

# Adaptation: reducing risk, gaining opportunity

*By Mark Stafford Smith and Andrew Ash*

## Key messages

- \* The less we reduce emissions, the more we will have to adapt; for warming greater than 2°C, many Australian sectors will be very vulnerable.
- \* The most sensitive sectors in Australia, which will require most early adaptation, are: water, the natural environments, cities and infrastructure, the coastal zone, and agriculture.
- \* Adapting in these areas presents significant challenges, but can also create great opportunities; early action will maximise our ability to capture these opportunities.
- \* Successful adaptation will depend on developing the knowledge and skills base in the industries and communities most affected, as well as enhancing the adaptive capacity of government agencies to provide the best policy context for adaptation.

As noted in earlier chapters, some climate change and consequent impacts are unavoidable due to the greenhouse gases that are already in the atmosphere and as future emissions increase due to our slow mitigation response. To limit the social, economic, and environmental impacts of these changes, we need to adapt.

## Adaptation in Australia

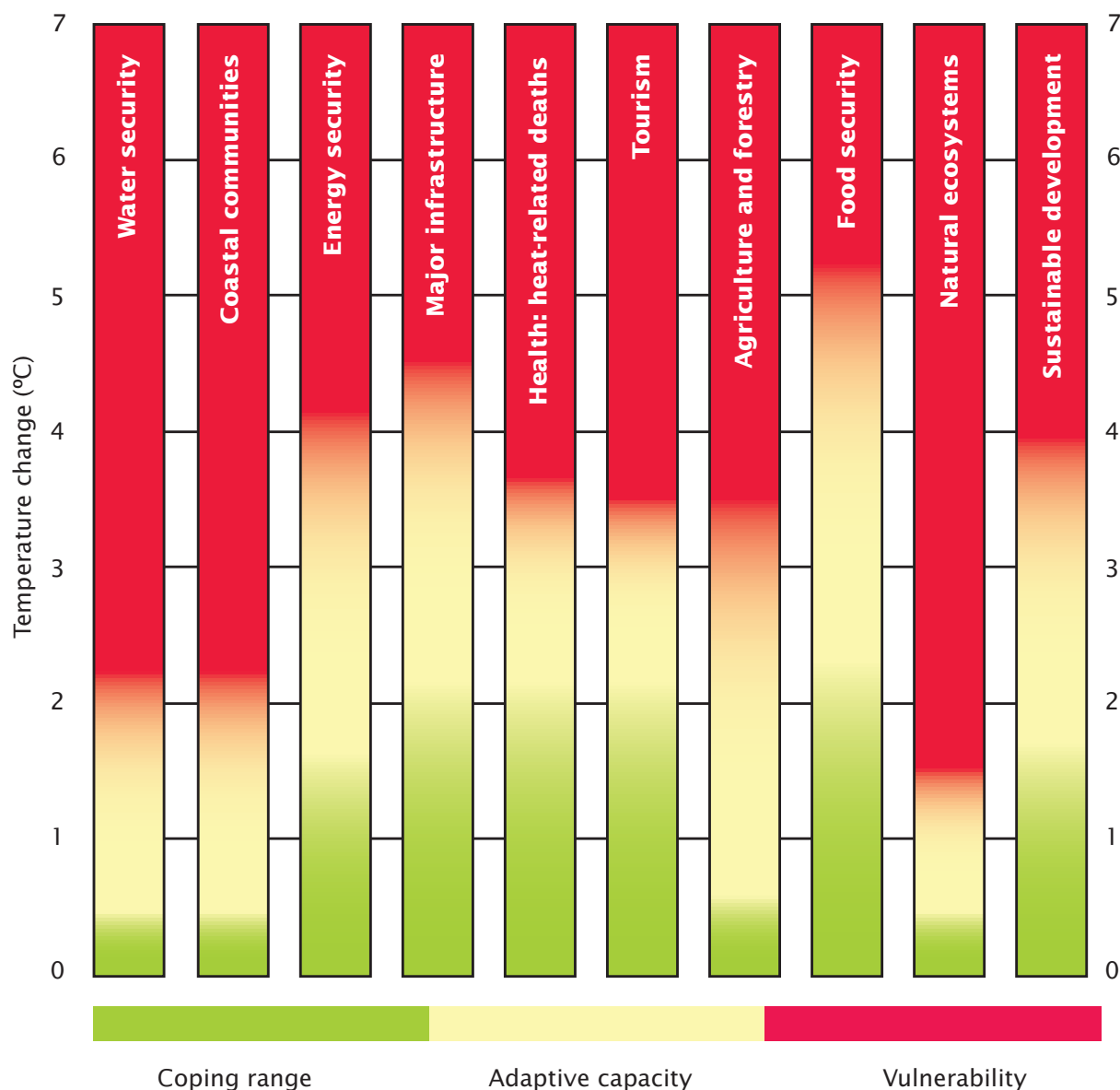
Australians are superb adapters. Indeed our entire history on this continent, both Aboriginal and European, is one of constantly adapting to its challenging climates, resources, and natural conditions – from bountiful seasons and baking summers to frost, fire, storms, flood, and drought. It is clear that the observed and predicted trends in our climate will confront us with further necessity to adapt and, indeed, with fresh opportunities that will make adaptation both worthwhile and profitable, as well as essential.

Adaptation is about coping with the changes that are already happening or that appear unavoidable in the future. Just as early settlers progressively adapted European farming systems to Australian landscapes and conditions or built their homes with wide verandas to suit our long, hot summers, so now we will need to change many of our society's activities, systems, and habits to make allowance for warmer, more variable, and extreme climatic conditions, as well as rising sea levels and other global environmental changes.

Adaptation and mitigation (that is, reducing the amount of climate change that occurs – see Chapters 8 to 10) are closely linked: the less we mitigate, the more we will be forced to adapt to inevitable changes in the climate, and the bigger the adaptations will have to be. Conversely, success in mitigation through early and deep cuts to greenhouse emissions will necessitate fewer, less extreme adaptations in the long run.<sup>1</sup>

There is now wide scientific agreement that the world is heading for at least 2°C warming, and possibly 4°C, by 2070<sup>2</sup> and that adaptation to the changed conditions that this implies has become a vital concern.<sup>3</sup> As the increase in average temperature begins to rise above 2°C, the challenges faced by societies will become increasingly significant; planned adaptation will help, but, even so, disruptions to economies, livelihoods, and lifestyles are likely.

There is no doubt that Australia is vulnerable to climate change. Figure 5.1 indicates just how vulnerable we are to various increases in temperature. At the green end of the temperature bars, up to about 1–1.5°C of global mean temperature rise for many sectors, we can cope pretty much as we do today. However, the yellow range, between 1.5°C and 3–4°C, indicates the need to take more extensive action in the various sectors listed to adapt to the changing conditions. At a global mean temperature rise above 4°C, life becomes far more difficult and our society increasingly vulnerable. Some sectors are more sensitive than others in Australia – notably water, coastal communities, natural ecosystems, and, to some extent, agriculture come under stress at lower temperature changes than the others.



▲ **Figure 5.1:** This figure, drawn from the IPCC's Fourth Assessment in 2007,<sup>4</sup> shows the aggregated relative vulnerability to climate change for key sectors, as assessed for the Australia and New Zealand region. The vertical axis shows increasing levels of global mean temperature rise from 0 to 7°C, while the colours show how much change the sector can cope with normally (green), how much it can adapt to autonomously (yellow), and when it becomes vulnerable (red). In Australia, water security, coastal communities, and natural ecosystems stand out as being particularly vulnerable to small temperature rises.

From this, it can readily be seen that adaptation is a vital strategy for the extent of climate change that is now expected to occur by the latter part of the 21st century, and that no part of society, no industry, and no individual will remain untouched by it or be able to avoid it. Indeed, our natural ecosystems, water resources, farm sector, and coastal communities are already feeling the pinch.

So Australians cannot avoid having to adapt. Even with 2°C of global mean temperature rise we will have to cope with changed conditions such as sea-level rise, increased frequency and intensity of bushfires and tropical storms, more frequent heatwaves, droughts and water scarcity, and year-round higher temperatures. These new conditions may involve changes as far-reaching as the progressive relocation of farming industries to more favourable climatic regions, or the imposition of planning controls in coastal shires to prevent people building in areas at risk from flooding, storm surges, and shoreline erosion.<sup>5</sup> However, not all of these adaptations need to happen at the same time or immediately: many can be achieved progressively over time; many will also lead to fresh opportunities, new markets, and more sustainable technologies. In other words, with good preparation, adaptation can be win-win.



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## Types of adaptation

Just as adaptation to change in the past has involved all parts of society, adaptation to climate change will engage all Australians, in every industry, in each community and as individuals in our daily lives, our work, our consumer choices and recreation. Domains that are emerging as priorities are:

- \* urban areas, including homes, offices, industries, transportation, water and energy systems, and overall design of towns and cities themselves
- \* coastal zones and estuaries and all areas at risk of sea-level rise, storm surges, and floods
- \* agriculture, the food supply, and other primary production, including mining
- \* our natural environment, including forests, woodlands, grasslands, lakes, rivers, and deserts and all the plant and animal species within them.

Given the wide range of adaptations to be undertaken across Australian society (see Figure 5.2), the challenge may appear complex to the point of overwhelming. This challenge is exacerbated by the uncertainties of what future climate change will actually be in different regions. There is a risk that the combined weight of the adaptation challenges and uncertainties associated with climate change projections will paralyse decision making. However, not all uncertainties are equal and not all decisions are equally difficult.<sup>6</sup> There are tried and tested methods for making decisions in the presence of uncertainty that are applied daily in other areas of Australian life, such as banking and finance, insurance, risk management, strategic business, and military planning. Some decisions are relatively straightforward, and can be founded on secure knowledge of what has happened with the climate so far: an example is the almost universal adoption of water saving measures around Australia to take account of drought conditions and local water shortages, and the apparently enduring decisions by millions of individual Australians to be more sparing in their private use of water (see Figure 5.6).

**Conservation:** actively manage long-lived species; enhance resilience of existing ecosystems



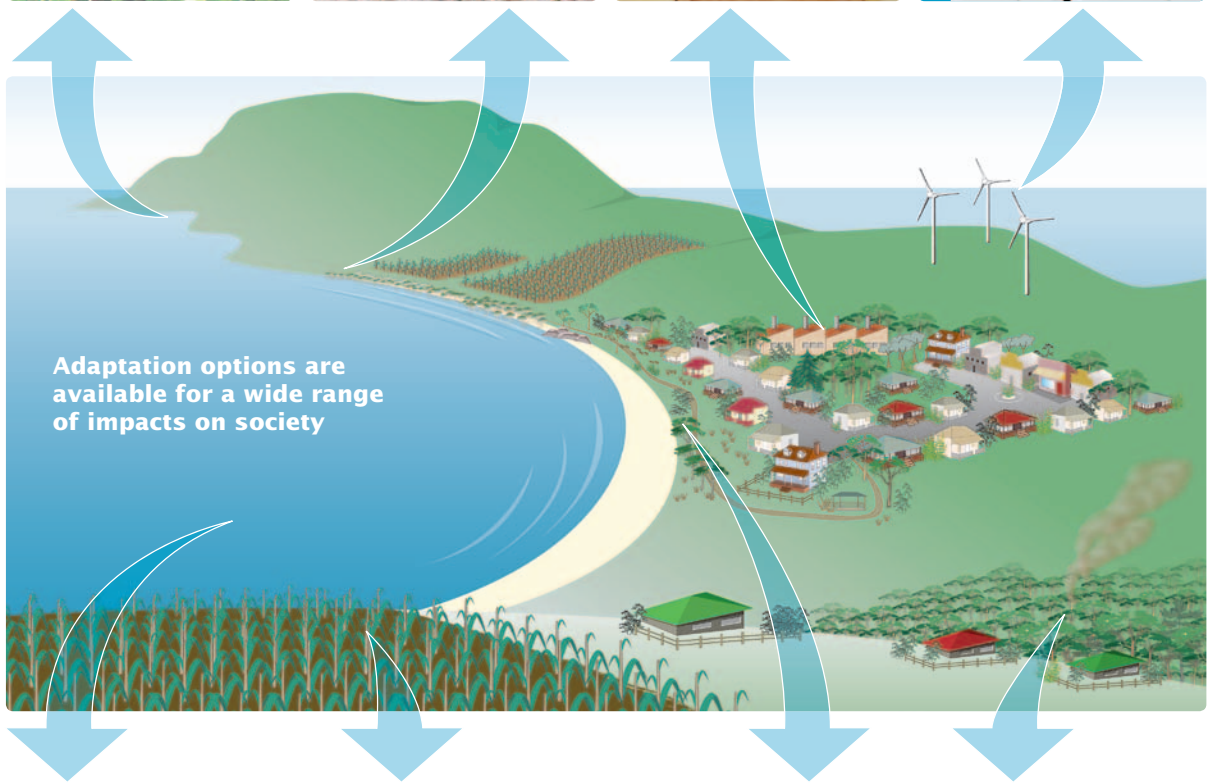
**Coastal erosion:** coastal defences; protective mangroves and marshes; changed recreation expectations



**Heatwaves:** support for elderly at risk; heat-resilient transport systems; urban greening to reduce heat stress



**Energy supply:** heat-tolerant transformers; more resilient distributed energy systems; reduced demand in extremes



**Fisheries:** reduce overfishing; allow landward migration of intertidal zone



**Food production:** new drought tolerant and high CO<sub>2</sub> cultivars; changed planting practices; relocation



**Coastal flooding:** flood-tolerant building designs; movable infrastructure; flood barriers

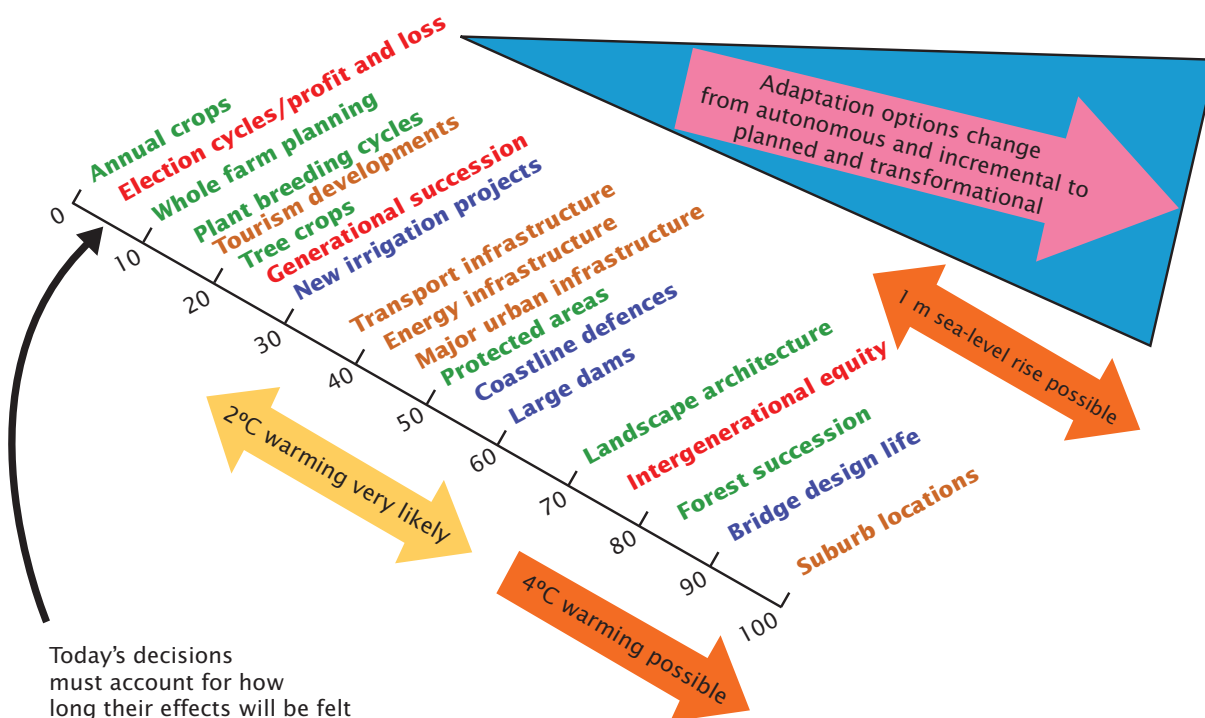


**Fire:** fireproof building designs; better early warning systems; avoiding building in risky places

▲ **Figure 5.2:** Adaptation is needed in many different areas of decision making in Australia.<sup>7</sup>

## Preparing for adaptation

One of the most important things to note about adaptation is that not all decisions have to be taken right away, or even in the next year or two. Some decisions do need to be taken as soon as possible, but there are others that we need to start planning for now, even though action on the ground may come later, and others still that we can consciously postpone while we monitor and assess what unfolds. Thus some decisions, such as choosing which annual crop cultivar to plant this year or what colour to paint our roofs, are very short term and adjustable, and can be re-assessed next year and the year after; this sort of decision only needs to take account of climate change as it happens. By contrast, the engineering design of a large dam or the location of a new coastal suburb locks in infrastructure for many decades or even centuries. These sorts of decisions today must take account of the uncertain state of the climate in 50 years' time and beyond. Figure 5.3 illustrates how different decisions play out over time.



▲ **Figure 5.3:** Different types of decisions play out over different time periods (years, on x-axis) and therefore intersect with different degrees of likely climate change.<sup>8</sup>

The types of decisions and technologies required for successful adaptation are therefore a mixture of incremental and transformational.

Incremental adaptation is what we tend to do throughout our normal lives as we cope with changed circumstances, gain new knowledge, acquire new technologies, or move to different places and jobs: we adapt constantly, and we do not fear it. In its early stages, climate change will mostly require incremental change, such as a farmer making a decision to plant a crop that is more drought-tolerant to suit drier conditions, householders choosing to insulate their homes to reduce heat stress, or architects ensuring that their building designs are ready for possible increased wind gust speeds.<sup>9</sup> Incremental adaptation is a gradual process of adjustment.



*Bob Schuster/CSIRO*

Transformational adaptation, on the other hand, requires far more profound change in people and the way they go about their work and lives. A transformational change, for example, might involve the relocation of an entire industry or community to avoid increasingly unfavourable conditions such as rising sea levels, floods, bushfires, or persistent drought. This demands careful planning with long lead times and usually a degree of support from all levels of government because of the disruption it can cause to people's lives and the psychological break with what they are used to. Such changes have been accomplished many times in our past – for example, when old mines or factories are closed and new ones opened, or when we built the Snowy Mountains hydroelectric scheme and had to relocate the townships of Jindabyne and Adaminaby. However, it is important to prepare the affected communities or industries well in advance and to engage them in the planning of their new future and the opportunities it affords.

## Attitudes to adaptation

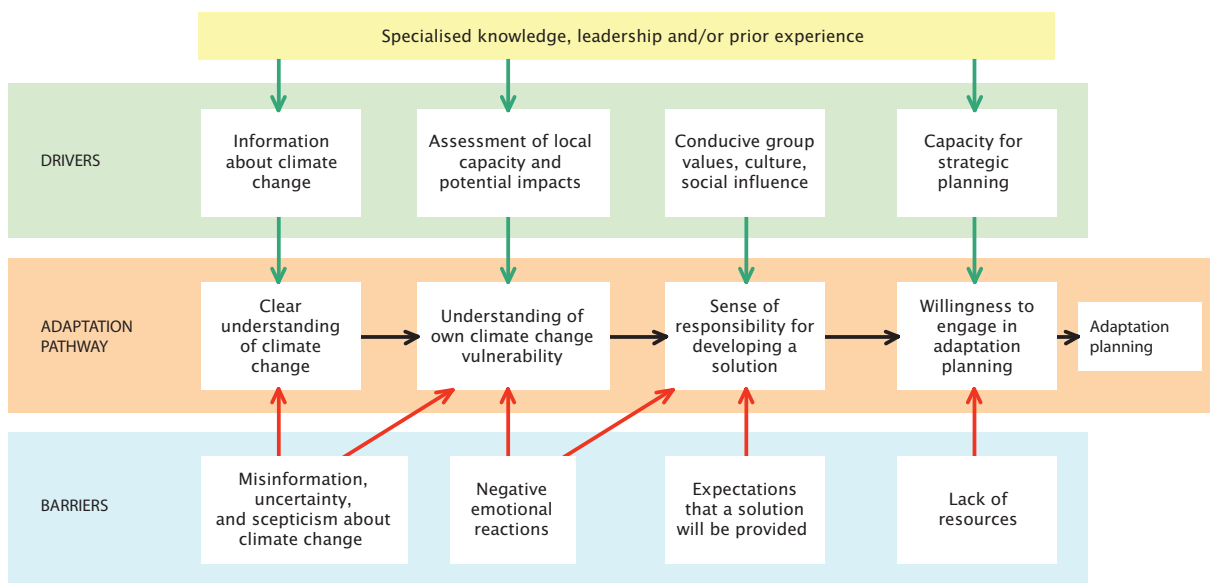
Australians currently hold mixed attitudes to adaptation, as a CSIRO survey of industry and government organisations reveals.<sup>10</sup> This found that the extent of adaptation activity now taking place appears to be linked to the organisation's knowledge and beliefs about climate change. Organisations that rate climate change, adaptation, and mitigation as important – and those with greater knowledge about adaptation and mitigation – are more likely to have carried out a vulnerability assessment of their operations to climate change and to have begun planning to adapt.

Adaptation was most notable in large organisations with longer planning horizons (such as water resource and energy system companies) and with strong links to expert organisations who can provide them with advice. Once an organisation has carried out a vulnerability assessment, especially if it turns out to be highly vulnerable, it is much more likely to embark on adaptation planning. Encouraging businesses, government bodies, and communities to conduct vulnerability assessments as early as possible will greatly help them to plan how they are going to adapt – and to identify opportunities for win-win or 'no regrets' outcomes.

Another thing clear from the survey is that many professionals are vexed with the imprecision and lack of certainty of climate projections. 'Tell us how high the sea levels will rise and by when, and we'll know how high to build the sea wall ...' or 'Tell me how bad the droughts will be and I'll know what changes to make to my farm' are typical responses. Unfortunately, while climate change itself and its general direction are highly predictable, its extent and speed are uncertain, particularly over longer timeframes. Over these time periods the major uncertainty arises from whether the global community responds by controlling its greenhouse gas emissions or not – a political uncertainty not amenable to scientific modelling. This means that adaptation strategies must apply well-established methods for risk management to encompass probabilities of different climatic outcomes, to be flexible, and to allow for worst-case scenarios.

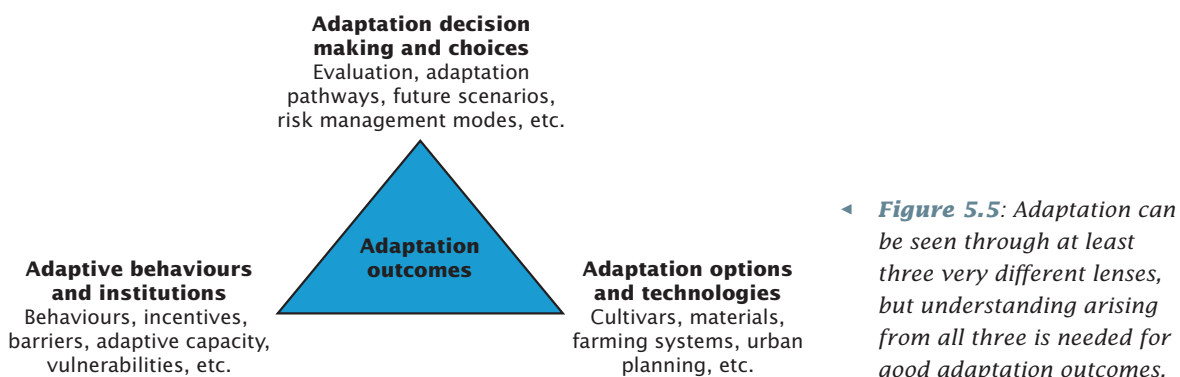
## Pathways to adaptation

The essential step is to start building pathways to adaptation – to position our sectors, regions, and communities so they are flexible and ready to change when the time comes, by building immediately their biophysical, social, and institutional capacity to adapt. Figure 5.4 illustrates the stages communities or organisations are likely to go through to do this, the factors that will drive them, and the obstacles they are likely to encounter on the way.



▲ **Figure 5.4:** A pathway for adaptation engagement with associated drivers and barriers.<sup>11</sup>

Three areas are critical to successful adaptation to climate change (see Figure 5.5) – decision making and how to go about it, the development of specific solutions (technical and other) to climate challenges, and the analysis of barriers to the adoption of systems and technologies that will help us adapt. Australia is leading the way in the coordinated approach to these areas of adaptation research.



◀ **Figure 5.5:** Adaptation can be seen through at least three very different lenses, but understanding arising from all three is needed for good adaptation outcomes.

An important concept is that adaptation occurs at different scales, ranging from the individual to the community or industry, to the city, to the nation, as well as over varying time scales. For adaptation to occur successfully depends on what has been put in place by the different levels of government – national, state, and local – which underlines the importance of government leadership and coordination in helping Australia adjust to the impacts of climate change. Often, what happens at local government level depends, in turn, on policies adopted by state and/or federal agencies. For example, effective coastal planning controls by local government may rely on higher levels of government indemnifying and supporting local authorities. Likewise, the redevelopment of agriculture in the Murray–Darling Basin will require a coordinated approach by all levels of government.



*Gregory Heath/CSIRO*

## Opportunities for adaptation

Humans often dislike having to change – yet, equally, we know from past experience that it also brings wonderful opportunities and, indeed, has been the chief driver in the advance of civilisation over millennia. Adapting to climate change is no different: while sometimes inconvenient, it will also offer us profound opportunities for enhancing our wellbeing, sustainability, and economic progress.

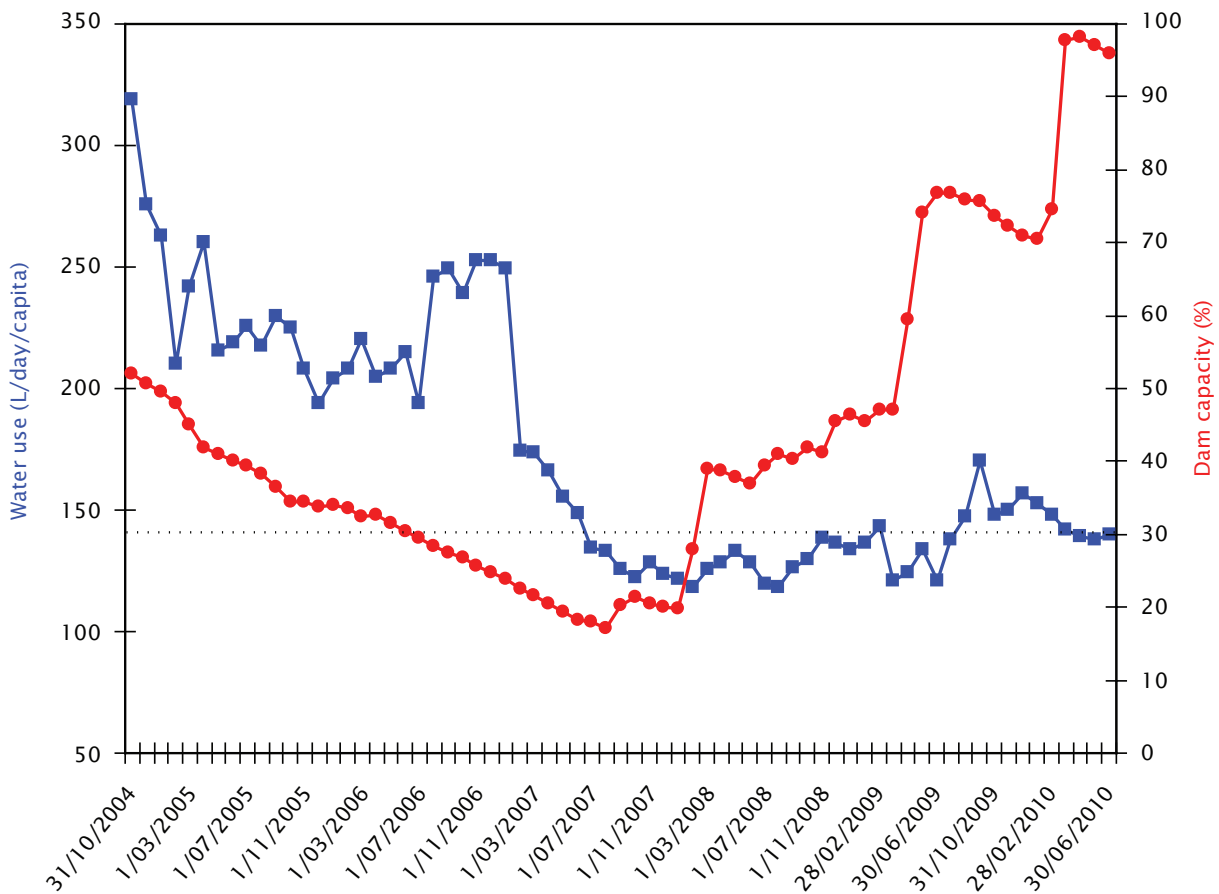
A central aspect of adaptation is to identify the opportunities, as well as the threats, we have to deal with. These will include both ‘no regrets’ measures – things we can do which make good sense anyway, like saving water – and ‘win-win’ activities, where adapting to climate change generates new industries, wealth, jobs, or other desirable outcomes.

In this category lie opportunities for Australia to reinvent itself as a global pioneer and exporter of green, effective, and successful adaptation strategies and technologies (as countries such as Denmark are already doing with wind power). In a very wide array of industries, CSIRO research is already hard at work developing the new systems, technologies, and products that will enable this national transition to occur.<sup>12</sup>

Here we provide just three examples of the many opportunities in adaptation through new technologies and ‘no regrets’ decisions:

1. For a treasured minority of decisions, the nature and extent of the response needs to be the same whatever the future climate – this leads to the classic ‘no regrets’ decision. For example, it has been observed that the core rules for systematic selection of conservation reserves – the so-called CAR (comprehensive, adequate, and representative) principles – remain the same under any future climate, because representing all environments in the reserve system is most likely to provide habitat for the maximum number of species, even if these no longer occur in their current locations.<sup>13</sup>
2. Australia has a long history of innovation in agriculture in adapting to a highly variable climate. We have the opportunity to lead the world in successful adaptation to a changing climate. Indeed, we have already seen adaptation to a warming climate through earlier planting of winter grain crops to take advantage of reduced frost incidence and these benefits can be large if frost risk is explicitly factored in to planting strategies.<sup>14</sup> While work on improving drought tolerance of crops through breeding has been underway for some years, work is also in hand to adapt crops to higher temperatures and a higher CO<sub>2</sub> environment to create a more system-wide approach to ‘climate ready crops’.
3. A wonderful example of adaptation to a water crisis is evident in South-East Queensland. In response to a very long drought and dam levels dropping to record low levels, the region’s water authorities gradually began introducing water restrictions in May 2005 to reduce water consumption from the then 300 L/capita/day. By April 2007, these restrictions had progressed to Level 5 and, although water usage had dropped, the risk of

the region running out of water was still very real. At that time the focus of community awareness and education shifted from the increasingly tough water restrictions as a regulatory control to target personal levels of consumption (the program was called Target 140 – targeting 140 L/capita/day consumption). This target approach for personal usage was combined with rebates and incentives for water tanks and other water saving devices (e.g. low-flow taps and showerheads), rates notices clearly illustrating household water use in comparison with the surrounding neighbourhood and the city, community education programs, and enforced water restrictions; together these led to the achievement of Target 140 by the middle of 2007. The true success of this adaptation strategy is that the water saving behaviours now seem embedded in the community, as shown in Figure 5.6. During 2009–2010, rainfall increased, the dams filled, restrictions on use of water were eased, including for watering gardens and lawns, and a permanent



▲ **Figure 5.6:** Combined dam capacity in South-East Queensland (red line) and water consumption per head (blue line) in the central part of the region from 2004–2010, showing how the consumption declined as water restrictions came into place, but did not rise again once they were relaxed.

water conservation target of 230 L/capita/day was introduced. However, water consumption remained at around the same levels as at the height of the crisis in 2007 and 2008, with average water consumption of approximately 145 L/capita/day across the region in the winter of 2010. This largely ‘no regrets’ approach has provided a win-win benefit, because the building of expensive new storages can be planned and implemented over a longer timeframe.

## Conclusion

In considering new opportunities for adaptation in a global context, social attitudes and equity are vital considerations – the equal sharing of the costs, burdens, and benefits that climate change implies. There will be many losers if we fail to adapt well, both here in Australia and in overseas countries. Australians, with our long history of egalitarianism, our belief in ‘a fair go’, and our willingness to share our knowledge and expertise with other people, are natural leaders when it comes to helping establish the ethics by which the world will adapt to the climates of tomorrow. Australia’s agriculture has to cope with large climatic variability, its cities are already exposed to heatwaves, and a large percentage of the population lives near a coastline vulnerable to flooding. As a consequence, we are well positioned to lead global adaptation efforts to these challenges, which we explore in the following chapters.

## Further reading

Climate Adaptation Flagship (2010) *Adaptation science: opportunities and responses to climate change impacts*. CSIRO, Brisbane.

Hennessy K, Fitzharris B, Bates BC, Harvey N, Howden SM *et al.* (2007) Australia and New Zealand. In Parry ML, Canziani OF, Palutikof JP, van der Linden PJ and Hanson CE (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, pp. 507–540.

Richardson K, Steffen W, Schellnhuber HJ, Alcamo J, Barker T *et al.* (2009) *Synthesis Report. Climate change: global risks, challenges and decisions*, Copenhagen, Denmark, 10–12 March, 2009.

Stafford Smith DM, Horrocks L, Harvey A and Hamilton C (2011) Rethinking adaptation for a four degree world. *Philosophical Transactions of the Royal Society A* **369**: 196–216.