to denote the current

¹ It should be noted that there is also a view expressed by both science and media commentators that the climate change discourse has been overstated. Most recently, an article in *The Australian* (Aitken, 2008:8).argued that 'consensus' by the IPCC or other groups regarding the science associated with climate change was flawed, as such science should be about testing 'theories against data' rather than reaching consensus.

and immediate future impacts of reduction in rainfall and increasing temperatures as well as reduction in resources more broadly. In this way, the paper attempts to establish a local (ie Western Australian) context to what still remains essentially a global dialogue.

2. Conceptual framework

In their groundbreaking report for Western Australians on health and climate change, Spickett, Brown & Katscherian (2008) highlight a framework or 'chain of events' for potential health impacts. When adopted, this enables impacts on a specific vulnerable group, such as people with a disability and their families, to be considered in more detail.

Their framework highlights:

- Identification of vulnerable group;
- Assessment of current coping capacity and the need for adaptation;
- Identification and development of opportunities for adaptation;
- Identification of gaps in current knowledge needed for assessment of coping capacity and/or development of adaptation;
- Identification of the appropriate sectors involved^{vi}.

When a specific component of climate change is identified, as for example, an increase in temperature, this 5-step process enables a deeper appreciation of the impacts (both positive and negative) on the vulnerable group under consideration.

The framework also suggests that vulnerability can be measured by considering the exposure to the issue, the sensitivity of the group to it, the potential impact of it on the group and the group's adaptive capacity towards it. Finally, the framework also proposes that adaptive capacity (coping capacity) towards the issue determines the ability of the group to minimize the impact through management and policy development.

It should be noted that this framework does assume that the vulnerable group is empowered – in civic terms – to be involved in such decision-making.

In summary, social and health impacts of climate change can be measured through an understanding of group vulnerability and adaptive capacity. This understanding, as the paper highlights, remains less than well developed in the Australian context as regards specific pre-existing vulnerable groups.

3. Climate change, vulnerability and social impacts

The IPCC Fourth Assessment report states that the warming of the global climate system "is unequivocal", and that global average temperature increased by 0.74° C during the 20th century, and could increase by up to 6.4° C this century, accompanied by a sea level rise of up to 0.59 metres^{vii}. This warming trend is expected to drive global changes in rainfall, wind patterns and extreme events and ice distribution^{viii}.

The Stern Report (2007) highlights that climate change threatens the basic elements of life for people around the world – access to water, food, health, and use of land and the environment. Two examples of predicted potential impacts include: (1) continued warming could include a doubling of deaths in 25 years to 300,000 people

a year and (2) that more than a million species worldwide could be driven to extinction by 2050^{ix}.

It has been argued that these predicted impacts of climate change on social-ecological systems through changes in temperature, sea-level and annual precipitation but also through increased intensity and in some cases frequency of floods, droughts, storms and cyclones, fires, heatwaves and epidemics will pose risks to human security^x. Climate variability and extreme weather events are already established as resulting in significant mortality, widespread human misery, and that they disproportionately affect, as Lee (2002) points out, people of colour, tribal communities and those from low socio-economic backgrounds (notably poor women in developing countries) as the most likely to suffer from climate change (see also FAO, 2007).

Current scholarship suggests that global market impacts mask substantial variation in market impacts at the continental, regional, nation and local scales. For example, Maddison (2003) reports increases in cost of living in low-latitude areas and decreases in high-latitude areas from a 2.5°C warming. A diversity in market impacts globally points to the importance of adopting an equity criterion when assessing which impacts are 'key' to the decision making process^{xi}.

4. National impacts

A brief overview of the key impacts predicted relevant to Australia, followed by review of the Western Australian context follows.

While the Australian contribution to global greenhouse gas emissions is only 1.6 per cent, the nation's *per capita* emissions are the highest in the developing world. This is attributed to cheap electricity, a declining use of renewable energy, a high level of land clearing, and a strong reliance on brown and black coal^{xii}. As the Kyoto Protocol ratification highlighted, not only does Australia have a moral obligation to find solutions to mitigate global climate change, it also has a strong vested interest in doing so. As a major net energy exporter, the environment sits prominently in the Australian psyche and as a nation it is vulnerable to the broader economic, social and environmental impacts of climate change.

Modelling to date has predicted that across the country, temperatures will rise, rainfall will change, sea levels will rise, and that extreme events will become more frequent and intense^{xiii}. CSIRO (2002) projects an annual average warming of 0.4° to 2°C over most of Australia by 2030 (relative to 1990), with slightly less warming in coastal areas and Tasmania, and slightly more warming in northwestern Australia. By 2070, the warming may be 1° to 6°C over most of Australia. While average mean annual temperatures have risen by 0.9°C since 1910, in the past 50 years, rainfall has decreased in the southwest of Western Australia, and in much of south-eastern Australia, especially in winter while it has increased over northwestern Australia^{xiv}.

More than 80 per cent of the Australian population continues to reside within 50 km of the coast, with 50 per cent of these living within 7km and some 6 per cent within 3km. of the shore in areas less than 5 metres above mean sea level^{xv}. Modelling has therefore highlighted that Australia is particularly vulnerable to rising sea levels and coastal inundation and erosion, both of which are expected to occur as a result of climate change (Garnaut 2008, IPCC, 2007a). Currently in Australia around 87 per cent of economic damage due to natural disasters (storms, floods, cyclones,

earthquakes, fires and landslides) is caused by weather-related events^{xvi}. Pittock (2003) highlights that marked trends toward greater population and investment in exposed coastal regions are also increasing vulnerability to further extreme events — notably tropical cyclones, storm surges and flooding of rivers in deltas and other outflow regions.

Climate variability is a major factor in the Australian economy. The increased risk of exposure to extreme events has been identified as having an economic impact, for example, with increased premiums possible for clients, insurers and re-insurers or reduced coverage^{xvii}. It has been suggested that this in turn may adversely affect some property values^{xviii}. According to Garnaut (2008) the potential impacts of climate variability on the national agriculture and forestry sectors include increased fire danger, damage to crops and soils due to flooding, land degradation, crop failure and livestock heat stress and even death. It has further been argued that potential productivity losses in the agriculture and forestry sectors are also likely to lead to a fall in gross regional product, and farm incomes in some regions.

Recent national droughts offer the most immediate examples of the impact of climate variability resulting in reduced incomes, an increase in health and welfare issues, a decline in educational access and a rise in the number of socially excluded people^{xix}. It has also transferred the focus of drought as simply a 'rural' issue to one that affects the whole nation. Also evident is that such events have differential impacts on women and men^{xx}. Experiences in rural communities during drought periods challenge resiliency and highlight losses of income which subsequently lead to increased workloads, family conflicts and withdrawal from social groups and communities with a consequent impact on social cohesion^{xxi}.

5. Impacts in Western Australia

According to the Indian Ocean Climate Initiative (IOCI), impacts of global climate change are difficult to predict at a sub-continental or regional level or for time scales. Where undertaken, international global climate models suggest that as atmospheric greenhouse gas concentrations continue to rise, Western Australia (WA) will become warmer and rainfall patterns will change further^{xxii}. In the southwest of Western Australia, rainfall has already decreased and is projected to continue decreasing throughout this century^{xxiii}. Future increases in temperature and potential evaporation are also anticipated^{xxiv}.

In parallel with global warming predictions, the annual mean temperature averaged across all of WA has increased by a little over 0.8°C since 1910, as indicated by National Climate Centre analyses which is in line with a global average increase of 0.74°C in the same period^{xxv}. CSIRO (2007) also reported that over WA, the enhanced greenhouse effect is most likely responsible for much of the observed warming. On a more positive note, between 1990 and 2004, the land management sector significantly reduced its emissions, mainly due to reduced clearing and increased carbon sequestration from tree plantations. However, if emissions from the land management sector are excluded, Western Australia's net greenhouse gas emissions increased by 46.36 per cent, between 1990 and 2004^{xxvi}.

The climate change pattern observed over WA with cooling in the north-east and reduced maxima in areas near the south coast, is consistent with the observed rainfall increase in the north and altered wind patterns in the south reflecting the increased influence of high pressure systems south of the State^{xxvii}. Climate variability

is currently evident in the south west of the state where rainfall decrease is impacting severely on soil moisture conditions and water resources^{xxviii}.

Adelaide and Perth have been identified as the main Australian capital cities with water supplies that are most vulnerable to climate change. In some areas in both cities, water resources are already stressed and are highly vulnerable, with intense competition for water supply. With further projected rainfall decreases, the stress on Perth's water resources will only continue to grow. The effects of the decline on natural runoff have been severe, as evidenced by a 50 per cent drop in annual inflows to reservoirs supplying the city of Perth since the 1970s^{xxix}. Similar pressures have been imposed on groundwater resources and wetlands. This has been accompanied by a 20 per cent increase in domestic usage in 20 years, and a population growth of 1.7 per cent per annum largely in the broader Perth metropolitan area^{xxx}.

As the IOCI suggests these changes to the State's climate could directly affect agriculture, forestry, health, biodiversity, water resources, energy demand, tourism, fisheries and industry. For rural areas, as has been experienced nationally over the past decade, the social consequences are economic hardship and social dislocation caused by drought, possible food shortages and rise in energy prices. Health commentators McMichael, Spickett et al and others suggest that the impacts of many of these changes are likely to lead to an increase in mental health disorders arising from stress, socio-economic and geographic disruption^{xxxi}.

In summary, therefore Western Australia is expected to:

- * Experience increased temperatures;
- * Experience decreased rainfall;
- * Experience increased sea levels;
- * Experience more heatwaves; droughts, bushfires, flooding, storms and tropical cyclones with the consequent *social implications of such changes*.

6. Vulnerability and mitigation

It is predicted that the most disadvantaged people in society may struggle to adapt to the changes or to relocate to reduce their exposure to the changes in climate.

According to the Australian Greenhouse Office (2005) highly vulnerable regions exhibit a potent combination of exposure to climate change, sensitivity and need for facilitative adaptive action. Therefore it is imperative that ongoing dialogue is encouraged between industry, governments and the scientific community. Green (2007) notes that there are many climate change impacts that will pose real challenges for social policy responses.

In Australia, Pittock (2003) argues that those most exposed to climate change risks are economically and socially disadvantaged groups of people including Aboriginal and Torres Strait Islanders who are particularly vulnerable due to the additional stresses on health and living conditions. In advocating for the needs of Indigenous people, Green (2007) suggests that the existing social and economic disadvantage caused by inadequate infrastructure, health services and employment present in most remote Indigenous communities serves to compound this problem, and can reduce these communities' ability to cope with climate change. By taking an equity

perspective to the issue, Green (2007) also outlines the need for any mitigation to include taking into account the social impacts of climate change.

Policy responses aimed at reducing greenhouse gas emissions, especially carbon trading, will also have a social cost if social issues are not addressed in policy formation^{xxxii}. In Australia, a carbon emissions trading regime is proposed on the assumption that market forces will increase the price of carbon and thus reduce carbon usage^{xxxiii}. Pricing carbon into energy, including petrol and electricity, means unit costs will rise. As with the impacts of climate change, the most disadvantaged people may struggle to either withstand increased costs or to be able to change current patterns of consumer behaviour to avoid price rises.

Analysis^{xxxiv} shows that the four household categories most adversely impacted by carbon pricing are

- * poor households;
- * unemployed households;
- * retired aged pension households and
- * households with children where government benefits exceed 30 per cent of income.

Strategies for mitigation include the more widespread introduction of minimum energy performance standards, for electrical appliances, cars and buildings, all of which have the potential to increase costs for buyers.

Carbon pricing will also raise the cost of all consumer goods, disproportionately impacting on lower income households, who spend a higher proportion of their income on essential items (such as food and heating) than do higher income households. The higher income household also has a greater capacity to invest in alternative goods which, although there may be a higher initial cost, has longer term cost savings.

7. Adaptation as social inclusion policy

To promote effective responses, regional and local adaptation planning requires coordination across all levels of government and the involvement of industry, scientists and community leaders and stakeholders. Much of the implementation of any adaptation strategy would inevitably be the responsibility of the state, territory and local governments reflecting their key roles in public infrastructure, safety, health and land use planning and control^{xxxv}.

We would argue that all important point in pursuing adaptive responses is that climate changes and their associated impacts vary greatly from location to location. Although national and international action is essential, many important decisions about how best to manage systems affected by climate change will need to be made at local and regional levels. If the place is vulnerable to climate change, then the impacts of such change on vulnerable groups within the vulnerable place are compounded. It needs to be stressed therefore that policy responses need to be 'place sensitive'.

Collaboration at all levels including the exchange of information, resources, best practices, and lessons learned across jurisdictional lines as well as among different groups of stakeholders becomes a key element of successful adaptation planning

^{xxxvi}.

According to the IPCC (2001b) adaptation requires the assessment of key vulnerabilities involving both scientific uncertainties as well as value judgments. While scientific analysis can inform policy processes about which vulnerabilities are 'key', and preferences for policies appropriate for addressing them, such decisions can be seen as essentially value judgments which are then determined through socio-political processes, taking into account considerations such as development, equity and sustainability, as well as uncertainties and risk.

8. Signposts to a future

Health impacts, including heat waves and the changed distribution of vector-borne diseases are beginning to be more specifically understood². Impacts on daily life, including access to public open space for sport and recreation and the protection of housing stock from extreme events are also recognized. Implications also include impacts on livelihoods and the continued economic viability of parts of rural Western Australia, with the possibility of forced internal migration. Changes in electricity costs, petrol prices, and the availability and affordability of alternatives will impact on all sectors of our state, but particularly those on low incomes.

When considering the immediate and longer term future (ie 5 – 20 years), the population of vulnerable people nationally, and Western Australia specifically, will increase with the growth of a population that is ageing. This review of the literature has highlighted that one of the key issues will be to determine which vulnerable groups will be supported in their demands for adaptive strategies and mitigation policies. We would argue that lessons from history teach us that it is highly likely that climate change adaptation will become a class issue – where those with resources will be able to create their adaptation and mitigation responses, and those who do not have resources, will suffer. This will be an important issue when considering the Federal Government's future agenda on social inclusion.

Spickett et al (2008) have identified adaptation strategies essential within the West Australian social/community context when considering the health impacts of climate change all of which have additional impact on people with a disability and their families. These include aspects of regulations; insurance issues; risk assessments; public education and awareness raising; cross-departmental information sharing and open dialogues (p. 51). They also highlight gaps in current knowledge to adaptation including: better understanding of extreme events in relation to health; policies to protect low income groups from added financial pressures and health implications of population demographics and change (p. 53).

One of the key roles for governments in the future will be to assist those vulnerable communities to build resilience to climate change. A case can also be made that governments should act as a 'safety net' for the truly vulnerable in times of loss. However, such government intervention needs to be considered in the context of the potential perverse incentives it may create. For example, the expectation of such government 'rescue' may increase incentives for risky private behaviour, or poor risk management practices. This review of literature highlights that any government's role should also include focusing on assisting individuals make informed decisions – the issue of civic engagement.

² <http://www.who.int/globalchange/climate/summary/en/index4.html> Retrieved 8th April, 2008.

This brief analysis concludes with a strong case for the importance of early planning and dialogue around the issues. Such planning also needs to include the commissioning of the science essential to undertake the necessary base line research which is currently woefully inadequate, on the specific geographic, cultural and social contexts of those groups that will be caught up in the events themselves, and who do not yet have the resources to plan or cope with the inevitable changes.

9. Conclusion

This discussion paper highlights the need for attention to the likely social outcomes of potential climate change and to the need for social policy planning to be included in climate change adaptation policy specifically as it will affect vulnerable groups and communities.

Policy researchers point out that no single metric for climate impacts can provide a commonly accepted basis for climate policy decision-making^{xxxvii} as aggregation, whether by region, sector or population group, implies value judgements about the selection, comparability and significance of vulnerabilities and cohorts^{xxxviii}.

The choice of scale at which impacts are examined is also crucial, as considerations of fairness, justice or equity require examination of the distribution of impacts, vulnerability and adaptation potential, not only between, but also within groupings^{xxxix}.

Clearly defining who should bear the risk of damage from climate change is likely to become an increasingly important issue as climate change worsens and its impacts are felt more strongly. An analysis of current scholarship highlights that responsibility for managing risk of climate change should be spread across various levels of government (local, state and federal) and should involve the civic engagement of all members of the relevant communities.

To conclude, any future assessment of potential impacts requires consideration of the response of biophysical and socio-economic systems to changes in climatic and non-climatic conditions over time, (e.g. changes in population, economy or technology) as well as important non-climatic developments that affect adaptive capacity, the potential for effective adaptation across regions, sectors and social groupings, value judgments about the acceptability of potential risks, and potential adaptation and mitigation measures.

Notes

- ⁱⁱ Cited in Wiseman, 2007:9
- ⁱⁱⁱ IPCC, 2007, 2007a; National Drought Review Panel 2004.
- ^{iv} Pittock, 2003.
- ^v Aitken, 2008; Pittock, 2003.
- ^{vi} adapted from Spickett et al, 2008:8.
- ^{vii} Vellinga & Wood, 2007; Schneider, Semenov & Patwardhan, 2007.
- ^{viii} CSIRO & BOM, 2007; Oppenheimer & Alley, 2005.
- ^{ix} Hennessy IN FULL 2007.
- ^x Barnett & Adger, 2007; McCarthy, Canziani, Leary, Dokken & White, 2001.
- ^{xi} Pittock, 2003.
- ^{xii} Hunt, 2004; Turton, 2004, cited in Kent & Mercer, 2006, p. 1047
- ^{xiii} IPCC, 2007.
- ^{xiv} BOM, 2007:17; CSIRO 2007:3.
- ^{xv} Chen & McAneney, 2006
- ^{xvi} Bureau of Transport Economics, 2001
- ^{xvii} Garnaut 2008
- ^{xviii} Pittock, 2003.
- ^{xix} Stehlik, Lawrence & Gray, 1999; Alston, 2006.
- ^{xx} Alston & Kent 2004, 2006; Alston 2006; Stehlik, Gray & Lawrence 1999.
- ^{xxi} Stehlik, 2008.
- ^{xxii} IPCC, 2007.
- ^{xxiii} Lal, 2005.
- ^{xxiv} Asseng, IN FULL 2005.
- ^{xxv} IPCC, 2007.
- ^{xxvi} DOE, 2007.
- ^{xxvii} CSIRO REF.
- ^{xxviii} IOCI, 2001
- ^{xxix} Pittock, 2003; IPCC, 2007
- ^{xxx} IOCI, 2002.
- ^{xxxi} McMichael 2006, Spickett et al, 2008; see also ABC, 2006; Lavelle, 2007.
- ^{xxxii} Alston, 2007.
- ^{xxxiii} Garnaut, REF; Brain, 2007.
- ^{xxxiv} NIEIR, IN FULL 2007
- ^{xxxv} IPCC, 2007a, 2007b:4.
- ^{xxxvi} IPCC, 2007; Pew Centre, 2007; Schneider, 2007.
- ^{xxxvii} Jacoby, 2004; Schneider, 2004
- ^{xxxviii} e.g. Azar, 1998; Azar & Sterner, 1996; Fankhauser et al., 1997.
- ^{xxxix} Jamieson, 1992; Gardiner, 2004; Yamin, et al., 2005, cited in Schneider, et al., 2007.

10. References & brief bibliography

- Alston, M. 2007. Gender and Climate Change, Variable Adaptations of Women and Men. *Just Policy*, 46, December. 29-35.
- Ahammad, H., Kenneth, W. & Qiang Ye, C. 2001. The regional economic impact of reducing greenhouse emissions: Western Australia. *Resources Policy*, 27, 225-233.
- Aitken, D. (2008) Good science isn't all about consensus. *The Australian*. Wednesday 9th April. p.14.
- Alston, M. 2006. 'I'd like to just walk out of here: women's experience of drought. *Sociologia Ruralis*, 46(2), pp. 154-170.
- 2000. *Breaking through the Grass Ceiling: Women, Power and Leadership in Rural Organisations*. Amsterdam: Harwood Publishers.
- Alston, M. & Kent, J. 2006. *Impact of Drought on Rural and Remote Education Access: a Report to DEST and Rural Education Fund of FRRR*. Centre for Rural Social Research, Wagga Wagga.
- 2004. *Social Impacts of Drought: Report to NSW Agriculture*. Centre for Rural Social Research, Charles Sturt University, Wagga Wagga.
- Allan, R. & Hunt, B. 1999. *Climate Change Modelling for the Southern Region of Western Australia*, CSIRO Atmospheric Research, Aspendale, Victoria.
- Asseng, S. Jamieson, P.D. Kimball, B. Pinter, P. Sayre, K. Bowden J.W. & Howden, S.M. 2004. Simulated wheat growth affected by rising temperature, increased water deficit and elevated atmospheric CO₂, *Field Crops Research*, 85, 85-105.
- Australian Broadcasting Commission (ABC). 2006. Farmer Suicide Rates Worry GPs. *ABC News Online*, October 24. Retrieved March 31, 2008, www.abc.net.au/news/newsitems/200610/s1771783.htm
- Australian Greenhouse Office. 2007. *Climate Change Adaptation Actions for Local Government*. Report by SMEC Australia to the Australian Greenhouse Office, Department of the Environment and Water Resources. Canberra.
- 2006. Australian National Greenhouse Accounts, State and Territory Greenhouse Gas Inventories 2004. Australian Greenhouse Office, Department of the Environment and Heritage.
- 2005. Climate Change Risk and Vulnerability: Promoting an efficient adaptation response in Australia. Australian Greenhouse Office Report prepared by Allens Consulting, March. Retrieved March 30, 2008, <http://www.greenhouse.gov.au/impacts/publications/risk-vulnerability.html>.
- Barnett, J. & Adger, W.N. 2007. Climate change, human security and violent conflict. *Political Geography*, 26, 639-655.
- 2003. Climate dangers and atoll countries. *Climatic Change*, 61, 321-337.
- Barnett, J. 2003. Security and climate change. *Global Environmental Change*, 13, 7-17.
- Brain, P. 2007. *The Impact of Carbon Prices on Victorian Selected Household Types: A Preliminary Analysis*, The National Institute of Economic and Industry Research, Melbourne.
- Brown, N. 1989. Climate, ecology and international security. *Survival*, 31, 519-532.
- Bureau of Meteorology 2007. *Annual Australian Climate Statement*. 2006. Issued January 3, 2007.: Bureau of Meteorology, Canberra. Retrieved March 30, 2008, http://www.bom.gov.au/announcements/media_releases/climate/change/20070103.shtml
- Bureau of Transport Economics (2001). *Economic costs of natural disasters in Australia. Report 103*, Bureau of Transport Economics, Canberra. Retrieved March 30, 2008, <http://www.btre.gov.au/docs/reports/r103/r103.aspx>
- Cambiar. 2007. *Submission to the National Emissions Trading Taskforce Secretariat for the Brotherhood of St Laurence*, May.
- Chen, K. & McAneney, J. 2006. High-resolution estimates of Australia's coastal population. *Geophysical Research Letters*, 33, L16601, doi: 10.1029/2006GL026981.

-
- CSIRO. 2007. CSIRO scientists and the climate change debate. Retrieved March 30, 2008, www.csiro.au/science/ps38v.html
- 2002. Climate Change & Australia's Coastal Communities. (8 page brochure). Retrieved March 25, 2008, www.dar.csiro.au/publications/coastal2002.pdf
 - 2001. Climate Change Impacts for Australia (8 page brochure). Retrieved March 25, 2008, www.marine.csiro.au/iawg/impacts2001.pdf
- CSIRO, & Bureau of Meteorology (BOM). 2007. Climate Change in Australia. Technical Report 2007. Retrieved March 30, 2008, www.climatechangeinaustralia.gov.au
- Department of Environment and Conservation 2007. Climate Change. Office of Climate Change, online publication. Retrieved March 20, 2008, http://portal.environment.wa.gov.au/portal/page?_pageid=54,5690855&_dad=portal&_schema=PORTAL
- Edwards, M. 1999. Security implications of a worst-case scenario of climate change in the South-west Pacific. *Australian Geographer*, 30, 311-330.
- Food and Agricultural Organisation (FAO). 2007. *Gender and Climate Change: Existing research and knowledge gaps*. Gender and Population Division, FAO. Rome.
- Fankhauser et al., 1997.
- Friends of the Earth Australia (FOE). 2007. *Climate Change and Equity*, FOE: Melbourne.
- Garnaut, R. 2008. Garnaut Climate Change Review: Interim Report to the Commonwealth, State and Territory Governments of Australia, February.
- Government of Western Australia. 2006. Draft State Water Plan. Retrieved March 20, 2008, <http://dows.kincdigital.com.au/files/Draft%20State%20Water%20Plan.pdf>
- 2003. Securing our Water Future: A State Water Strategy for Western Australia, Government of WA. Retrieved March 20, 2008, [http://dows.lincdigital.com.au/files/State Water Strategy complete 001.pdf](http://dows.lincdigital.com.au/files/State%20Water%20Strategy%20complete%20001.pdf)
- Green, D. 2007. Culture and Climate Change: Impacts for Indigenous Australians. *Just Policy*, 46, December, 18-20.
- Hamilton, C. 2007. *Scorchers: The Dirty Politics of Climate Change*, Black Ink: Sydney.
- Harle, K.J. Howden, S.M. Hunt, L.P. & Dunlop, M. 2007. The potential impact of climate change on the Australian wool industry by 2030. *Agricultural Systems*, 93, 61-89.
- Hennessy, K. 2007. *Climate Change Impacts, Adaptation and Vulnerability in Australia*. CSIRO Climate Change and Human Health Conference, Melbourne.
- Hennessy, K. Fitzharris, B. Bates, B.C. Harvey, N. Howden, M. Hughes, L. Salinger, J. Warrick, R. Becken, S. Chambers, L. Coleman, T. Dunn, M. Green, D. Henderson, R. Hobday, A. Hoegh-Guldberg, O. Kenny, G. King, D. Penny, G. & Woodruff, R. 2007. Chapter 11, Australia and New Zealand. In *Climate Change 2007, Summary for Policymakers*. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (eds). Cambridge University Press, Cambridge.
- Hunt, C. 2004. Australia's greenhouse policy. *Australasian Journal of Environmental Management*, 11, 2, 156-163.
- IOCI (Indian Ocean Climate Initiative). 2005a. *How our climate has changed* - Introduction. Compiled by Brian Sadler, Climate Note 1/05, Department of Environment, Perth..
- 2005b. How our temperatures have changed. Compiled by John Cramb, Bureau of Meteorology, Climate Note 2/05, Department of Environment, WA.
 - 2005c. How our sea temperatures have changed. Compiled by Feng, M. Meyers, G. & Church, J., CSIRO, Climate Note 3/05, Department of Environment, WA.
 - 2005d. How our winter atmospheric circulation has changed. Compiled by Smith, I & Hope, P. Climate Note 4/05, Department of Environment, WA.
 - 2005e. How our rainfall has changed - The south-west. Compiled by Hope, P. & Foster, I. Climate Note 5/05, Department of Environment, WA.
 - 2002. Climate Variability and Change in South West Western Australia. Indian Ocean Climate Initiative Panel, Department of the Environment, September. Department of Environment, Water and Catchment Protection, East Perth: WA. Retrieved, March 25, 2008, http://www.wrc.wa.gov.au/ioci/Tech_Report_2002_SC.pdf

-
- 2001. Towards Understanding Climate Variability in south-western Australia - Research Reports on the Second Phase of the Indian Ocean Climate Initiative, Water & Rivers Commission. Western Australia.
 - 2000. *Understanding the Past, Exploring the Future - The Oceans, the Atmosphere and Climate Variability in south-western Australia*. Water & Rivers Commission, Western Australia.
- IPCC. 2007a. Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (eds.) Cambridge University Press, Cambridge.
- Climate Change 2007: The Physical Science Basis. Summary for Policymakers. Contribution of Working Group 1 to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Approved by IPCC WGA, Paris, February 2007. Retrieved March 30, 2008, <http://www.ipcc.ch/SPM2feb07.pdf>
 - 2007b. Climate Change 2007: The Physical Science Basis. Summary for Policymakers. The Physical Science Basis, Contribution of Working Party Group I to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor & H.L. Miller (eds). : Cambridge University Press, Cambridge.
 - 2007c. Climate Change 2007: Mitigation. Contribution of Working Group III to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. In B. Davidson, O.R. Bosch, P.R. Dave, R. & Meyer, L.A. (eds.), Cambridge University Press, UK. Retrieved March 30, 2008, <http://www.ipcc.ch/ipccreports/ar4-wg3.htm>
 - 2004. IPCC Expert Meeting on the Science to Address UNFCCC Article 2 including Key Vulnerabilities, *Expert Meeting Report IPCC*: Buenos Aires, Argentina, May, 18-20.
 - 2002e. Climate Change 2001: Synthesis Report, Contributions of Working Groups I, II, and III to the *Third Assessment Report of the Intergovernmental Panel on Climate Change*, World Meteorological Organisation and United Nations Programme, IPPC, Cambridge University Press: Cambridge.
 - 2001a. Houghton, J. Ding, Y. Griggs, D. Noguer, M. van der Linden, P & Xiaosu, D. (eds.). The Scientific Basis Contribution of the Working Group I to the *Third Assessment Report of the Intergovernmental Panel on Climate Change*. World Meteorological Organisation and United Nations Programme, IPPC, Cambridge University Press: Cambridge.
 - 2001b. McCarthy, J. Canziani, O. Leary, N. Dokken, D. & White, K. (eds). Climate Change 2001: Impacts Adaptation and Vulnerability, Contribution of Working Group II to the *Third Assessment Report of the Intergovernmental Panel on Climate Change*, World Meteorological Organisation and United Nations Environment Programme, Cambridge University Press: Cambridge.
 - 2001c. Metz, B. Davidson, O. Swart, R. & Pan, J. (eds). Climate Change 2001: Mitigation, Contribution of Working Group II to the *Third Assessment Report of the Intergovernmental Panel on Climate Change*, World Meteorological Organisation and United Nations Environment Programme, Cambridge University Press: Cambridge.
 - 2001d. Climate Change 2001: The Scientific Basis Summary for Policymakers, A report of Working Group 1 to the *Third Assessment Report of the Intergovernmental Panel on Climate Change*, World Meteorological Organisation, Geneva: United Nations Environment Programme, PCC: Nairobi.
- Karl, T.R., & Trenberth. K E 2003. Modern Climate Change. *Science* 302 (5651), 1719-1723.
- Kates, R.W. Parris, T.M. & Leiserowitz, A.A. 2005. What is sustainable development?: Goals, indicators, values and practice. *Environment, Science and Policy for Sustainable Development*, 47, 8-21.
- Kent, A. & Mercer, D. 2006. Australia's mandatory renewable energy target (MRET): an assessment. *Energy Policy*, 34, 9, 1046-1062.
- Lal, R. 2005. Forest soils and carbon sequestration. *Forestry Ecological Management*, 220, 242-258.

- Lambert, F.G. Stott, P.A., Allen, M.R. & Palmer, M.A. 2004. Detection and attribution of changes in 20th century land precipitation, *Geophysical Research. Letters*, 31, L10203-6. Retrieved March 30, 2008.
- Lawlor, D.W. & Mitchell, R.A.C. 2000. Crop ecosystems responses to climatic change: wheat. In K R Reddy & H F Hodes (eds.), *Climate Change and Global Crop Productivity*. CAB International, Cambridge, pp. 57-80.
- Lee, C. 2002. Environmental Justice: building a unified vision of health and the environment. *Environmental Health Perspective Supplements*, 110, S2, April. Retrieved March, 30, 2008,
- Ludwig, F. & Asseng, S. 2005. Climate change impacts on wheal production in a Mediterranean environment in Western Australia. *Agricultural Systems*, 90, 159-179.
- Maddison, D. 2003. *The World Economy: Historical Statistics*, OECD Development Centre.
- McCarthy, J. Canziani, O. Leary, N. Dokken, D. & White, K. 2001. *Climate change 2001: Impacts, adaptation and vulnerability*. Cambridge: Cambridge University Press.
- McMichael, A.J. 2007. *Climate Change and Human Health: Implications for Risk Management and for Sustainability*. Climate Change and Human Health Conference, October, 2007, Melbourne.
- McMichael, A.J. 2006. *Climate Change and Risks to Health in Remote Indigenous Communities, Sharing Knowledge: A Workshop on Climate Change Impacts and Adaptation Strategies for Northern Australian Indigenous Communities*, Darwin, March 30-31.
- Monbiot, G. 2006. *Heat*, Allen Lane: London.
- Munasinghe, M. Canziani, O. Davidson, O. Metz, B. Parry, M. & Harrison, M. 2003. *Integrating sustainable development and climate change in the IPCC Fourth Assessment Report*. Munasinghe Institute for Development, Colombo, 44-52.
- National Drought Review Panel. (2004). *Consultations on National Drought Policy: Preparing for the Future*. Department of Agriculture, Fisheries and Forestry. Canberra.
- New Agriculturalists. 2005. *Climate Change: China's capacity to cope*. Retrieved March 25, 2008, <http://www.new-agri.co.uk/05-4/focuson/focuson6.html>
- New Zealand Ministry for the Environment 2001. Climate change impacts on New Zealand. *Report prepared by the Ministry for the Environment as part of the New Zealand Climate Change Programme*, Ministry for the Environment, Wellington, p. 39.
- Oppenheimer, M. & Alley, R.B. 2005. Ice sheets, global warming and Article 2 of the UNFCC. *Climate Change*, 68, 257-267.
- Peng, S.B. Huang, J.L. Sheehy, J.E., Laza, R.C. Visperas, R.M. Zhong, X.H. Centeno, G.S. Khush, G.S. & Cassman, K.G. 2004. Rice yields decline with higher night temperature from global warming. *PNAS* 101, 9971-9975.
- Pew Center. 2007. *Climate Change 101: Understanding and Responding to Global Climate Change*, Pew Centre on Global Climate Change and on US States. Washington.
- Pittock, A. B. 2006. "Are Scientists Underestimating Climate Change?". *EOS, Transactions American Geophysical Union*, 87, 34, 340-341.
- (ed.) 2003. *Climate Change: An Australian Guide to Science and Potential Impacts*. Prepared for the Australian Greenhouse Office: Canberra, ACT. Retrieved March 30, 2008, <http://www.greenhouse.gov.au/science /guide/index.html>
- Preston, B.L. & Jones, R.N. 2006. *Climate Change Impacts on Australia and the Benefits of Early Action to Reduce Global Greenhouse Gas Emissions*. A report for the Australian Business Roundtable on Climate Change, CSIRO, Canberra. Retrieved March 30, 2008, <http://www.csiro.au/resources/pfbg.html>
- Robinson, J.B. & Herbert, D. 2001. Integrating climate change and sustainable development. *International Journal of Global Environmental Issues*, 1, 130-149.
- Ryan, B. & Hope, P. 2005. *Indian Ocean climate initiative stage 2: report of phase 1 activity*. July 2003 to December 2004. Establishing the methodological foundations of stage 2 and updating regional interpretations from global climate modelling. IOCI, Perth.
- Schneider, S.H. & C. Azar, 2001 Are Uncertainties in Climate and Energy Systems a Justification for Stronger Near-term Mitigation Policies? Prepared for the Pew Center on Global Climate Change.

- http://stephenschneider.stanford.edu/Publications/PDF_Papers/UncertaintiesInClimate.pdf
- Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez & F. Yamin. 2007. Assessing key vulnerabilities and the risk from climate change. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (eds) Cambridge University Press, Cambridge. 779-810.
- Sherrard, J. & Tate, A. 2007. *An Australian Snapshot, Equity in Response to Climate Change Roundtable*, In Brotherhood of St. Lawrence, Equity in response to climate change roundtable, Brotherhood of St Lawrence, Melbourne.
- Simioni, G. Ritson, P. McGrath, J. Miko, U. Kirschbaum, F. Copeland, B. & Dumbrell, I. 2008. Predicting wood production and net ecosystem carbon exchange of *Pinus radiata* plantations in south-western Australia: Application of a process-based model. *Forest Ecology and Management*, 255, 901-912.
- Smith, I.N. McIntosh, P. Ansell, T.J. Reason, C.J.C. & McInnes, K. 2000. Southwest western Australian winter rainfall and its association with Indian Ocean climate variability. *International Journal of Climate*, 20, 1913-1930.
- Spickett J., Brown, H. & Katscherian, D. (c2008) *Health impacts of climate change: Adaptation strategies for Western Australia*. Department of Health. Perth.
- Stanley, J. 2007. Climate Change: The Opportunities and Costs of Carbon Pricing and Trading. *Just Policy*, 46, December, 60-65.
- Stern, N. (2007). Economics of climate change. The Stern Review. Cambridge: Cambridge University Press. www.hm-treasury.gov.uk/independent_reviews/sternreview_economics_climate_change/sternreview_index.cf Retrieved March, 25, 2008.
- Stott, P.A. Stone, D.A. & Allen, M.R. 2004. Human Contribution to the European Heatwave of 2003. *Nature*, 432, 610-614.
- Stehlik, D. (2008) *Climate change & social cohesion: What has the drought taught us?* Invited Paper to Drought Symposium. Australian Institute of Family Studies Conference. Melbourne Exhibition Centre. Melbourne. 9-11th July.
- Stehlik, D. Gray, I. & Lawrence, G. 1999. *Drought in the 1990s: Australian Farm Families' Experiences*. Rural Industries Research and Development Corporation, Resilient Agricultural Systems Research and Development RIRDC Publication No 99/14. RIRDC Project No. UCQ-5A, RIRDC, Canberra.
- Stehlik, D., Lawrence, G. & Gray, I (2000) Gender and Drought: Experiences of Australian Women in the Drought of the 1990s. *The Journal of Disaster Studies, Policy and Management*. 24. 1. 38-53.
- Swart, R. 1996. *Security risks of global environmental changes*. *Global Environmental Change*, 6, 187-192. The Climate Institute (2007a) Briefing: The Intergovernmental Panel on Climate Change Report - Implications for Australia. The Climate Institute (Australia), Sydney.
- 2007b. *Evidence of accelerated climate change*, November 2007. Prepared by the Climate Adaptation Science and Policy Initiative. The University of Melbourne for the Climate Institute, retrieved March, 30, 2008, http://www.climateinstitute.org.au/images/stories/C1056_EACC_Report_v1.pdf
- The National Institute of Economic and Industry Research. 2007. *The impact of carbon prices on Victorian and Australian households*. A report for the Brotherhood of St Laurence, Melbourne, May.
- Timbal, B. Arblaster, J.M. & Power, S. 2006. Attribution of the late-twentieth century rainfall decline in Southwest Australia. *Journal of Climate*, 19, 2046-2062.
- Turner, B. L. Turner, II, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Grete K. Hovelsrud-Broda, Jeanne X. Kaspersen, Roger E. Kaspersen, Amy Luers, Marybeth L. Martello, Svein Mathiesen, Rosamond Naylor, Colin Polsky, Alexander Pulsipher, Andrew Schiller, Henrik Selin, & Nicholas Tyler 2003.

-
- Illustrating the Coupled Human-Environment System for Vulnerability Analysis: Three Case Studies. *Proceedings of the National Academy of Science*, 100, No. 14, July 18.
- Turton, H. 2004. Greenhouse gas emissions in industrialised countries: Where does Australia stand? *Research Paper, No. 66*, The Australia Institute, Canberra.
- United Nations Framework Convention on Climate Change. 2007. Draft decision -/CP.13: *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Decisions adopted by COP 13 and CMP 3, United Nations Climate Change Conference 2007, Bali, Indonesia. Retrieved March 25, 2008, http://unfccc.int/files/meetings/cop_13/application/pdf/cp_arfour.pdf
- U.S. Committee on Climate Change & Transportation 2008. *Potential Impacts of Climate Change on U.S. Transportation: Special Report 290*. Committee on Climate Change and U.S. Transportation. Retrieved March 30, 2008, <http://www.nap.edu/catalog/12179.html>.
- van Ittersum, M.K., Howden, S.M. & Asseng, S. 2003. Sensitivity of productivity and deep drainage of wheat cropping systems in a Mediterranean environment to changes in CO₂, temperature and precipitation. *Agriculture, Ecosystems and Environment*, 97, 255-273.
- Van Herwaarden, A.F. Richards, R.A., Farquhar, D.G. & Angus, J.F. 1998. "Haying-off" the negative grain yield response of dryland wheat to nitrogen fertiliser. III. The influence of water deficit and heat shock. *Australian Journal of Agricultural Research*, 49, 1095-1110.
- Vellinga, M. & Wood, R.A. 2006. Impacts of thermohaline circulation shutdown in the twenty-first century. *Climatic Change*, doi 10.1007/s10584-006-9146-y.
- Wiseman, J. 2007. Climate Change and Social Justice: Towards an Australian Research and Policy Development Agenda. *Just Policy*, 46, 8-11.
- Woodruff, R., Hales, S., Butler, C. & McMichael, A. J. 2006. *Climate Change Health Impacts In Australia: Effects of Dramatic CO₂ Emission Reductions*. Report for the Australian Conservation Foundation and the Australian Medical Association. Prepared by National Centre for Epidemiology and Population Health, The Australian National University and Department of Public Health, Wellington School of Medicine, University of Otago, New Zealand..
- World Bank. 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. Washington DC, USA World Bank.
- Water Corporation. 2006. *Planning for New Sources of Water*. West Australian Water Corporation. Retrieved March 28, 2008, http://www.watercorporation.com.au/W/water_sources_new.cfm
- 2005. Perth water desalination project.
- Zillman, John W., Warwick McKibbin, J., & Aynsley Kellow. 2005. *Uncertainty and Climate Change: The Challenge for Policy*. Academy of Social Sciences. Canberra. Policy Paper 3.