Rain on Our Parade:
La Niña and the Impact of Climate Change on 'Sunny' Sydney

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Dismal, grey and wet: Sydney summers had been fizzers in the early 1960s. In sympathy with the clouds that lined the horizon, a feeling of irritability accompanied the longing for a decent hot summer. The fifties had been very wet, the wettest decade ever in New South Wales. Sydney-siders concluded that they lived in a wet climate. Four wet summers in a row had put a damper on the expectations of city dwellers that summer should be sunny, warm and, above all, dry. The experience of severe and extended drought in the forties had faded into the past. If heavy rain continued for an extended period of time it was felt that the problems of water supply, so evident in previous droughts, would be overcome. Yes, it was time for a break in the weather.

This paper examines perceptions of climate in Sydney in the twentieth century and argues that it is influenced by everyday experience and

Sydney Journal
Vol 4, No 1 (2013): 141-153
ISSN: 1835-0151

memory of what has gone before. It relates notions of climate with the oscillating cycles of the main climate drivers in Australia, the inter-annual cycle of El Niño Southern Oscillation and the longer inter-decadal cycle of the Inter-decadal Pacific Oscillation. This paper demonstrates how these natural cycles – these changes in the climate between years and between decades – can influence our perception of what is 'normal' and what is unusual. It uses popular conceptions of weather taken from the press as markers of public opinion. [1]I argue that natural climate cycles and how they make us think about the weather, can mask popular recognition of permanent human-induced climate change.

Sydney's climate is described as 'pleasantly moderate' on the City of Sydney's website. But in the early sixties the weather seemed far from pleasant. In 1963, Sydneysiders decided they were suffering from a paucity of summer heat and sunshine. There had been three 'dismal' summers in a row in NSW and headlines such as the *Sydney Morning Herald's* 'Summer: Will there be one?' typified the sense of longing for a decent, hot summer. Nostalgia for the 'lazy, hazy day' of a 'real summer' seemed to infect government officials as well with the Sydney Weather Bureau's information officer, Pat Carr, predicting that the 1963-64 summer was unlikely to bring a 'break' from the watery weather.[2] As Carr remarked: 'Well, let's face it, we live in a wet climate.' The *Herald* agreed that it had been four years since Sydney had 'basked in sunshine' through the Christmas/New Year holiday period and had contended with 'soggy' conditions since. By September the city had experienced 1627 mm of rain which was more than the set annual average at that time (1216 mm). Fine weather between September and December was seen as an 'unlikely prospect' and the *Herald* predicted that the annual rainfall record of 2194 mm (86.33 inches) set in 1950, would be exceeded.[3]

In order to gauge what had happened to the weather, the *Herald* spent considerable time poring over a century of Sydney rainfall records with Carr. It was noted there had been a steady decline through the turn of the century, tenuously maintained into the 1940s. Since then there had been an overall return to higher rainfalls with more wet than dry summers and winters over the previous twenty years. The *Herald* concluded that the city was more adequately equipped to deal with water shortages than in the times of the eleven successive dry summers in the drought years between 1899 and 1910. This seemed to be an assurance that a hot, dry summer would not be a discomfort, but rather a pleasure to be looked forward to.[4]

A bleak winter spurred the desire for warm, blue-sky summers. Writing in July, Rastus of Riverwood commented in a Letter to the Editor: 'I have, like everyone else, been cursing the wet weekends… I'm eagerly awaiting the next glimmer of blue sky to break.'[5]

Two years earlier, in the summer of 1961, *Australian Women's Weekly* columnist Dorothy Drain, summed it up for her readers when she panned the Weather Bureau. The bureau had predicted that the weather 'should be finer'. 'What he meant', wrote Drain, 'was that tomorrow wouldn't be quite so miserably, soakingly, chillingly, sloppily, mouldily wet'. 'To be finer', she noted, 'the weather needed first to be fine, which it hadn't been for days'. But after the spell New South Wales had endured, she decided she 'couldn't blame the Weather Bureau for trying to find a cheerful wording for its bulletin'.[6] So, what had brought about this dreadful run of bad weather?

Climate Drivers

Although not identified by climate scientists as such at the time, in 1963, and for the fifteen years prior and after, Sydney weather was under the combined influence of two of the most significant climate drivers that impact eastern Australia.

One of these, the El Niño Southern Oscillation or ENSO, was identified in the late sixties.[7] After the past two summers most of us have become familiar with the wet cycle of ENSO, that of La Niña. We have experienced the heavy rainfall and flooding that often accompanies a La Niña event. The flipside of La Niña is El Niño, which brings drier weather and sometimes prolonged and extended drought. While La Niña and El Niño may be household names, less familiar is the longer inter-decadal cycle that underpins ENSO. This cycle can last between fifteen and thirty years and is known as the Inter-decadal Pacific Oscillation (IPO). The importance of the IPO is that it acts as either a brake or a throttle on ENSO. For much of the fifties and until the late seventies, the IPO was in a 'cool' cycle. This had the effect of accentuating the La Niña events as when the 'cool' cycle of the IPO combines with La Niña, the impact of La Niña is reinforced.[8]

Why the weather was getting on everyone's nerves in Sydney by 1963 was that there seemed to have been a change from a dry to a wet climate. There had been a run of wet years since 1950 with only a few dry patches. NSW was soaked by back to back La Niñas in 1950-51 and from 1954-57. This prolonged wet period started in decisively in 1950 when Sydney was deluged, particularly in the winter months of June and July. The city recorded a total of 2194 mm that year (almost twice the

annual long-term average of 1215 mm) and although it was wetter than usual in the La Niña years of 1955 (1842mm) and 1956 (1711mm) there has not been a year as wet since.[9] The wet weather was so intense and prolonged that some city residents felt moved to write to the *Sydney Morning Herald*, stating that what was needed was a good drought. The heavy rainfall in 1950 brought chaos at times. Landslides undermined houses and blocks of flats, rendering scores of residents homeless. In Tamarama two homes were made unsafe by a landslip, with the lounge of one being carried away.[10] On July 24 floodwaters threatened homes, disrupted public transport, and took the life of a 13-year-old boy. Gordon Hogden had been diverting water to a drainage channel in an attempt to save his pet canaries, when he slipped into the channel and was carried away into the nearby George's River. In Clovelly, seven-year-old Marilyn Newton was pulled semi-conscious from under a parked car where she had been wedged by floodwaters after falling while crossing a flooded road. Her mother had managed to save her sister Margaret but Marilyn was carried away down the flooded gutter of Clovelly Road.[11] By September the rainfall total for the year had succeeded all others in the twentieth century.

The fifties in NSW were to remain wet with 1955 and 1956 almost as wet as 1950. The heavy rain that caused much flooding throughout NSW, Victoria and Queensland, was due to an extended La Niña event that ran from April 1954 until January 1957.

The longing for a decent hot summer expressed by meteorologist Pat Carr and *Herald* readers in 1963 was to be satisfied at the end of that year as the influence of the IPO weakened somewhat in mid cycle. The Sixties saw two El Niño events – that of 1963-64 and another close on its heels in 1965-66. Both were marked by sweltering temperatures, even on the coast, and sustained drought conditions. The latter was marred by extensive bushfires and smoke from the Australian fires drifted east across the Tasman and spread a brown haze over much of New Zealand. But the 'cool' IPO reasserted its influence and La Niña dominated the early seventies – 1970, 1971, 1973, 1974 and 1975 were La Niña years[12] – until the longer-term climate cycle switched from cool to warm in 1976.[13]

The longer-term cycle of the IPO is a relative newcomer to the climate science stable. But these shifts in climate did not go unnoticed in the twentieth century. Commentary in the *Sydney Morning Herald* in 1950 wondered if a drought would follow the heavy rains and questions to various 'experts' on this matter elicited the opinion that this was likely. V.R. Alldis, a surveyor and amateur weather watcher from Orange, was of the opinion that droughts and floods seemed to be associated and that it was very likely that a severe drought would follow the exceptional

rains.[14] The peaks of wet and dry were separated by about 30 years, according to Alldis's observations – the same span given by today's climatologists to the cycles of the IPO.[15]

WEATHER AND MEMORY

Orlove and Strauss make the distinction between how people describe weather and climate and how they comprehend them.[16] I would argue that there is quite a lot to be gained from understanding how ordinary people gauge the shifts in climate, how our experience and memory of weather events can influence the way we think about climate as a whole. As Tim Sherratt has argued, in 1950 a long wet and cold spell 'led many Sydneysiders to conclude that the climate was changing for the worse'. Moreover, bouts of what seemed unusually hot or cold weather throughout the late nineteenth and twentieth centuries brought forth exchanges between ordinary weather observers and meteorologists who debated the extent to which the climate was changing or remaining the same. Meteorologists had statistics on their side, but ordinary people relied on memory.[17]

'Popular' conceptions of weather have their limitations. As Garden argues, memory, oral traditions and written records such as crop returns cannot be termed scientifically reliable. However, memory has its place, if only to convey how climate and weather have been perceived.[18] In the summer of 1892-93, for example, Sydneysiders were lamenting the lack of sunshine over the Christmas-New Year holiday period. Indeed the weather seemed more like winter than the usual 'sweltering heat of the average January'. A local poet was moved to write:

> Southerlies and showers on Sunday
> Ditto, ditto booked for Monday.
> Tuesday cold and slightly wetter,
> Wednesday worse instead of better.
> Thursday stormy winds will blow,
> Friday hail and frost and snow.
> Saturday a foot of rain,
> Then the same sweet round again.
> Holiday-makers fume and bustle,
> Cursing Wragge and likewise Russell.[19]

COMMUNICATING CLIMATE CHANGE

The reference to meteorologists Clement Wragge and Henry Chamberlain Russell shows the connection between men of science and weather events at the time. Indeed, meteorologists were often the butt of

jokes about the weather, particularly when their forecasts proved inaccurate.[20]

One of the dilemmas for today's climate scientists is how to adequately communicate the reality of permanent anthropogenic climate change – that somewhat thorny issue of global warming, the debate about which is currently fuelled by energy use reform and the carbon tax. I can see how political expediency drives the agendas of some of the radio shock jocks, and the stark opposition of some politicians to the consensus of twenty-first century climate science.[21]

But what of everyday, ordinary Australians, many of whom oppose strategies such as the Clean Energy Bill and are unsure that permanent climate change is upon us – who remain unconvinced? What feeds their doubts? As Clive Hamilton has asked, why in a continental nation 'where the climate deeply affect our psyches', do Australians appear to be in a state of denial? Hamilton argues that even some environmentalists have not fully gauged the gravity of climate change. He concludes that an adherence to an economic growth fetish and a naivety about the ability of humans to control climate are some of contributing factors to this denialism.[22]

Other arguments put forward range from an inability to comprehend the complexities of climate science, to the conspiracy theory – that the oil companies are funding experts who will help the case of climate change denial and more recently the publicity and doubt cast on scientific findings. It's been evident in both the United States and Australia that the concern about human-induced global warming has subsided since 2008. In 2006 addressing climate change was thought to be the number one foreign policy priority in Australia and in 2007 the most important domestic policy priority. Australians supported strong action on climate change.

In 2006 more than two thirds of the people surveyed by the Lowy Institute for International Policy agreed with the statement, 'global warming is a serious and pressing problem. We should begin taking steps now even if this involves significant costs'. All this has changed. In 2010 and 2011, dealing with climate change ranked third last among 12 foreign policy priorities, down 29 per cent since 2007.[23] In the US, most Gallup measures up to 2008 had shown increasing concern over global warming on the part of the average American. The public opinion tide turned in 2009, when several Gallup measures showed a slight retreat in public concern about warming. In 2010, the downturn was even more pronounced.[24]

A Change in the Weather

The decline in concern about permanent human-induced climate change, it has been argued, is also a reflection of everyday events such as changes in the weather.[25] On a continent such as this one, where climate is highly variable due to ENSO, natural cycles can mask public perception of permanent change. In America there had been record-breaking snow and cold temperatures in the winter of 2000-10.[26] In Australia, where we worry about drought and water shortages a lot of the time, our last two summers have been very wet due to very strong La Niña events. In something of a parallel to how wet summers were viewed in the early sixties the past two summers have elicited headlines such as 'More rain as city's hopes of summer fade to grey', in February 2012 and, 'Heavy rain spoils Sydney weekend' shortly before the Australia Day holiday.[27]

The consequences of heavy rain in the summer of 2010-11 were more serious than a BBQ stopper in cities such as Brisbane and towns in southeast Queensland and north western Victoria. On 11 January 2011 an eight-metre wall of water flowed down the Lockyer Valley in Southeast Queensland. The next morning Queensland Premier, Anna Bligh confirmed that eight people were dead and eleven missing. Queensland Police Commissioner, Bob Atkinson, likened the flood to 'an inland instant tsunami'. Although Bligh commented that this was Queensland's darkest hour, worse was to come.[28] As the flood rains headed downstream to the coast, water released from the Wivenhoe Dam produced a flood wave that put much of Brisbane under water between 11-12 January.[29] In all 33 people died from flooding in Queensland from late December 2010 to mid January 2011 and three remained missing. More than 78 per cent of the state was declared a disaster zone and more than more 2.5 million people were affected. Over the period of a few weeks, some 29,000 homes and businesses suffered some form of inundation.[30]

The scale of the disaster led to the establishment, on 17 January 2011, of the Commission of Inquiry into the Queensland floods of 2010-11. The commission reported its findings in March 2012. In their final report the commissioners commented that the floods took a state 'more accustomed to drought by surprise'. While the commission saw room for improvement in planning for emergency response, it noted:

> the disastrous floods which struck south-east Queensland in the week of 10 January 2011 were unprecedented, in many places completely unexpected, and struck at so many points at once that no government could be expected

> to have the capacity to respond seamlessly and immediately everywhere, and in all ways needed. A great deal can be doneto improve readiness to deal with disaster generally, but it is impossible that any government could be permanently ready to come at once to the assistance of everyone needing help in a disaster of that scale and suddenness, unless it were to maintain a standing force of rescue personnel beyond the present capacity of society to fund.[31]

As La Niña wound down Sydney experienced record rains in the month of March, 200 mm falling in 24 hours on 21 March which was one and a half times the monthly average.[32] Later in 2011 the *Herald* ran a headline linking flooding in Australia with climate change.[33]

Some of the confusion about permanent human-induced climate change due to global warming surrounds that term 'warming'. Many of us feel that the past two summers have not been all that warm at all. In fact we feel we have missed out. While climate scientists agree that the world has warmed and rainfall patterns have shifted, how do we relate that to what we experience when it rains heavily and temperatures are cooler than expected?

Climate scientist Neville Nicholls relates an initially somewhat amusing experience when his family holidayed on the Gold Coast in the pouring rain in 1991. Nicholls had been involved in forecasting an El Niño. As the family drove north through driving rain to Queensland the Met Bureau made the announcement that another El Niño was on its way. The joke soured of course, when the kids grew tired of the soggy conditions while very wet *Courier Mail* billboards outside every newsagent and milk bar trumpeted 'Drought Fear: El Niño Returns'. But the rain stopped, the family enjoyed their beach holiday, and the remainder of the year was very dry.[34]

Climate Shifts

In 2008, some 40 years after the resignation of Pat Carr to Sydney's soggy weather of 1963, the Bureau of Meteorology no longer thought NSW had a wet climate. This is no surprise in a way as the long-term climate cycle had shifted from 'cool' to 'warm'. After the drying impact of the 2006-7 El Niño, the Bureau of Meteorology's head of climate analysis, David Jones, questioned whether drought had become a permanent state. South-eastern Australia had been particularly hard hit by this El Niño. By November 2007, large parts of southern and eastern Australia had been mostly dry since October1996, a total of eleven years. For some

areas, the accumulated total rainfall deficit over this period was in excess of a full year of normal rain.[35] Jones pointed to NSW's mean temperature gain of 1.13 degrees above the average when he commented: 'Perhaps we should call it our new climate'.[36]

Clive Hamilton has warned that the consequences for Australia of climate change will be horrendous. There is a high probability of vast tracts of the continent settling into a permanent El Niño state, he has said.[37] Since then the IPO is thought to have entered another 'cool' phase and we have had the two severe La Niña events. But the general trend is for the north of Australia to get wetter and the southeast of the continent to dry. As well, an overall rise in temperature has been experienced which is most pronounced in Queensland.

A Hotter Sydney

For Sydney permanent climate change is expected to result in a high number of heat-related deaths, from an annual 176 to between 364 and 417 by 2020. This is because Sydney will heat up. The average annual Sydney temperature (calculated on a 1971-2000 base) now stands at 18.3 degrees Celsius. This is expected to rise around one degree Celsius by 2030 and the number of days each year over 35 degrees Celsius to increase. Indeed, this trend to higher temperatures already appears to be in place. The average daily temperature at Sydney Observatory Hill was 0.8 degrees Celsius above average during 2012, with temperatures closer to normal at shorter-record stations in western Sydney. This was the twentieth consecutive year with above-average temperatures in Sydney, with both days and nights warmer than average in the city.[38] In addition the city will get drier. Sydney's annual rainfall is predicted to decrease from an annual average of 1277 mm to about 1238 mm by 2030. The city's coastal suburbs and settlements along waterways will also be impacted by sea level rises of between 18 to 59cm by 2100.[39]

While many climate scientists have been reluctant to link individual extreme events to human-induced climate change the peak climate body has tentatively moved in this direction. The Intergovernmental Panel on Climate Change 2011 report supported previous findings linking climate change to the intensity and frequency of natural disasters such as bushfires, floods and droughts. With an ENSO-driven climate, Australia is vulnerable to this increase in natural disasters.[40]

More recently climate researchers have attributed the severe weather of 2011 to the effects of human activity on the planet's climate systems. Last year's record warm November in the United Kingdom – the second hottest since records began in 1659 – was at least 60 times more likely to

happen because of climate change than owing to natural variations in the Earth's weather systems, according to studies by the National Oceanic and Atmospheric Administration in the United States, and the Met Office in the United Kingdom. The devastating heat wave that blighted farmers in Texas in the United States last year, destroying crop yields in another record 'extreme weather event', was about 20 times more likely to have happened owing to climate change than to natural variation.[41]

In Australia, where ENSO and the IPO are the major climate drivers, how we view these changes in cycles is an important step in recognising the presence of permanent human-induced climate change and in being able to plan for it. So what we think about the weather has far-reaching effects. As Tim Sherratt argues, 'Global warming demands changes in our behaviour that are unlikely to be achieved solely by rational persuasion. We receive the warnings not as scientists or statisticians. But as people who have known the weather intimately all our lives. The context in which we each must grapple with the challenges of climate change is not in the detailed records of meteorological observations, but in the realm of emotion and meaning.'[42]

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ENDNOTES

[1] While there are limitations to using newspaper sources, particularly as such accounts of weather can be open to considerable interpretation, nevertheless, as Garden argues they provide a rich and diverse picture of weather conditions, their impact, and of the human and economic repercussions as well as contemporary insights on local issues and ideas. See Don Garden, *Droughts, Floods and Cyclones: El Niños that shaped our colonial past,* Australian Scholarly Publishing, North Melbourne, 2009, p19.

[2] Bob Johnson, 'Summer: Will there be one?', *SMH*, 1 September 1963, p43.

[3] ibid.

[4] ibid.

[5] Rastus, Letter to the Editor, *Australian Women's Weekly*, 24 July, 1963, p74S.

[6] Dorothy Drain, 'It Seems to Me', *Australian Women's Weekly*, 13 December 1961, p17.

[7] Some basic understanding of El Niño Southern Oscillation was developed between the 1870s and 1940s. See Don Garden, *Droughts, Floods and Cyclones: El Niños that shaped our Colonial Past,* Australian Scholarly Publishing, North Melbourne, 2009. In 1969 Norwegian Jacob Bjerknes described the El Niño Southern Oscillation (ENSO) as a Pacific basin-wide interannual variation of the tropical ocean and atmosphere interactions. See, J. Bjerknes, 'Atmospheric teleconnections from the equatorial Pacific,' Mon. Wea. Rev., 1969: 97, pp163-172. Since then this analysis has been considerably developed. The Australian Bureau of Meteorology defines ENSO in these terms: 'The term El Niño refers to the extensive warming of the central and eastern tropical Pacific Ocean which leads to a major shift in weather patterns across the Pacific. This occurs every three to eight years and is associated with a weaker Walker Circulation and drier conditions in eastern Australia. El Niño Southern Oscillation (ENSO) is the term used to describe the oscillation between

the El Niño phase and the La Niña, or opposite, phase.' Australian Bureau of Meteorology, 'El Niño Southern Oscillation (ENSO)', http://www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml?bookmark=enso.

[8] This relationship between ENSO and the IPO is discussed in Greg McKeon, Wayne Hall, Beverly Henry, Grant Stone, Ian Watson, *Pasture degradation and recovery in Australia's Rangelands: Learning from History,* Indooropilly, Queensland, Department of Natural Resources, Mines and Energy, 2004, pp40-41.

[9] Bureau of Meteorology, 'Monthly Rainfall: Sydney (Observatory Hill)' http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_stn_num=066062

[10] 'Foundations undermined: families leave flats', *SMH,* 20 July 1950, p3.

[11] 'Bankstown Boy Disappears', 'Rain Chaos in Sydney and Suburbs', *SMH,* 24 July 1950, p1.

[12] Over the 22-month period from June 1970 to March 1972 rainfall was above average over much of Queensland, NSW, Victoria, Tasmania and the southeast of South Australia. Tasmania was particularly wet, with most of the state having totals in the highest 10% of the historical record as did southwest Victoria, coastal SA and some parts of eastern Queensland. Some notable dry periods occurred during the event. Apart from in Tasmania and southern Victoria, winter 1970 was especially dry. Summer 1970–71 was drier than average over the Northern Territory, western Queensland, South Australia and eastern WA, while the March–June period in 1971 was much drier than average from southeast Queensland, through eastern NSW to East Gippsland. There were several floods during this La Niña. In August 1970, 89% of Tasmania had monthly rainfall in decile 10, with flooding on the Deloraine and La Trobe rivers in the north of the state. Flash floods occurred in Canberra in January 1971, while in February of that same year, there was widespread flooding in the Gippsland area of Victoria, which caused large agricultural losses. March brought flooding in Broken Hill. Australian Bureau of Meteorology, 'La Niña: Detailed Australian Analysis', http://www.bom.gov.au/climate/enso/lnlist/.

[13] R.J. Allan, G.S. Beard, A. Close, A.L. Herczeg, P.D. Jones, and H.J. Simpson 'Mean Sea Level Pressure Indices of the El Niño-Southern Oscillation: Relevance to stream discharge in south-eastern Australia', April 1996, CSIRO Divisional Report 96/1 ISSN 1033 5579.

[14] 'Will Drought Come Next?', *SMH*, August 23 1950, p2.

[15] 'Wet and Dry Years', *SMH,* September 4 1950, p2.

[16] Sarah Strauss and Ben Orlove (eds), *Weather, Climate, Culture,* Berg, Oxford and New York, 2003.

[17] Tim Sherratt, 'Human Elements', Tim Sherratt, Tom Griffiths and Libby Robin (eds), *A Change in the Weather: Culture and Climate in Australia*, National Museum of Australia Press, Canberra, 2005, p2.

[18] Don Garden, *Droughts, Floods and Cyclones: El Niños that shaped our colonial past,* Australian Scholarly Publishing, North Melbourne, 2009, p18.

[19] 'Our Lost Summer', *Illustrated Sydney News*, 7 January 1893, p3.

[20] Henry Chamberlain Russell was Government Astronomer of New South Wales from 1870-1905. G.P. Walsh, 'Russell, Henry Chamberlain', *Australian Dictionary of Biography*, http://adb.anu.edu.au/biography/russell-henry-chamberlain-4525. Clement Wragge was a meteorologist in the Queensland Weather Bureau from 1887 to 1903. Paul D. Wilson, 'Wragge, Clement Lindley', *Australian Dictionary of Biography*, http://adb.anu.edu.au/biography/wragge-clement-lindley-9193.

[21] A CSIRO study of communicating climate change in Australia concluded: 'the majority of respondents find that climate change is a complex issue that is often difficult to understand. It is perceived as a topic of considerable importance for the scientific community, although there is a perception of disagreement among scientists about climate change, and there is doubt about the capacity of science to

predict the nature and effects of climate change'. Peta Ashworth, Talia Jeanneret, John Gardner and Hylton Shaw, 'Communication and Climate Change: what the Australian public thinks', CSIRO, May 2011, http://www.csiro.au/files/files/p11fh.pdf.

[22] Clive Hamilton, 'The social psychology of climate change', in Sherratt, Griffiths and Robin (eds), p187.

[23] Michael Wesley, 'Climate Views have moved on', *The Australian*, July 2012, http://www.theaustralian.com.au/national-affairs/opinion/climate-views-have-moved-on/story-e6frgd0x-1226413834287. A CSIRO study has found that the measurement of actual knowledge of climate change demonstrates that the public's level of knowledge remains moderate to low. The study concludes this finding suggests that 'communication attempts about climate change may be poorly understood by the general public without the provision of further explanatory information'. Peta Ashworth, Talia Jeanneret, John Gardner and Hylton Shaw, 'Communication and Climate Change: what the Australian public thinks', CSIRO, May 2011, http://www.csiro.au/files/files/p11fh.pdf.

[24] Lydia Saad, 'Increased number think global warming is "exaggerated": most think global warming is happening but urgency has stalled', 11 March 2009, http://www.gallup.com/poll/116590/Increased-Number-Think-Global-Warming-Exaggerated.aspx.

[25] Lydia Saad, 'Increased number think global warming is "exaggerated": most think global warming is happening but urgency has stalled', 11 March 2009, http://www.gallup.com/poll/116590/Increased-Number-Think-Global-Warming-Exaggerated.aspx. On the other hand, Howe et al argue that the experience of local weather events and climate change may play an important role in the formation and support of public policy aimed at mitigating the impact of a changing climate. They maintain that 'people can perceive and adapt to aspects of climate variability and change based on personal observations', and that these observations can influence their opinion on climate change on a global basis. Peter D. Howe, Erza M. Markowitz, Tien Ming Lee, Chia-Ying Ko, Anthony Leiserowitz, 'Global Perceptions of Local Temperature Change', *Nature Climate Change,* April 2013, vol 3, no 4, pp352-56. A CSIRO study of Australian perceptions of climate change found that, adverse weather patterns, temperature changes and seasonal changes were cited as evidence that climate change was already happening. Peta Ashworth, Talia Jeanneret, John Gardner and Hylton Shaw, 'Communication and Climate Change: what the Australian public thinks', CSIRO, May 2011, http://www.csiro.au/files/files/p11fh.pdf.

[26] Frank Newport, 'Americans' Global Warming Concerns Continue to Drop', *Gallup Politics*, 11 March 2010, http://www.gallup.com/poll/126560/americans-global-warming-concerns-continue-drop.aspx.

[27] James Robertson, 'More rain as city's hopes of summer fade to grey', *SMH*, 2 February 2012, http://www.smh.com.au/environment/weather/more-rain-as-citys-hopes-of-summer-fade-to-grey-20120201-1qtij.html, 'Heavy rain spoils Sydney weekend', 16 January 2012, http://www.smh.com.au/environment/weather/heavy-rain-spoils-sydneys-weekend-20120116-1q265.html.

[28] Aaron Cook, Philip Wen and Wendy Frew, 'Weeks of Rain, one fatal hour,' *SMH*, 11 January 2011, http://www.smh.com.au/environment/weather/weeks-of-rain-one-fatal-hour-20110110-19l7n.html#ixzz23bBz3aTe.

[29] Marissa Calligeros, 'Wivenhoe Dam release caused Brisbane flood: report', *SMH, 11* March 2011, http://www.smh.com.au/environment/weather/wivenhoe-dam-release-caused-brisbane-flood-report-20110311-1bqk7.html.

[30] Queensland Floods Commission of Inquiry, Final Report, March 2012, http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0014/11705/QFCI-Final-Report-Preface,-Chapter-1-Introduction.pdf.

[31]Queensland Floods Commission of Inquiry, Final Report, March 2012, http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0014/11705/QFCI-Final-Report-Preface,-Chapter-1-Introduction.pdf.

[32] Glenda Kwerk, 'Sydney's heavy weather: six weeks' rain in a day', *SMH,* 21 March 2011, http://www.smh.com.au/environment/weather/sydneys-heavy-weather-six-weeks-rain-in-a-day-20110321-1c2t7.html.

[33] Karen Kissane, 'Flooding rains plain truth of climate change: scientist', *SMH*, 21 October 2011, http://www.smh.com.au/environment/climate-change/flooding-rains-plain-truth-of-climate-change-scientist-20111020-1macf.html#ixzz23mczIpyG

[34] Neville Nicholls, 'Climatic Outlooks: from revolutionary science to orthodoxy', in Tim Sherratt et al, *A Change in the Weather: Climate and Culture in Australia,* National Museum of Australia, Canberra, 2005, pp18-29.

[35] National Climate Centre, Special Climate Statement 14: Six years of widespread drought in southern and eastern Australia November 2001–October 2007, 1 November 2007, http: www.bom.gov.au/climate/current/statements/scs14.pdf.

[36] Richard Masey, 'This drought may never break', *SMH*, 4 January 2008.

[37] Clive Hamilton, 'The social psychology of climate change,' in Sherratt, Griffiths and Robin (eds), *A Change in the Weather*, p187.

[38] Australian Bureau of Meteorology, Sydney in 2012: Average conditions hide a year of two halves, http://www.bom.gov.au/climate/current/annual/nsw/archive/2012.sydney.shtml#summary.

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