4. Understanding climate change

What this chapter is about

- The natural variability in climate thought to affect Sydney's supply and demand balance
- The need to better understand and adapt to human-induced climate change
- New studies to increase understanding of natural variability and the potential impacts of climate change on Sydney's supply and demand balance.

What has been done to understand climate change

- NSW studies have built on international and national studies to increase understanding of the effects of human-induced climate change across a range of sectors and to progress strategies for limiting greenhouse gas emissions
- A study to understand the effect of future greenhouse gas emission scenarios on projected runoff into Sydney's main water storages has commenced.

What will be done next

- Studies to consider climate variability and climate change impacts on Sydney's future rain-fed water supply and Sydney's demand for water will continue and will inform future iterations of the *Metropolitan Water Plan*.

4.1 Introduction

As outlined in the previous chapter, securing Sydney's water needs in drought has been a principal driver shaping the configuration of the rain-fed water supply system, including decisions to implement water restrictions. The current estimate of water available from the system is influenced by the observed pattern of runoff into Sydney Catchment Authority's storages over the last 96 years, a relatively short period in climatic terms. As well as affecting the amount of water in storages, climate also affects the rate at which the water is consumed.

Both natural and human-induced phenomena affect regional and local climate. Major international, national and NSW studies have been undertaken, and some studies specific to the Sydney region have commenced. To manage Sydney's water supply and demand balance over the long term requires improved understanding of climatic cycles and trends, as described below.

4.2 Climate variability in the Sydney region

Sydney's climate is thought to vary naturally over a number of time scales. At times, single rain events deliver large proportions of the annual rainfall. The ENSO (El Niño-Southern Oscillation) phenomenon, characterised by alternating drought and wet periods at opposite sides of the Pacific Ocean, can also impact Sydney rainfall patterns over a timescale of a few years up to a decade. Many El Niño years (such as 1965, 1982, 1994 and 2002) were associated with very low rainfall in the Sydney region.

Longer term rainfall variability in the Sydney region is more difficult to quantify because written records of rainfall and river heights in the Sydney region are available only for the relatively short period of time coincident with establishment of farmlands, towns and the like.

In order to improve understanding of longer term rainfall variability, the University of Newcastle is undertaking research for the Sydney Catchment Authority on long term rainfall patterns in the Sydney region over the last 1,000 years. This study will use techniques that look for evidence of wetting and drying cycles in natural archives. For example, stalagmites are highly responsive to climate variability because the composition of the drip waters that feed them changes with shifts in regional temperatures, biological activity and rainfall. The physical characteristics of sediment that builds up on river floodplains, such as changes in particle size, can show the history and magnitude of past floods. Stalagmites from the Wombeyan Caves, west of Mittagong in the Warragamba Dam catchment, and floodplain sediments from sites in the middle and lower Hawkesbury-Nepean will be considered in the University of Newcastle study, the findings of which are expected to be available in 2009.

4.3 Human induced climate change

In addition to this natural climate variability, human induced climate change may also impact Sydney's future supply and demand balance. Human induced climate change refers to the impact of increasing atmospheric concentrations of greenhouse gases such as carbon dioxide and their impact on global climate systems. There is an increasing body of evidence to indicate that increased greenhouse gas concentrations – due largely to the combustion of fossil fuels in the energy and transport sectors, as well as vegetation clearing and agriculture – are already having an impact on climate, and that these impacts will likely become more pronounced over time.

The Intergovernmental Panel on Climate Change, an international organisation of more than 2,500 climate scientists, including several leading Australian scientists, concluded in its 2001 Third Assessment Report that:

- an increasing body of observations gives a collective picture of a warming world and other changes in the climate system

University of Newcastle study of stalagmites

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- emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that affect the climate system
- there is new and stronger evidence that most of the global warming observed over the last 50 years is attributable to human activities
- confidence in the ability of models to project future climates has increased
- by the year 2100, global average temperature may rise 1.4 to 5.8°C if there are no explicit policies to limit greenhouse gas emissions
- projected changes in climate extremes could have major consequences, and
- since global warming cannot be avoided completely, adaptation will be necessary to complement efforts to reduce net greenhouse gas emissions.

For more information refer to: **(http://www.ipcc.ch/pub/un/syreng/spm.pdf)**

The timing and scale of climate change impacts will be influenced by a wide range of factors, including the level of atmospheric greenhouse gas concentrations over time. This in turn is affected by parameters such as economic growth, technology change, global efforts to reduce emissions and so on. As such, it is difficult for scientists to predict with certainty what impacts climate change will have globally – and estimating impacts at the regional and local levels is even harder.

To deal with the uncertainty inherent in projecting future climate change, scientists use scenarios to examine what might occur under varying levels of atmospheric greenhouse gas concentrations. Such analyses tend to take a long term view, for example estimating potential impacts in 2030 and 2070. This reflects the time lag that exists between the actual emission of greenhouse gases, the resulting increase in atmospheric concentrations of greenhouse gases, and the impact that this has on global climate systems. Taking a longer term view also allows analysts to isolate the effect of increased atmospheric concentrations from short term natural climate variability.

In 2001, the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) released climate change projections for Australia. Changes in future Australian temperature and rainfall were projected for the years 2030 and 2070 on the basis of simulations by nine different climate models run for scenarios with higher than current greenhouse gas concentrations. Climate change is projected to impact Australia in a variety of ways – including changed rainfall patterns, more hot days, higher evaporation rates, more prolonged and intense droughts and more intense bushfires and storm events.

For more information refer to: **http://www.dar.csiro.au/impacts/future.html**

The CSIRO 2001 climate projections also included projections for major cities across the country, including Sydney, although it was noted that the coarse spatial scale of the climate models available at that time limited their ability to simulate the details of regional climate change, which is influenced by local conditions such as landform, vegetation type and urbanisation.

In 2004, the NSW Greenhouse Office published CSIRO's analysis of potential impacts of climate change across NSW under a range of climate change scenarios. CSIRO examined past climate records and the results of 12 climate models to assess past changes in NSW climate and likely changes over the next 70 years, for both average climate and its extremes. It found that, across NSW, rivers are likely to decline and extreme weather events are likely to become more frequent.

For more information refer to: **http://www.cabinet.nsw.gov.au/greenhouse/linked_files/Climate%20change%20in%20NSW.pdf** and **http://www.cabinet.nsw.gov.au/greenhouse/linked_files/Change.pdf**

CSIRO's 2004 study has informed the development of the NSW Government's *2005 Greenhouse Plan*, which proposes further analysis of climate impacts on particular regions and sectors, and outlines mitigation strategies (to reduce greenhouse gases) and adaptation strategies (to reduce the impacts of climate change).

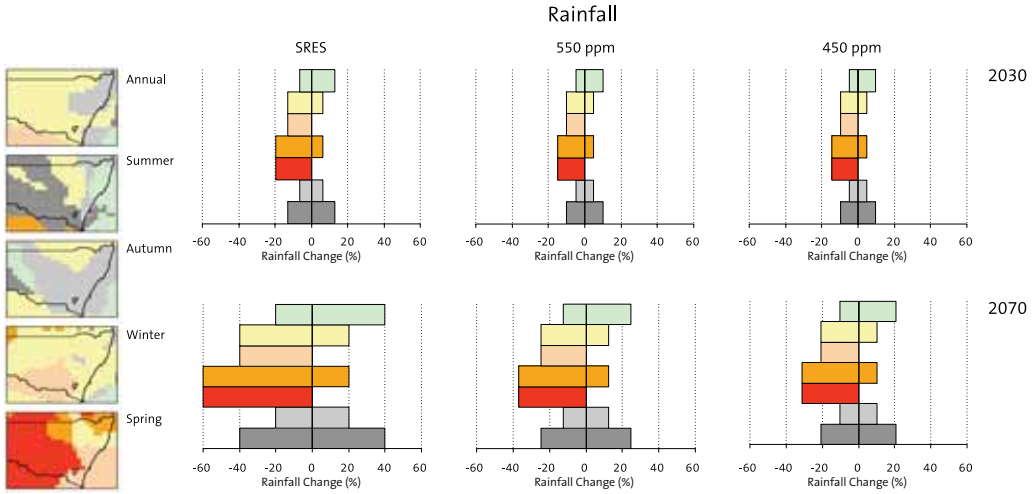
For more information refer to: **http://www.greenhouseinfo.nsw.gov.au/__data/page/927/11-11_FINAL_GHO_Exec_Summary.pdf** and **http://www.greenhouseinfo.nsw.gov.au/__data/page/927/28-11_FINAL_NSW_GH_Plan_web.pdf**

4.4 Potential impacts of climate change on Sydney's water balance

Analysing the potential impact of climate change on the Sydney water supply system involves taking the outputs from global climate models and examining how these results might impact at the regional and local level. Climate change impacts on water availability in Sydney may include:

- higher temperatures
- changed rainfall patterns
- increased evaporation (which will increase evaporative losses from the system and reduce the amount of run-off that flows into the system), and
- longer and more intense droughts.

Rainfall projections for NSW under various greenhouse gas emission scenarios (SRES, 550ppm, 450ppm) in 2030 and 2070, relative to 1990



Together these impacts may reduce the amount of water available on average in the Sydney system. Conversely, however, the frequency and intensity of storm events may increase in future – leading to more storm events that will fill the storages after prolonged periods of low rainfall.

On the demand side, an increase in the number of hot days and prolonged periods of low rainfall may result in greater demand for water as a result of increases in garden watering, use of evaporative cooling, the number of showers people tend to take each day, and so on. Potential changes to rainfall patterns may also impact the potential contribution of rainwater tanks to meeting Sydney's supply and demand balance.

Two studies are already under way in the Sydney region. The Upper Parramatta River Catchment Management Trust has commissioned CSIRO to examine extreme rainfall events across Sydney under future scenarios. The University of New South Wales, in collaboration with the Sydney Catchment Authority, is undertaking a study to downscale the global and regional climate models to the scale of Sydney's water supply catchment. The modelled catchment scale rainfall projections will subsequently be translated into run-off projections and will provide an indication of future changes in catchment yields under different greenhouse gas emission levels.

To further improve understanding, the NSW Government has commissioned a study to examine the potential impacts of climate change on both water supply and demand across the whole of Sydney. The study will produce estimates of the potential impacts of climate change on water availability and projected water demand in 2030 and beyond. Contributors to the study include CSIRO, the University of New South Wales, Sydney Catchment Authority, Sydney Water Corporation, the Australian Greenhouse Office and NSW Greenhouse Office. The results from this study will be available in two to three years time and will inform future iterations of the *Metropolitan Water Plan*. In the interim, as discussed in Chapter 2, section 2.5, the independent consultants advise that the suite of measures outlined in this *2006 Plan* provide confidence that Sydney's supply and demand balance will continue to be met in the near- to mid- term, even if climatic conditions worsen.

Given that climate change projections and anticipated impacts are inherently uncertain, it will be important to maintain an adaptive approach to managing Sydney's water needs, including potential climate change impacts. To this end, the Government will continue to monitor trends in water availability and water demand as part of regular reviews of the *Metropolitan Water Plan*. This will enable cost effective and sustainable policy responses (such as additional investment in recycling and water conservation) to be tailored to ensure that Sydney's water supply and demand balance continues to be met over time.

What will be done next

- Studies to consider climate variability and climate change impacts on Sydney's future rain-fed water supply and Sydney's demand for water will continue and will inform future iterations of the *Metropolitan Water Plan*.