

A close-up, high-resolution portrait of an elderly man. He has a weathered face with deep wrinkles, particularly around his eyes and forehead. He has a thick, grey mustache and a short, grey beard. He is wearing a red cap with a green band. The background is blurred, showing hints of green foliage. The overall tone is serious and contemplative.

The Climate Institute

Coming Ready or Not:
Managing climate risks
to Australia's infrastructure

Coming Ready or Not



This Spotlight Report provides an analysis of Australia’s exposure to and preparation for the impacts of climate change on major infrastructure.

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Coming Ready or Not: Managing climate risks to Australia’s infrastructure

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Australia should
be well-placed to adapt
to the changing climate,
but our readiness is
at best patchy.

Foreword

Foreword

This report was prepared against a backdrop of recurring news stories of climate-related damage and destruction in the United States. Stories of temperature records being broken across the country were joined by reports of a ‘flash drought’ withering corn and soybean crops and increasing global food prices. The impacts of what became recognised as the United States’ hottest summer since records began were also felt by the country’s infrastructure: roads buckled, rail bridges collapsed and power plants were forced to shut down because cooling water was too warm.

Here in Australia, we have recent memories of similar experiences. Moreover, it is becoming increasingly clear that, even with concerted global action to reduce carbon pollution, we are feeling the symptoms and costs of early climate change. More is on the way. The loss of Arctic sea ice this northern summer set a new record low with observed changes already tracking at the high end of predictions. The global environment is changing faster than expected.

With our experience of extreme weather, Australia should be well-placed to adapt to the changing climate. But our readiness for the impacts of climate change is at best patchy. Government policies and regulations are inconsistent, confusing and sometimes counter-productive. Market signals to encourage smarter management of climate-change related risks are weak or non-existent. Information is fragmented, dispersed and often not accessible.

There is a widespread view that mitigating climate change is a global issue, but adapting to it is a local issue. This is only partly true. Just as organisations and individuals at all levels must play a role in reducing carbon pollution, building Australia’s resilience to the impacts of climate change also demands collaborative efforts across all levels of government and areas of the economy.

Nowhere is this more obvious than in the case of infrastructure, on which our economy relies, and which itself consists of networks of interdependent systems. Making our infrastructure climate-ready presents many challenges. We need to change the way we build new infrastructure, and where we build it. Even more difficult, we need to protect existing infrastructure in ways that do not impose unsustainable costs. And we need to do this for an extraordinarily broad range of physical assets, for which responsibility is dispersed across all layers of government and many actors within the private sector.

This cannot be done by national decree, but it cannot be done without national leadership and participation from all sectors. Australians need to have a robust and well-informed conversation on the realities and choices we face.

This report examines the consequences of climate change risks to infrastructure, the state of preparation among businesses and governments and the steps needed to improve Australia’s climate readiness. It calls on businesses to fully account for their climate risks and for governments to integrate climate risk management into nationally coordinated policies and regulations.

John Connor, CEO, The Climate Institute

Approach

Acknowledgements

This project was conducted with support from key partners Manidis Roberts (member of the RPS Group Plc), Mirvac and Westpac. Manidis Roberts provided a large proportion of the research, and project supporter Bond University’s Mirvac School of Sustainable Development contributed the Melbourne case study. Thanks are also due to Stella Whittaker, Manidis Roberts; Greg Picker, AECOM; Dr Matthew Inman, CSIRO; Dr John Higgins, Department of Climate Change and Energy Efficiency; Emma Herd, Westpac; and Sonya Ku, Mirvac for their advice on earlier drafts of this report.

Approach

This report synthesises information from a broad range of sources and comprises a desktop review of academic, business and government documents supplemented by engagement with companies, industry associations, regulators and government departments. The report itself has been extensively peer reviewed (see acknowledgements). Our intent is to provide a coherent and compelling overview of the current state of knowledge and activity in the following areas: scientific understanding of climate change-related impacts on infrastructure; exploration of the economic and social consequences; and action undertaken in Australia to address climate change risks to infrastructure.

Many organisations define as ‘climate risk’ both risks associated with the physical impacts of climate change and risks associated with emissions reduction policy. For the purpose of this report, ‘climate risk’ refers to the first category, with the second category defined as ‘carbon risk’.

Summary

Managing Australia’s climate risks

Australia is among the developed countries most vulnerable to climate change. Our climate is highly variable and predisposed toward extreme weather events, and our ecosystems are finely balanced and often unique. Most of the country’s population lives in coastal cities exposed to rising sea levels and connected by infrastructure exposed to the full range of weather conditions. Climate change will have direct economic costs for Australia that need to be managed.

With strong national wealth and experience living with a highly variable climate, Australia should be better placed to manage climate risk than many other countries. However, with some exceptions, our preparedness is patchy and we are not using our strengths as we should.

This report synthesises recent research on the physical impacts and flow-on consequences of climate change. It analyses preparations for climate change impacts in Australia amongst owners and operators of major infrastructure assets, focusing on property, electricity, road and rail, and finance. Activity in the water sector is briefly examined to highlight contrasting approaches.

We have chosen to focus on infrastructure because it is a critical enabler for activity across all sectors of the economy, and because its exposure to climate change puts other parts of society at risk. Infrastructure sectors are interdependent; when one is damaged others may be impaired. Climate impacts to infrastructure cascade through the economy and are felt throughout the community.

Modelling for the 2008 Garnaut Review conservatively estimated that the annual costs of unmitigated climate change on Australia’s infrastructure would reach 0.5 per cent of GDP (about \$9 billion) in 2020 and 1.2 per cent of GDP (\$40 billion) in 2050.¹

Globally, climate change is already costing an estimated \$US1.6 trillion per year, rising to over \$US4 trillion by 2030.² Infrastructure damage is the largest single cost incurred.³

Most infrastructure assets are intended to last for many decades: electricity networks may be in place for 60 years, buildings over 100 years, bridges and dams 200 years. Given the long lead times required to build and operate major infrastructure, we need to be planning for tomorrow’s climate today.

The extent to which Australia’s climate changes this century depends largely on the success of global efforts to reduce greenhouse gas emissions, but some warming is already locked in.⁴ The rapidly changing climate drives not just warmer but wilder weather.⁵ Adaptation is therefore a necessary complement to efforts to reduce greenhouse gas emissions.

Organisations—public and private—that adapt better to climate change are more likely to provide resilient infrastructure and services, while those that don’t manage their climate risks will face higher costs. These include the costs of impacts on staff and stakeholders, physical damage and repair, interruptions to supply chains and operations, and insurance and reputational damage.

Preventing dangerous climate change is crucial. As global emissions and temperatures rise, so do the costs of adaptation, and the risks of getting it wrong. For a global temperature rise of less than 2°C, climate impacts must at least be integrated to infrastructure design, construction, maintenance, operations and regulations as a matter of routine. For a world where global warming is greater, we need this and much more: radical realignment of exposed infrastructure, alternative pathways for essential services and dramatic transformation of how and where we live and work.

Manage the unavoidable, avoid the unmanageable.

Sector Snapshots

We have reviewed a number of key industry sectors that deliver essential economic and social infrastructure and services across Australia. The following table summarises these findings.

	SAMPLE IMPACTS	ACTION UNDERWAY	READINESS RATING
<div>WATER</div> 	Systems stressed by flooding Supply risks for water users	Coordinated action taking place Sector-wide collaboration on modelling impacts and responses Investigation of interdependencies with electricity and telecommunications	RELATIVELY ADVANCED PREPARATION
<div>PROPERTY</div> 	Damage and destruction of property by flood, bushfire Degradation of foundations Impaired health and productivity	Widespread examples of early action but uncoordinated at industry and government levels Regulation and planning suffers from gaps, inconsistency, conflict across and within jurisdictions	EARLY PREPARATION
<div>ELECTRICITY</div> 	Damage from flood/fire Strain/collapse in heatwaves Impaired health and productivity	Action is at early stages. Examples of cooperation among networks Regulatory framework an obstacle to action.	UNDERPREPARED
<div>ROAD + RAIL</div> 	Flood-induced washouts Heat induced rail buckling, road cracking Impaired transportation of people and goods	Action is at early stages. Fragmentation of responsibility an obstacle Regulation and planning suffers from gaps, inconsistency across & within jurisdictions	UNDERPREPARED
<div>FINANCIAL SERVICES</div> 	Insurers directly exposed to increasing costs of extreme events Investors exposed to impacts on assets	Action is at early stages Action not yet translated into market signals	UNDERPREPARED

NB: Observations and the determination of readiness ratings have been tested against expert opinion (see Acknowledgements). These are the views of The Climate Institute and are intended as prompts for further discussion.

Key Findings

By looking at the management of climate risk across the Australian economy, critical industry sectors and specific company examples, a number of key findings have become apparent.

- + **Government policy is fragmented.** Australia still lacks a nationally coordinated approach to managing climate risks to major infrastructure, with much of the burden of policy implementation left to local councils – the least-resourced and most decentralised level of government. Information on Australia’s preparedness for likely climate impacts is fragmentary and dispersed.
- + **The business response is uneven.** Some organisations are moving to better understand and manage their exposure to climate risks. However, most infrastructure owners and operators are focused on maintaining their assets to standards based on historic, not future, climate. Laggards face no or little penalty, while early movers are hampered by fragmented information, and inappropriate and inconsistent regulation.
- + **Infrastructure is highly interdependent, but action on adaptation is isolated at the organisational level.** Despite some examples of collaboration, preparation for climate change tends to focus on organisation-level risk management. The implications of climate impacts on interdependent systems and communities remain underexplored.
- + **Concern about climate change has fallen among those sectors most exposed.** There is also emerging resistance to adaptive decisions at the community level. This is particularly the case when local planning decisions are inconsistent and often poorly communicated and implemented.

The implication of these trends is ‘maladaptation’ or counterproductive actions resulting in unnecessary costs, risks, and impacts to business, government and the community.

Adaptation is an ongoing process. Generally, the most effective strategies are those that can accommodate a range of likely climate change scenarios, recognise systemic interdependencies, and take account of the broader community context.

Infrastructure owners and associated businesses have a community responsibility and, over the long term, a strong financial incentive to take a well-informed, constructive lead. Effective climate risk management is not simply a question of apportioning liability, nor is it solely an engineering problem. Rather, it has a very human dimension, requiring changes in human attitudes, behaviours, and institutions.

Government and business should urgently address the gaps in climate change adaptation in order to avoid unnecessary loss of life, incomes, and damage to major infrastructure assets. Progress is being made but it is piecemeal, locked in past paradigms and uncoordinated. To address this we need to take decisive actions.

Action Plan

For Business

- 1. Assess exposure and vulnerability to climate risk impacts.**
 - + Identify material climate risks for your operations, supply chain, customers, employees as well as interrelated infrastructure systems.
 - + Determine how resilient your business is to existing and future climatic variability.
- 2. Implement a Climate Risk Management Plan**
 - + Establish a 3-5 year plan to manage climate adaptation requirements and explore potential business opportunities and sources for competitive advantage.
 - + Embed ongoing management of climate risk into core risk management frameworks, including appropriate staffing and resourcing.
- 3. Disclose material climate risks to the market**
 - + Ensure shareholders and investors are informed of material climate risks and risk management strategies to protect shareholder value.
- 4. Collaborate to build capacity**
 - + Participate in cross-industry and public discussions about climate risk to build understanding and resilience to emerging climate risk across the community.

NB:
This process equally applies to government asset owners

For Government

- 1. Refresh the National Climate Change Adaptation Framework**
 - + Work across Federal, State and Local Government jurisdictions to develop agreed approaches including standards and guidelines for including climate risk in planning, development and approval processes.
 - + Coordinate between levels of government to improve consistency of adaptation action by agreeing practical requirements for infrastructure planning and development.
 - + Develop sector specific guidelines for the assessment of climate risk on a consistent basis across key regulated industry sectors.
 - + Investigate a national initiative to better identify emerging climate risk impacts for interdependent infrastructure networks.
- 2. Expand analysis of infrastructure interdependencies to climate risk**
 - + Expand the approach for ‘critical’ infrastructure taken by the Federal Critical Infrastructure Program for Modelling and Analysis (CIPMA) to all other key infrastructure assets and industry sectors.
 - + Work with asset owners and operators of critical infrastructure to better manage cross-sectoral interdependencies and climate risk impacts.
- 3. Publish a National Resilience Report Card**
 - + Develop a national adaptation scorecard to measure the degree to which Australia is adapting effectively and report on progress against agreed targets.
 - + Publish tools and resources for small business and the community to support effective adaptation at the local level.
- 4. Deliver Leadership Through Collaboration**
 - + Collaborate with government and private sector asset owners and operators to continue to build skills and capacity around identifying and managing climate risk effectively.
 - + Establish city-wide taskforces with private and public sector participation to better coordinate adaptation and climate risk management strategies for each of the major capital cities across Australia.

Section 1.0

The Impacts of Climate Change

The Economic Impacts of Climate Change



The dice are loaded

Australia's climate is naturally highly variable, but the 'land of droughts and flooding rains'⁶ is beginning to see hotter droughts and heavier downpours. A rapidly changing climate drives not just warmer but wilder weather. For our infrastructure – economic, social and natural – this means that the past is no longer a good guide to future risk.

In southeastern Australia, high fire danger conditions showed a rapid increase in occurrence through the 1990s and early 2000s.⁷ The dry conditions experienced by much of Australia last decade were unusual not just since records began but for the last thousand years.⁸ Despite the flooding in 2010 and 2011, most of the continent saw drier-than-average conditions in 2011. Western Australia saw rainfall in April at nearly 60 per cent below average: the lowest since 2001.⁹

These unusual events follow the warmest decade since records began. Australia's average daily maximum temperatures have warmed by about 0.75°C since 1910.¹⁰ The frequency of days above 40°C is rising and record hot days now outnumber extremely cold days by more than two-to-one.¹¹ The south of the continent – where most of us live and most of our food is produced – has seen a significant decline in average annual rainfall.¹² Ready or not, we are living with the early symptoms of climate change and their costs. Australia makes up 2 per cent of the global insurance market, but over the last five years the country has incurred 6 per cent of the losses.¹³

While the extent to which Australia's climate changes this century depends largely on the success of global efforts to reduce greenhouse gas emissions, some global warming is already locked in.

The human influence on broad weather patterns is becoming more evident. A recent study by the US National Oceanic and Atmospheric Administration concludes that La Niña-related heat waves, like the one that struck Texas in 2011, are 20 times more likely than they were 50 years ago. In Britain, extremely cold Decembers (like that of 2010) are now half as likely, while very warm Novembers (like that of 2011) are now 62 times as likely.¹⁴ In other words, the dice are now clearly loaded in favour of more such events.¹⁵

The risks associated with environmental changes are often nonlinear. For example, today's 1-in-100 extreme storm surge will occur several times a year with a 10cm sea-level rise. A 50cm sea-level rise may increase its frequency to 10-1000 times a year, depending on the location.¹⁶ Similarly, bushfire risk in southeastern Australia increases by 5 per cent with a 1.5°C rise in global temperatures above pre-industrial levels, but by 20 per cent with a 3.4°C increase.¹⁷ Global temperatures have already increased by 0.7°C since the Industrial Revolution.¹⁸

Extreme events continue to wreak major economic damage, at home and abroad. A summer of heatwaves and drought in the United States has shrivelled agricultural output, buckled rail and roads and strained power generators.¹⁹ In Queensland, coalmines still hold water from last year's floods, costing the industry \$7 billion in lost exports.²⁰

Added to the direct impact of disaster are the indirect or knock-on effects; still poorly understood and often ignored. Disasters tie up emergency services, the armed forces, and medical professionals and volunteers. They damage supplies of power, water, fuel and food. They destroy farms and tourism centres, and may slash export earnings by millions, even billions of dollars.

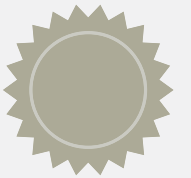
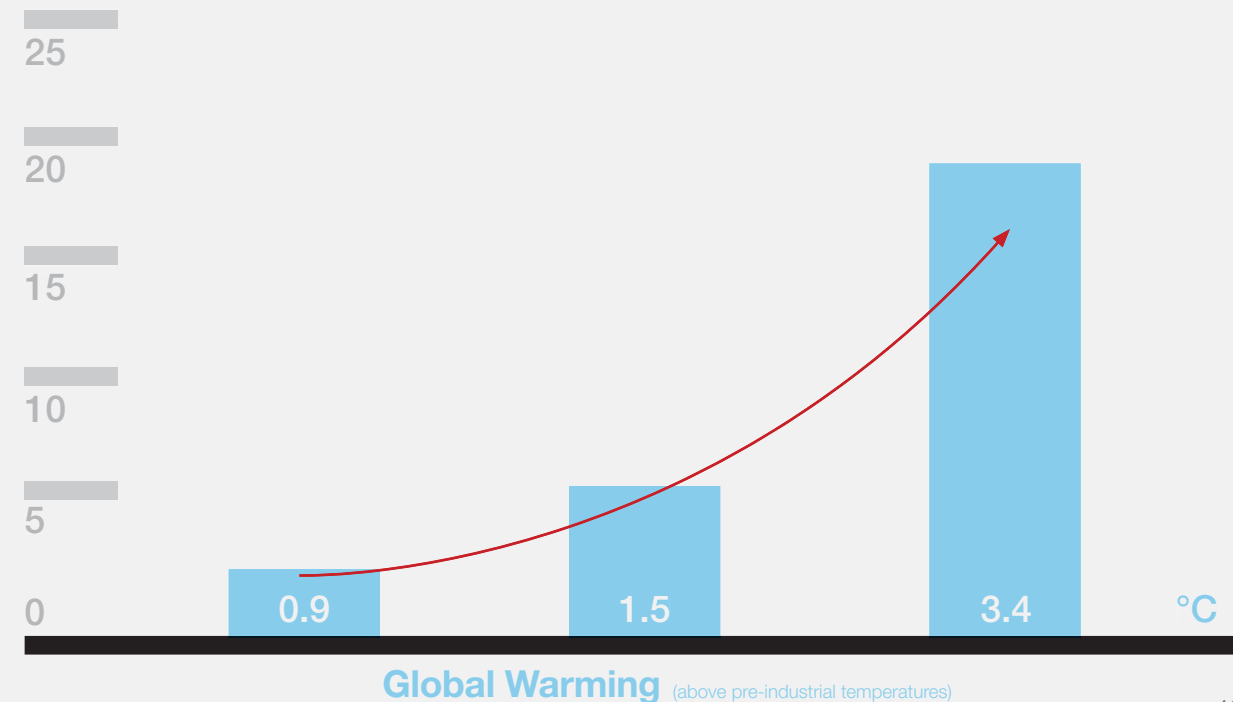


Figure 1.0

Climate change raises the probability of extreme events nonlinearly. Bushfire risk in southeastern Australia increases by 5 per cent with a 1.5°C rise in global temperatures above pre-industrial levels, and by 20 per cent with a 3.4°C increase. Global temperatures have already increased by 0.7°C since the Industrial Revolution.

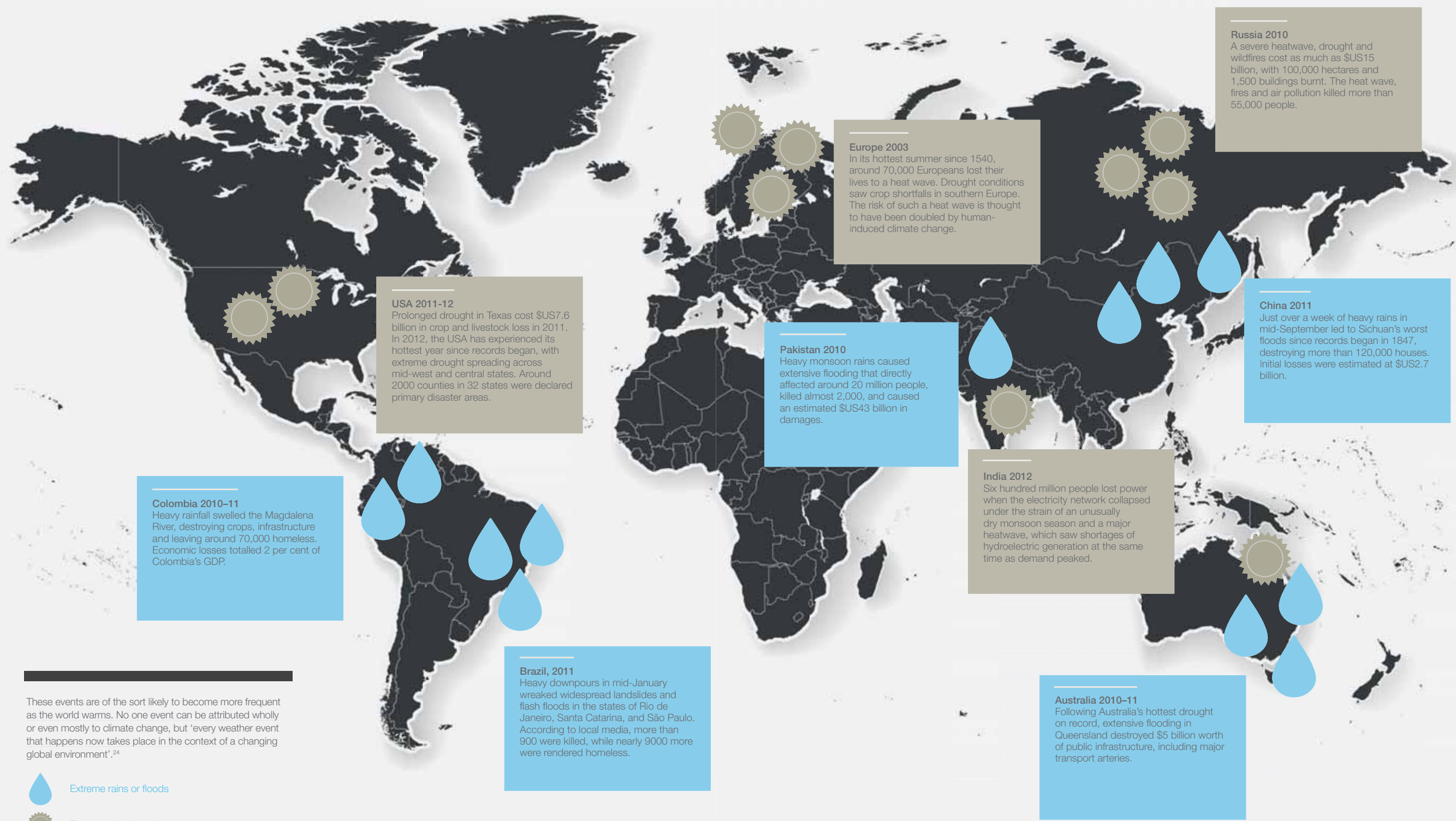
% Increase in Bushfire Risk



We've got the
storm of the century
every year now.²²



Figure 1.1
World Map of Extreme Weather + Impacts²³



These events are of the sort likely to become more frequent as the world warms. No one event can be attributed wholly or even mostly to climate change, but 'every weather event that happens now takes place in the context of a changing global environment'.²⁴

Why Infrastructure?

The foundations of our economy

Our society is supported by a web of economic, social and natural infrastructure that many take for granted, but which is a critical enabler for activity across all sectors of the economy. However, the bulk of Australian economic infrastructure is built and maintained to standards based on historic, not future, climate patterns. Existing assets and those constructed in the future will need to cope not only with gradual rises in sea level and temperatures, but with the growing risk of extreme events and their consequences. Given the long lead times required for the future operation of many types of core infrastructure, planners, architects and engineers need to be planning for tomorrow's climate, today.²⁵

Planning for future climate risk avoids future costs. Modelling for the Garnaut Review found the impacts of unmitigated climate change on infrastructure would reduce annual GDP by half a percentage point or \$9 billion in 2020. By 2050, costs reach 1.2 per cent of GDP, or around \$40 billion. The review noted that these figures are likely underestimates, as the full range of impacts was too broad to be modelled.²⁶ The replacement value of Australia's buildings alone is approximately \$5.7 trillion.²⁷

Planning, design and construction processes may take years to complete. Operating lives span many decades: electricity networks may be in place for 60 years, buildings over 100 years, bridges and dams 200 years.²⁸ Major infrastructure construction requires significant investment, with ongoing maintenance, repair and retrofits adding further costs. Climate change is likely to increase these costs substantially, primarily through direct damage or deterioration of the asset.²⁹

Infrastructure Australia notes that:

Australians experience the consequences of poor or inadequate infrastructure planning, investment and regulation in their daily lives... An agreed position on climate change will be needed to progress crucial investment decisions. In short, there is a sense that our infrastructure networks are barely adequate for current needs, and that they are beginning to impose significant long-term costs.³⁰

Infrastructure damage has flow-on effects. Infrastructure is interconnected; when one element is damaged others may also be impaired. Water shortages, for example, can threaten electricity supply where generators cannot access sufficient water for cooling. Conversely, electricity systems are in many places crucial to the functioning of the water supply, as well as transport services such as tunnels and rail systems. The loss of power to Sydney's CBD one evening in March 2009, for example, forced the closure of the Sydney Harbour Tunnel and Eastern Distributor during peak traffic hours, causing areas of gridlock.³¹

Climate impacts to infrastructure cascade through the economy, and are felt throughout the community. Some of these costs imposed by infrastructure damage are not recovered at all, but others flow through into higher prices, insurance premiums and taxes. Preparing now for climate change risks enhances the resilience not only of Australian infrastructure but of Australian society.

Existing assets and those constructed in the future will need to cope not only with gradual rises in sea level and temperatures, but with the growing risk of extreme events and their consequences.

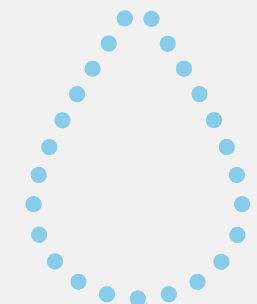
Social infrastructure

The Australian economy is enabled and strengthened by social infrastructure such as healthcare and community welfare structures and systems. This sector faces two main forms of climate risk: greater need for services as a result of more extreme weather events and decreased capability to respond to this need due to its own vulnerability to infrastructure impacts. A survey by the Queensland Council of Social Services found that most community organisations were unable to function for 2–5 days during the floods, after which an average 70 per cent of their workload was flood-related.³²



Natural infrastructure

Human society depends on natural ecosystems that produce goods (food, freshwater, timber, etc.) and regulate natural processes, such as air and water purification, and soil fertility. The Millennium Ecosystem Assessment – a global stocktake of the health of the natural environment – found that 15 of 24 ecosystem services evaluated have been degraded over the past 50 years.³³ These are vulnerable to further degradation from population increase, economic development and climate change. The total value of the natural services and services provided by the global biosphere has been estimated at US\$33 trillion annually.³⁴



Manage the Unavoidable

Climate readiness enhances resilience

In one sense, preparing for climate change offers a unique challenge. Extreme weather can be shocking and sudden, like Cyclone Yasi or the Victorian 'Black Saturday' bushfires, or long and drawn out, like drought. Background conditions – like rises in average temperatures and sea level – change gradually, but this raises the likelihood of greater extremes, such as heatwaves and storm surges. Whether exposed to direct damage, operational or logistical interruptions, vulnerabilities within the supply chain or customer base, or natural resource constraints, a wide range of businesses must grapple with a wide range of climate change-induced risks. For example, Figure 1.2 shows the range of direct and indirect consequences of a 60 cm sea level rise. No two businesses will face exactly the same risks.

In another sense, climate change is just another force shaping the business environment, in which uncertainty is inescapable, flexibility is essential, and complacency leads to failure. The Australian economy is already adapting to major unavoidable shifts:

- + In consumer behaviour, where growing use of internet and mobile technologies are transforming the media and retail sectors;
- + In international influence, as the rise of Asia reshapes trade flows and geopolitics; and
- + In demographics, where the baby boomers' entry into retirement signals higher health costs and a lower tax base.

International consultancy KPMG lists climate change as one of ten global 'megaforces' redefining business sustainability. Others include resource scarcity and population growth.³⁵ Companies that recognise and ready themselves for these game-changers are better placed to succeed than their less-prepared competitors. 'The companies that are beginning to emerge as the most profitable are also the ones that are looking to be the most sustainable.'³⁶

Long-term sustainability challenges require companies to develop better resilience to external shocks, by minimising the costs and impacts of megaforces like climate change. Companies that fail to adapt are likely to be disadvantaged relative to their peers. This could include short-term cashflow impacts from sudden and unplanned maintenance, repair and insurance, or protracted operational outages with consequent loss of income and market share. For organisations that are large employers, provide essential services, or play a major role in the community, these costs may have a ripple effect through the wider economy and create significant reputational or even fiscal damage, jeopardising their 'social licence to operate'. This in turn can generate political momentum for tougher or more restrictive regulations.

We live in a world shaped by the infrastructure decisions of our ancestors, and future generations will live in cities and communities shaped by our own decisions now.

Avoid the Unmanageable

Staying within safe limits

Preventing dangerous climate change is crucial. As global emissions and temperatures rise, so do the costs of adaptation, and the risks of getting it wrong. At the UN climate conference in Copenhagen in 2009, 167 countries signed an accord to keep global warming below 2°C. By 2015, this will be reviewed with a view to keep temperatures below 1.5°C. The IPCC estimates that, by century's end, the average global temperature could climb more than 6 degrees above the pre-industrial average without effective action.³⁷

Beyond two or three degrees the challenges and costs of climate change associated with an additional degree of warming, regardless of the warming the planet has already experienced, are likely to overwhelm any attempts at adaptation to reduce the costs.³⁸

'Society may be lulled into a false sense of security'³⁹ by the idea that the global environment will change steadily and slowly.³⁴ However, the science suggests we are headed for tipping points in the earth system beyond which adaption becomes very difficult and costly. The limit of 1.5–2.0°C is the global community's best guess of a global warming guardrail; above this the risk of abrupt, irreversible, and dangerous climate change rises.⁴⁰

In late August 2012, Arctic summer sea ice reached its smallest extent since satellite observations commenced in 1979, part of a longer-term trend of sea-ice loss.⁴¹ As the area of sea ice shrinks, darker ocean surface is exposed, absorbing more radiation and amplifying the warming. Several other potential global tipping points or nonlinear changes have been identified with varying risks and uncertainties. These include a collapse of the Greenland Ice Sheet leading to a more rapid sea-level rise, the release of large volumes of methane and carbon dioxide presently trapped by permafrost, a sudden and huge volume of emissions with heavy drought and fire in the Amazon Basin, and a permanent shift in the El Niño–Southern Oscillation (ENSO), bringing even more extreme and more frequent droughts and heat waves to Australia.⁴²

Just how big are the risks of these nonlinear changes is the subject of intense study, but we already have some good indications. Analysis undertaken to date indicates that while Brisbane and Melbourne, for example, currently have \$3.4 billion and \$2.2 billion in exposed assets, a rise in average global temperatures of 'only' a couple of degrees sees their exposure increase to \$33 billion and \$40 billion respectively.⁴³ Research conducted by CSIRO, the Bushfire CRC and the Bureau of Meteorology for The Climate Institute projects that by 2020 the incidence of catastrophic fire weather days could almost double and by 2050 the risk of such fires is substantially more commonplace. For the Melbourne region this means catastrophic fire days could occur, not once in every 33 years as at present, but once every 2.4 years on average.⁴⁴

As Figure 1.3 shows, each degree of global warming places added strain on our capacity for resilience. The risks compound, as impacts become more frequent and more intense, and each shock to communities and businesses may weaken their ability to recover from the next.

Figure 1.2 Unavoidable
 The cascading consequences of a 60cm sea level rise⁴⁵

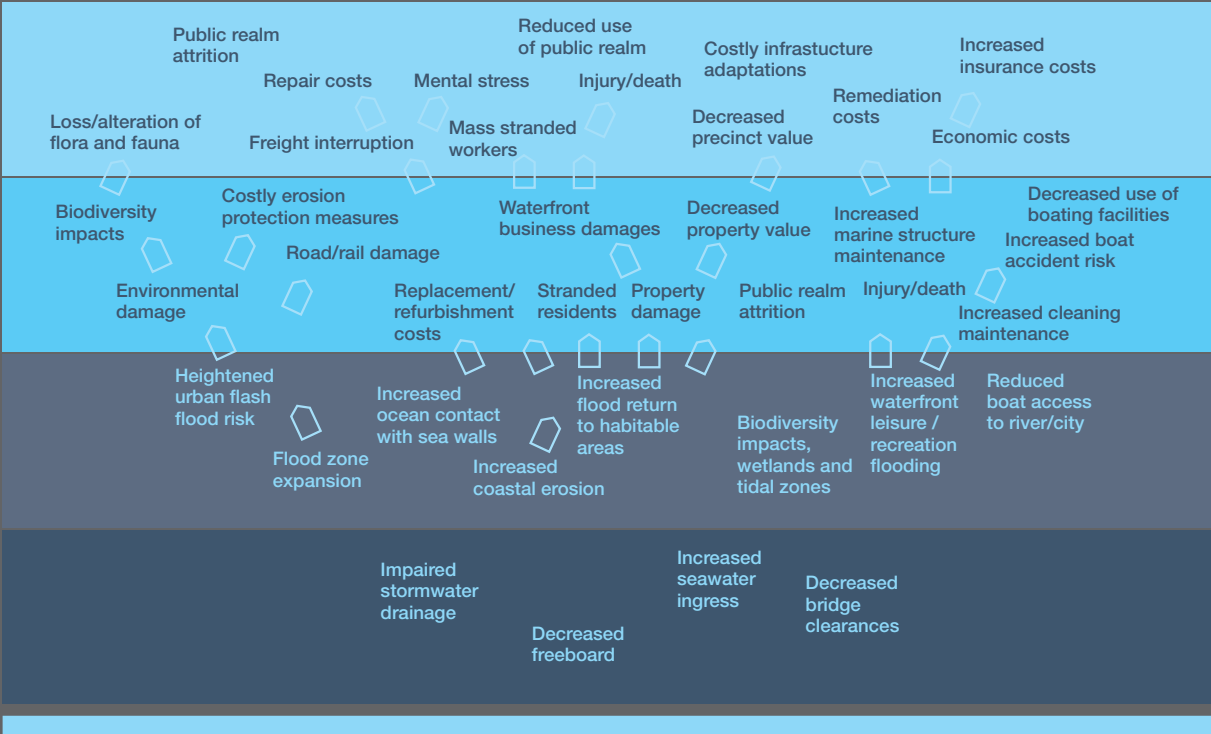
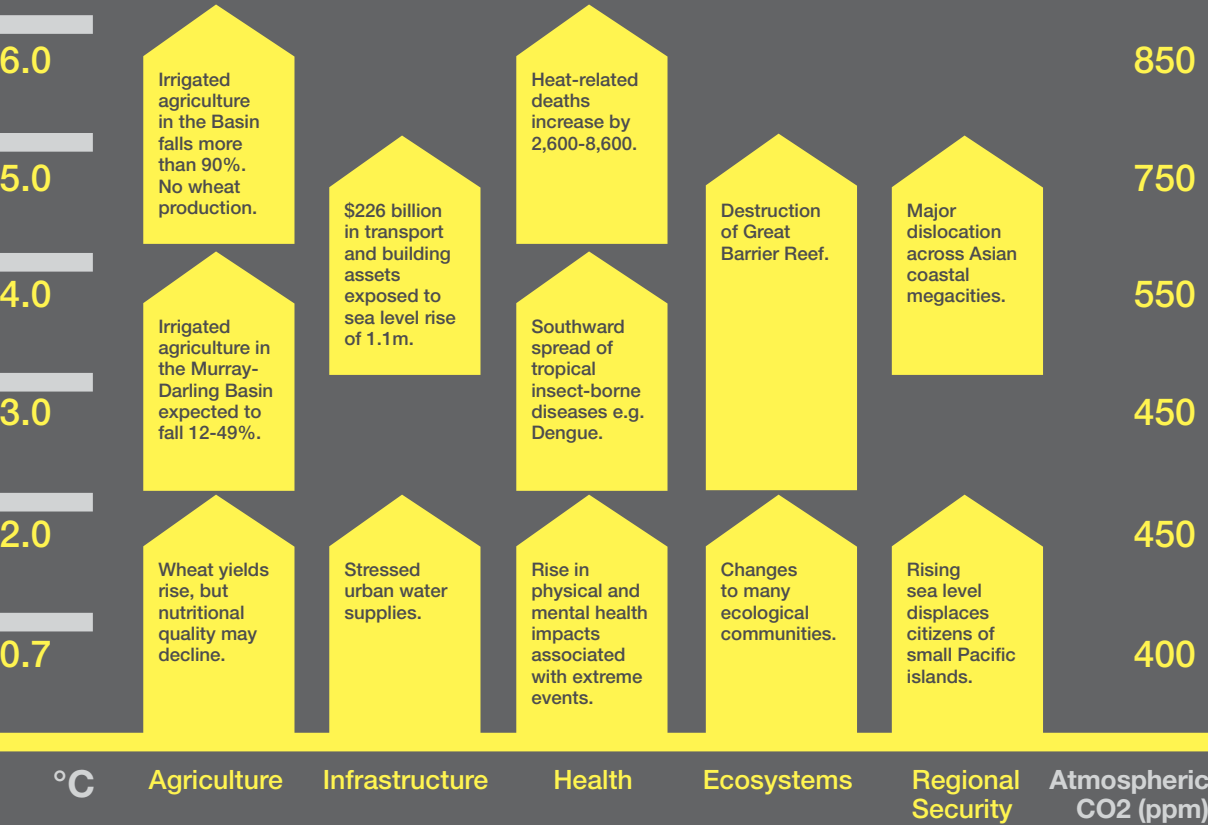


Figure 1.3 Unmanageable
 Adapting to climate change becomes more difficult as temperatures rise⁴⁶



Who Pays?

Counting the costs of the
2010–11 Queensland floods



The State

Over summer 2010–11, Queensland suffered severe flooding. Three-quarters of the state was declared a disaster zone and \$6 billion worth of public infrastructure was damaged or destroyed.⁴⁷ Although the primary cause of the floods was the La Niña weather cycle, climate change forecasts and observed warmer sea surface temperatures in the region predict increases in the intensity of rainfall. This suggests that similar events are more likely to occur as the climate changes further.⁴⁸



The Community

The floods affected nearly two-thirds of Queensland's population. Twenty-three people lost their lives and many more suffered property loss and damage. In the months after the floods community organisations noted higher rates of homelessness, relationship breakdown and alcohol-related domestic violence. Organisations providing support to vulnerable groups were hampered by the impact of the flood on their own staff and services.⁴⁹



The Industry

The floods forced closure of three-quarters of the coal industry – Queensland's biggest exporter. Many mines were flooded, and in some cases remain so. Much of the transport infrastructure on which the industry depends was severely damaged, with rail lines washed away and ports closed. Many of the large mining companies declared a force majeure event. Although the supply squeeze pushed up the price of coking coal, the industry lost an estimated 40 million tonnes in sales and \$7 billion in revenue.⁵⁰

Businesses not directly affected by flooding found that the flow-on consequences were much greater than they had initially anticipated.



The Business

Six months after the floods, businesses affected directly were still operating below business as usual owing to the impacts on their customers, poor consumer confidence, low demand, insurance and construction delays, flow-on impacts from the damage to major resource projects, and difficulty accessing finance. Businesses not directly affected by flooding found that the indirect consequences were much greater than they had initially anticipated.⁵¹



The Insurer

Insurance companies received 58,000 claims worth \$2.4 billion.⁵² However, many households lacked coverage, while others found that their policy's definition of 'flood' excluded compensation for this event.⁵³ Premiums in many areas of the state tripled. Suncorp Insurance placed an embargo on new covers in Roma and Emerald, two towns for which the floods were the third in three years.⁵⁴



The Citizen

The costs of the floods were felt well beyond state borders. The damage to Queensland's agricultural production sent fruit and vegetable prices up by nearly 15 per cent, and drove up inflation.⁵⁵ The Commonwealth Government imposed a flood levy on income over \$50,000 to raise \$1.8 billion for reconstruction. In total the floods were estimated to have knocked \$9 billion and 0.5 of a percentage point off Australia's GDP in 2010–11.⁵⁶

Section 2.0

Building Better Resilience



The Challenges of Preparing for Climate Change

Uncertainty is no excuse

The vulnerability of Australia's infrastructure depends not only on the degree of climate change to which it is exposed, but on how we deal with it: how and where we build new structures, how we adapt existing ones, and how we modify our infrastructure use.

There is a widespread view that, given the uncertainties associated with future climate change, adaptation to its impacts should not be undertaken until some or all of these uncertainties are resolved. A version of this argument supports focusing primarily on improving adaptation to current climate variability over preparing for future climate change.⁵⁷

However, many climatic changes are unlikely to be predicted with certainty early enough to inform a significant amount of today's infrastructure planning and construction, given existing commercial drivers. A company building a port, for instance, does not want to delay construction until the range of predicted sea-level rise has narrowed. As port construction for today's conditions risks more costly retrofitting at a later date, many port operators are factoring in an amount of sea-level rise anyway.

For example, the development proposal for a fourth coal terminal ('T4') at the Port of Newcastle assumes a projection of sea level rise of 0.9m and a 10 per cent increase in intense rainfall.⁵⁸

Similarly, areas that meet standards for historic climate conditions may become highly vulnerable under future climate change. Developing new settlements and infrastructure in these areas without recognition of the increasing climate risks places lives and assets in jeopardy unnecessarily.⁵⁹

The argument that action is unnecessary in the absence of certainty also simplifies and overstates the nature of climate change uncertainty. Climate change is probabilistic and can be modelled as such. The argument also underplays the risks of a more hostile climate. CSIRO and others note that the minimum impact from many climate change variables can be specified, while uncertainty within climate projections is overwhelmingly on the high side of forecasts.⁶⁰

For much major infrastructure, acting early is essential to avoid locking in future vulnerabilities, and can also provide benefits. Acting today may cost less than acting tomorrow if it prevents locking society into infrastructure pathways that would be costly to reverse in the future. And certain actions can bring immediate benefits beyond climate risk management. For example, resource efficiency improvements, investment in staff training or deeper supply chain analysis all contribute to corporate capabilities and resilience.

Ultimately, for most infrastructure planning, the question is less, 'Will the sea rise 50cm?' than, 'When will this rise occur and how much higher could it rise within the life of the asset - and what storm surge and other impacts will accompany it?'

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Develop flexible strategies

Generally, the most effective strategies for climate preparation are those that can accommodate a range of likely climate change scenarios. Five strategies to deal with climate uncertainty are:

No regrets – actions that yield benefits even in the absence of climate change. Such benefits may include increased resilience against current climate variability, or reduced exposure to supply chain shocks. For example, efficiency improvements in water or energy use can minimise the impact of shortages or disruptions to supply while reducing costs. Better early warning and emergency management systems will also reduce vulnerability to current weather risks.

Flexible/Reversible – actions that minimise the cost of being wrong about future climate impacts. These include constructions that can be easily retrofitted or upgraded, or decisions that can easily be reversed.

Safety Margin – designing infrastructure to cope with the full extent of likely climate impacts. This is appropriate when the higher costs of initial construction are relatively small compared with the costs of retrofitting later.

Soft – financial, institutional or behavioural tools. Insurance; incorporation of regularly reviewed long-term planning horizons.

Reducing decision-making time horizons – building cheaper, shorter-lived assets.⁶¹

Adapting to climate change is an ongoing process. Organisations may find that their optimal solutions combines strategies as the relative merits of each solution change over time.

For example, research undertaken by AECOM investigated cost-effective responses to the increasing risk of flooding in Narrabeen, NSW, caused by sea level rise. The study found that some steps could be taken immediately while others could be deferred. Immediate steps included an early warning system for residents of Pittwater (soft strategy; net benefit: \$12 million), a 3 metre (m) levee along part of Lake Park Rd (safety margin strategy; net benefit: \$0.9 million), and amendments to planning regulations to require a 1m rise in floor height for new buildings and renovations (soft and safety margin; net benefit: \$13.8 million). Widening the ocean entrance to Narrabeen lagoon to 70m could wait until 2035, while building a levee for Prospect Park could probably wait until after 2100.⁶²

Examples of this type of quantification of impacts, costs and benefits are very rare.

Be Ready for Major Shifts

When is a step-change needed?

The strategies outlined on page 26 are based on preserving existing areas of development and activity. However, tipping points or thresholds triggered by climate change – singly or in combination with other forces – may increase community vulnerability to catastrophic risk to such an extent that this becomes unprofitable or even impossible.

Incremental solutions in these cases may not only be inadequate, they may be counterproductive for circumstances where the probability of a catastrophic loss is low but the costs are high.

For example, building coastal defences against sea-level rise is an incremental solution that enables activity to continue in a vulnerable area – which may not be the best long-term result. A transformational solution, on the other hand, might be to shift that activity away from the coast altogether. This would be more appropriate if sea-level rise is greater than can be managed at a reasonable cost.

Figure 2.0 outlines the action needed to ensure successful adaptation of Australian infrastructure and coastal settlements to two climate change scenarios: a 2°C rise in global temperatures (best case) and a 4°C rise (consistent with current international commitments).

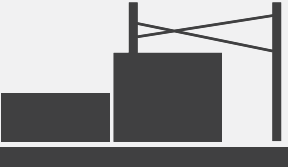

Managing risks in a 2°C world is much less challenging than doing so in a 4°C world. The latter demands transformational responses and a significant step-change in resourcing and implementing successful adaptation. It also requires greater innovation in engineering and design.⁶³

Climate readiness strategies should also include recognition of the risks to other systems or institutions on which an organisation depends. Recognising the interdependency of our infrastructure and our communities is critical to building true resilience to climate risk.

The urban water sector (see Sydney Water case study, page 42) provides an example where adaptation to climate change is being undertaken through collaboration not just across the sector, but with related infrastructure systems and government.

Climate readiness strategies should also include recognition of the risks to other systems or institutions on which an organisation depends.

Figure 2.0 What do we need to do to prepare for climate change?⁶⁴

SECTOR	ADAPTATION NEEDED BY 2030 IF HEADING TO 2°C RISE INCREMENTAL	ADAPTATION NEEDED BY 2030 IF HEADING TO 4°C RISE TRANSFORMATIONAL
 INFRASTRUCTURE	Climate impacts routinely incorporated into design, construction, maintenance standards and activity	AS FOR 2°C RISE PLUS Major re-alignment of exposed infrastructure – roads, rail, bridges, wastewater facilities, electricity networks
	Demand management routinely used in framing service capacity	Alternative paths for service provision
 COASTAL SETTLEMENTS	Regulation of infrastructure investment leads to proactive adaptation	Consumers accept lower security of supply
	Public disclosure of risk	Regulation of infrastructure investment requires proactive adaptation
	Access to consistent risk information	AS FOR 2°C RISE PLUS Policy/planning in place to redesign/relocate settlements
	Consistent approach to adaptation planning, risk and responsibility across decision-makers	Appropriate sharing of risk between private and public sectors
		Stronger emphasis on retreat
		More innovation in engineering responses from private sector
		Greater focus on sustainable urban form to minimise heat island effect

Australian Business Preparedness

Patchy + uncoordinated preparation

Australia should be relatively well-placed to adapt to some degree of climate change. Among our advantages are wealth, experience with extreme events, and significant intellectual capital. However, as the Black Saturday Royal Commission discovered, we are a long way from perfect in dealing with natural variability, let alone the increased risks from climate change.

Information on the extent to which Australia is preparing for likely climate impacts is, fragmented and dispersed. Australia lacks the necessary coordination of information provision, policy and legislation, resulting in poor communication between and within industry sectors, duplicated effort and wasted resources. All of this has potentially adverse outcomes for business and the community.

There is evidence that some organisations are moving to better understand and manage their exposure to climate risks. There are examples of proactive companies in all sectors, and some industries have made great strides in improving sector-wide and even cross-sectoral management of climate variability. Recent experience of drought saw major investment in water security projects, ranging from desalination to water efficiency, stormwater harvesting and recycling. Sydney Water, for example, is working with other industry bodies to develop a quantitative tool to assess climate impacts on water infrastructure and gain regulator support for adaptation actions.

There are few signals in the market, however, to encourage consideration of climate risk more broadly. Most infrastructure owners and operators are focused on maintaining their assets to standards based on historic, not future, climate conditions.⁶⁵

This may change, as elements of the finance industry – particularly insurers and institutional investors – are increasingly focused on managing their exposure to climate risk. Currently, however, laggards face no or little penalties, while early movers are often hampered by fragmented information, and inappropriate and inconsistent regulation.

The Federal Government has, through the National Climate Change Adaptation Research Facility, the CSIRO Adaptation Flagship and the Department of Climate Change and Energy Efficiency, undertaken modelling of climate change risks to some forms of infrastructure. However, climate science been unevenly integrated into Australian policy and practice. For example, state land-use planning policies incorporate varying projections of sea-level rise and storm surge, ranging from 38cm by 2100 in Western Australia to 100cm in South Australia.⁶⁶ The NSW Government recently withdrew its sea level rise policy and will no longer recommend statewide benchmarks.⁶⁷

Aside from research efforts, there has been little visible progress on the National Adaptation Framework agreed by COAG in 2007. A draft national climate change adaptation standard is still awaiting finalisation. The lack of national coordination and inappropriate regulatory reform has left much of the burden of policy implementation to local councils – the least-resourced and most fragmented level of government.

‘We are neither nationally nor locally where we want to be on climate adaptation response and preparedness, especially given the potential future impacts, and... in some respects we are at risk of going backwards.’

There is good reason to believe that the level of activity in Australian organisations is insufficient to meet the scale and urgency of the task. Two surveys by CSIRO of over 400 public and private sector organisations, representing sectors most likely to be exposed to climate change impacts, found that concern about climate change had fallen since 2008. The proportion of organisations reporting that they had carried out a vulnerability assessment for climate impacts fell from a majority (nearly 60 per cent) in 2008 to less than half (47 per cent) two years later, and those that had taken action or made plans for adaptation in response to the findings of the vulnerability assessments were even fewer – just over a third.⁶⁸

More recently, a workshop hosted by Australian National University, which drew together representatives from the private sector, industry associations, researchers, consultants and all levels of government, noted that in some instances, organisations are not going beyond the initial vulnerability or risk assessments. Participants concluded:

*We are neither nationally nor locally where we want to be on climate adaptation response and preparedness, especially given the potential future impacts, and ... in some respects we are at risk of going backwards.*⁶⁹

Similar results were reported in The Climate Institute's *Climate of the Nation 2012* research into public attitudes to climate change. This found that the politicisation and scare campaigns surrounding the introduction of the carbon laws have undermined public confidence in both climate science and climate policy.⁷⁰

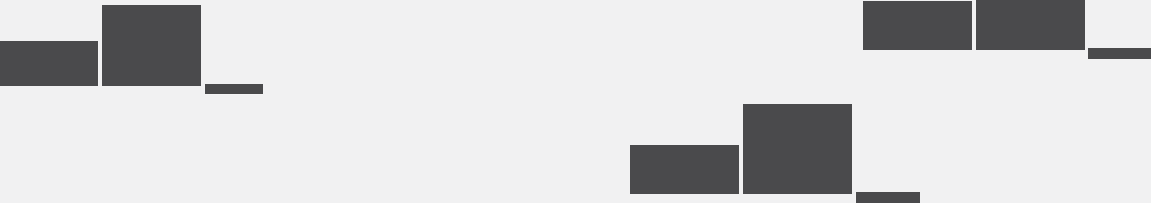
There is also emerging community resistance to adaptive decisions that are inconsistent and often poorly communicated and implemented. One example is the struggle by local government to implement responses to sea-level rise projections in the face of unclear guidance, existing use and property rights, existing coastal defences, and concern from waterfront property owners. Byron Shire Council, for instance, has faced several court battles from residents opposed to the council's planned retreat policy.

Notwithstanding some examples of collaboration, action tends to focus on organisation-level risk management. However, some solutions to climate change may impose costs elsewhere if done in isolation. For example, securing water supplies for electricity generation may cause shortages for other users, and affect agriculture and ecosystems. A price-regulated industry such as energy distribution may be prevented from factoring climate adaptation costs into future asset augmentation if the climate impacts are felt outside the sector. The implications of climate impacts on interdependent systems, or on a broad spectrum of stakeholders, remain underexplored.

Government and business should urgently address the gaps in climate change adaptation in order to avoid unnecessary loss of life, incomes, and damage to major infrastructure assets. Progress is being made but it is piecemeal, locked in past paradigms and uncoordinated. Without a broad and collaborative focus, autonomous adaptation to climate impacts could result in counterproductive actions, or maladaptation.

Property

Australia's buildings are characterised by diversity in ownership and use as well as diversity in structure, location, and exposure to climate change.



SECTOR SNAPSHOT

Australia's buildings are worth approximately \$5.7 trillion.⁷¹ Among these, an estimated \$159 billion worth of buildings are vulnerable to sea level rise and storm surge. This includes more than 8,000 commercial, 6,000 industrial and 274,000 residential buildings around the country.⁷² Buildings, particularly in southern Australia, also face higher bushfire risk, and degradation of foundations and materials, as higher temperatures and reduced rainfall cause soil to dry and move.⁷³

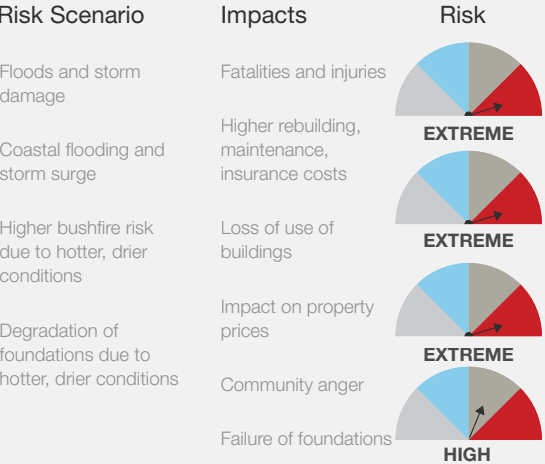
Risks to this sector are not limited to the impacts on physical structures, but also include the ability of a building's inhabitants to maintain their daily routine. As well as the direct impacts of extreme events on operations, a key risk for building users is the impact of higher temperatures on electricity demand. More frequent and intense heatwaves will likely lead to higher electricity prices, and possibly grid strain and blackouts (see electricity sector snapshot, page 35).⁷⁴ They also put stress on air conditioning systems, already a major issue for commercial centres. A more dangerous consequence is increased morbidity and mortality, particularly among vulnerable groups such as the poor and elderly.⁷⁵

The sector is regulated principally by planning policies set by state and local governments, and the national Building Code of Australia (BCA), for which each state and territory has amendments and opt-outs. Many of these regulations are considered ill-suited to the changes in risk profile, as they tend to rely on assessments of historic climate risks.⁷⁶



New construction compliant with the current BCA has been assessed as 'likely to be reasonably adequate' only under 'low emission scenarios'. Buildings built to earlier standards may be vulnerable to climate impacts, as are BCA-compliant buildings under higher emission scenarios.⁷⁷ Updated standards generally apply to new rather than existing developments, although improvements may be gradually incorporated through maintenance or retrofits. The consideration of climate change risks in legislation and planning policy varies considerably between Australian states. Local councils also differ considerably in their approach to climate change risk for new and existing infrastructure, ranging from no consideration to detailed prescriptions. In particular, Australia lacks a cohesive national coastal planning framework. The lack of coordination in planning policies risks inefficient adaptation to climate change, and, long-term, greater vulnerability.

HOW BIG IS THE PROBLEM?



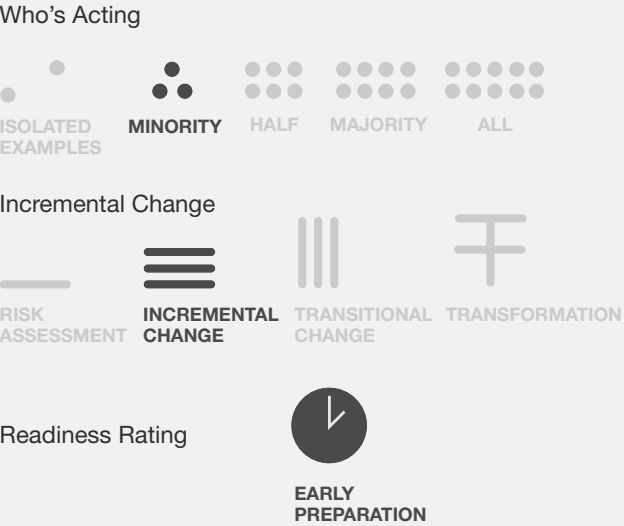
Risk ratings derived from the likelihood and consequences of such impacts under a high emissions scenario. These are ascribed to the sector as a whole – individual infrastructure assets' risk profiles will vary substantially.⁷⁸

WHO IS DOING WHAT?

Major companies such as Mirvac, Stockland, GPT and DEXUS have all examined their exposure to climate risk and developed strategies to minimise their vulnerability. Mirvac has integrated climate related risks into its enterprise risk management system as part of a broader approach to managing climate change related impacts. DEXUS created a climate-change risk register and property action plans, and has incorporated climate change into its annual risk management workshops. Stockland has examined the climate risk profile of each asset within its property portfolio, assessing each one on its location and design, structure, operation and maintenance, utilities and services and stakeholders. This enables new commercial property to be built and operated to appropriate standards; it also allows existing assets to be made more climate-resilient by improving their operation and maintenance regimes.

Some not-for-profit organisations have also begun preparing for climate impacts, despite facing additional capacity and structural challenges. For example, Surf Lifesaving Australia is developing strategies to help its 309 separately incorporated life-saving clubs manage climate risk. Most of the clubs are near the shorelines of sandy beaches, vulnerable to sea-level rise and storm surge, and nearly two-thirds are in areas classified as 'zones of potential instability'. Sea-level rise will also alter the physical form of beaches, with implications for the occupational health and safety of lifesaving staff and volunteers as well as beach-goers.⁷⁹

ACTION INDICATORS



Green Cross Australia is running several projects to facilitate adaptation: 'Harden Up' focuses on building community resilience; 'Build It Back Green' on ensuring post-disaster reconstruction is sustainable.⁸⁰

Various industry associations are beginning to facilitate climate adaptive activity: the Australian Green Infrastructure Council has produced Climate Change Adaptation Guidelines for Infrastructure, while the Insurance Council of Australia is developing with Edge Environment an online tool for residential property owners to assess the risk profile of their property. The Green Building Council of Australia has incorporated climate adaptation and resilience into its Green Star program, while the Australian Sustainable Built Environment Council has developed a framework for greater industry-government coordination.⁸¹

A number of local councils have begun to incorporate future climate risks into regulation. In some cases this has led to strong community opposition, particularly where policies threaten existing use rights and property values.⁸² For example, Gosford Council repealed its policy to require sea-level rise warnings in planning certificates after waterfront property owners protested.⁸³ Victoria's Coastal Climate Change Advisory Committee has warned that 'strategic planning as currently undertaken... is unlikely to be effective in driving the significant planning needed for climate change responses', due to a lack of agency integration, but also a 'lack of sense of priority across state and within local Government areas'.⁸⁴

Case Study Mirvac

Mirvac is a leading Australian integrated real estate group, listed on the Australian Securities Exchange (ASX). The group designs, constructs and manages property throughout Australia.

Reducing energy price exposures

Improvements in energy efficiency in Mirvac's investment portfolio have reduced Mirvac's carbon footprint as well as the company's exposure to some climate impacts in the electricity sector. Since 2009, Mirvac has reduced the energy intensity of its assets by 34 per cent and carbon intensity by 36 per cent while increasing group revenue and NLA by more than 91,000m². For some assets, operating expenses were considerably lowered through energy efficiency projects with minimal capital investment.

Gary Flowers, Chief Operating Officer:

Buildings are an important part of our national infrastructure and we need to account for the long term future of these assets. Companies that seek to play a role in providing Australia's infrastructure should consider climate within a suite of key risks to deliver a quality, future-proof product.

Enterprise risk management

Mirvac's enterprise risk management system registers consideration of 11 physical climate impacts in the management of both operational and project based risk. In 2011 Mirvac completed a climate risk assessment of its assets across its Investment and Development divisions. In assessing Mirvac's adaptive capacity, the report considered potential physical impacts of climate change, together with the Australian regulatory and business operating context. The physical impacts considered include temperature rise, extreme weather events, precipitation changes and increase in sea level. Data for the assessment used a 'moderate' emissions scenario from the IPCC. A sea level rise of 0.8m to 2100 was assumed,⁸⁵ in alignment with coastal zone planning guidance adopted by various Australian states.⁸⁶

Under this assessment, existing property investments were examined against key climate risks, with some variance in adaptive capacity to specific risks dependent upon: the age, structure and size of the asset; existing design elements (energy efficiency); and any planned future capital upgrades. Therefore whether older assets should be upgraded to increase resilience will be dependent upon the expected life of the asset, cost of the upgrade, effectiveness of the adaptation measures, the overall vulnerability of the asset, and the strategic role of the asset within the property portfolio.



Integrated strategy

The climate change risk assessment is one of several initiatives that were adopted in response to Mirvac's strategic driver of sustainability excellence. The business case for the climate change risk assessment and a climate related strategy included: best practice risk management for existing assets and acquisitions; minimising costs whilst protecting asset values; and anticipating changes to due diligence requirements.

The future

Mirvac's ongoing response to climate change balances both mitigation and adaptation efforts to achieve an integrated approach, including:

Mitigation

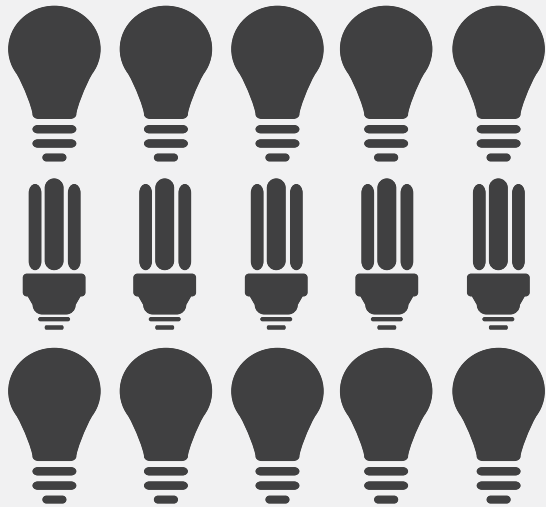
- + Continued focus on reducing energy and carbon intensity of applicable Mirvac-operated assets
- + Encouraging the uptake of low carbon design and technology where feasible
- + Monitoring the performance of existing assets and continuing to seek opportunities to curb emissions
- + Maintaining transparent disclosure of greenhouse gas emissions profile and performance
- + Providing staff training to manage assets more efficiently.

Adaptation

- + Considering key climate impacts in the acquisition of new sites or assets, and in the design or upgrade of new and existing buildings
- + Considering climate impacts within the site planning and construction management process
- + Response readiness - assisting users of Mirvac owned or managed buildings, including tenants during extreme weather events
- + Continuing to meet statutory disclosure obligations and regulatory design requirements
- + Engagement in public and industry dialogue in formulating responses to climate change.

Electricity

The electricity network is both essential to the functioning of other infrastructure systems, and dependent on them to maintain reliable power supply.



SECTOR SNAPSHOT

The electricity supply system is one of the most essential elements of Australia's core infrastructure. Electricity consumption is central to almost every home and business. It is also a critical component of other infrastructure systems: water supply, wastewater management and telecommunications. At the same time, the electricity sector is dependent on other infrastructure systems. Coal- and gas-fired and solar thermal generators need water to run steam turbines and to cool exhaust steam.⁸⁷ Electricity transmission and distribution networks – 48,000km of transmission lines and 800,000km of distribution lines spread over large and varied geographic areas – need functioning road and telecommunications networks to deploy their workforce for maintenance and repair.

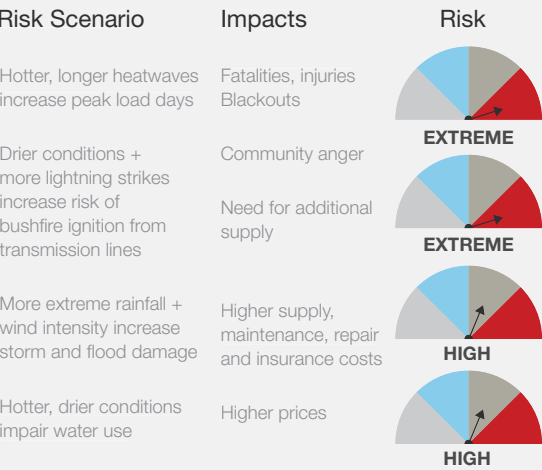
Climate change affects electricity infrastructure in very different ways. Higher temperatures and longer, more intense heat waves skew electricity use: lower in winter, but with higher, more sustained peaks in summer, to meet consumer demand for cooling. Higher temperatures also reduce the effectiveness of cooling systems and transmission lines, decreasing the efficiency of electricity generation at the very time it is most needed. This combination drives up electricity costs and stresses the system, increasing the likelihood of blackouts.⁸⁸ The heatwave-induced blackout in Melbourne in January 2009, for example, shut down the city's rail and tram networks, forced thousands of businesses to close and crippled internet services nation-wide.⁸⁹ An estimated 500,000 homes lost power.⁹⁰



More frequent or persistent droughts reduce the availability of water for electricity production. While new thermal plants may use dry rather than wet cooling, this option is less efficient and may produce more greenhouse gas emissions. All forms of extreme weather events can knock out generators or networks, and may also delay restoration of supply.

Australia's electricity sector comprises a mix of state-owned and private generators, network service providers and retailers. Each section of the supply chain is subject to different regulatory frameworks. Regulation focuses principally on security of supply, with no explicit reference to risks posed by climate change.

HOW BIG IS THE PROBLEM?



Risk ratings derived from the likelihood and consequences of such impacts under a high emissions scenario. These are ascribed to the sector as a whole – individual infrastructure assets' risk profiles will vary substantially.⁹¹

WHO IS DOING WHAT?

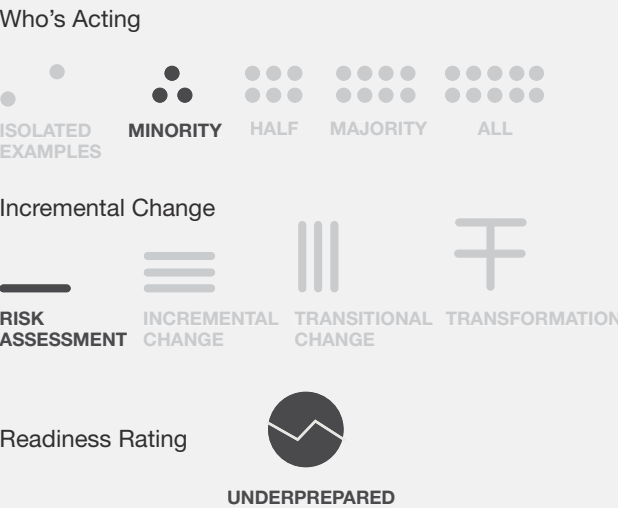
Isolated examples of activity can be found among electricity generators. Network service providers are at an early stage of coordination among themselves and with regulators.

Macquarie Generation, for example, has examined the exposure of its coal plants to water shortages. Recognising the risk in relying solely on the Hunter River, the company diversified its supply by extending pipelines into Lakes Liddell, Plashett and Glenbawn. (See also AGL case study over page.)

Within the transmission and distribution sector, companies have recently begun to examine their climate risk exposure. Queensland's Ergon Energy and Energex developed a combined Network Adaptation Plan in 2011. This involved identifying and prioritising physical climate change risks and developing recommendations for design standards, mapping and analysis, emergency management, and additional investigations. It is anticipated that the plan will be updated approximately every five years.⁹²

In Victoria in 2010, the state distribution companies made the country's first attempt at incorporating climate risk management into a regulated price determination. The companies had commissioned analysis based on CSIRO and Bureau of Meteorology projections, which found that the networks faced more hot days, more extreme wind events, increased bushfire risks, increased termite damage, and the need for reviews of climate-change risk.

ACTION INDICATORS



The work also quantified the associated disruption of service and impact on asset performance for some of these risks. The companies proposed to address these risks during 2011–15 by upgrading components of the network. For this they sought an additional \$47 million from the Australian Energy Regulator (AER), within a total pricing determination of some \$7 billion.⁹³ However, the AER was unpersuaded that the companies required extra funds for climate-proofing activity within the five-year period.⁹⁴

Nonetheless, the AER supports engagement with the industry to jointly resolve the regulatory challenges posed by climate change in advance of the next round of determinations (covering 2015–2020).⁹⁵ This would allow for mutual agreement on appropriate climate risk methodologies and treatments. Developments in the UK also indicate a potential path forward: the country's energy industry has been undertaking collaborative research with the Met Office to assess the scale of climate change impacts. Research will explore several areas relevant to the Australian energy sector. These include new methods to project impacts dependent on succession and combinations of weather parameters, and probabilistic climate projections for risk management, as well as cost-benefit analysis of climate adaptation options.

Case Study AGL

AGL is a major energy supplier with a diverse generation portfolio. AGL also operates retail, merchant energy and upstream gas businesses, and has over three million customer accounts.

Incorporating climate risk

In 2006 AGL conducted a climate change risk analysis for its assets and customer base. This found that, aside from risks associated with carbon pricing policy, the key forms of climate risk affecting AGL are physical impacts to energy infrastructure caused by extreme weather events, water availability risks exacerbated by drought, and financial risks associated with changes in energy demand.

Senior managers have incorporated climate change risk into their risk register, and assigned various elements of climate risk to key staff throughout the organisation. AGL is expanding its carbon risk assessment process beyond mitigation to more closely look at adaptation issues, and has continued to update vulnerability assessments of essential infrastructure, working off the release of updated information on the impacts of climate change on Australia's physical climate.

Many identified actions require the involvement of other businesses and government agencies, and are being addressed through AGL's policy and advocacy efforts.

Energy demand

Rising temperatures, along with increased uptake of air conditioning, will likely lead to periods of greater peak demand in summer, during which wholesale electricity prices can often increase by several thousand per cent. This peakiness increases price volatility. AGL has tried to reduce this risk through development of peaking power stations, and demand management and time of use pricing, but is hampered by limitations in energy demand forecasts. These include temperature and other weather data, but this analysis does not yet incorporate climate change modelling into its projections of future climatic conditions.



Physical risks to infrastructure

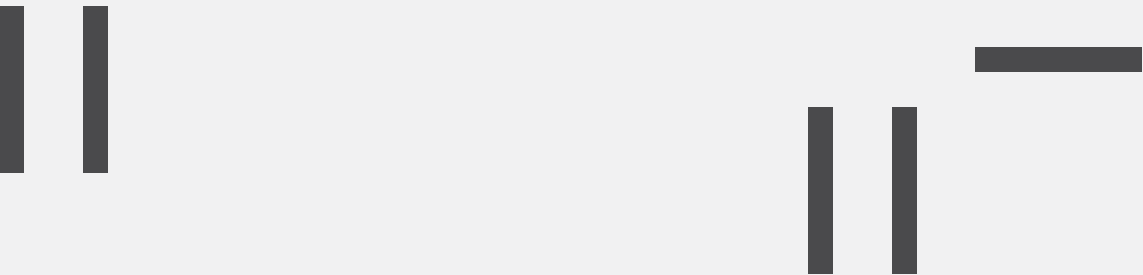
AGL's gas and electricity generation assets are exposed both to physical damage and reduced supply reliability from extreme weather events and bushfires. AGL examined the proximity of its assets to coastlines and does not believe that sea level rise poses a significant threat.

Water availability risks

Another physical impact identified in AGL's climate risk process was the availability of water for their network of hydro electricity generation assets. AGL undertook various hydrological assessment in the initial phases of due diligence to ensure water security, and engaged climate and rainfall experts in this field to consider the risks associated with reduced precipitation and other changes in rainfall patterns.

Road+Rail

The Australian land transport system is vast, but lacks integrated strategic management.



SECTOR SNAPSHOT

The dispersal of a relatively small population across a massive landmass means that Australia is deeply dependent on its land transport infrastructure. The country has 812,000 kilometres of road, ranging from freeways to unsealed tracks, and 37,000 bridges.⁹⁶ The estimated total value is \$100 billion.⁹⁷ There are 43,000km of rail track, some more than 100 years old. Rail is responsible for about 40 per cent of Australia’s freight transport.⁹⁸

The main climate risk to road and rail is increased flooding owing to more intense rainfall. This results in landslides, road collapse, and washout of roads and rail tracks. The 2011 Queensland floods caused \$1 billion in rail damage and a further \$26 million in lost revenue.⁹⁹ Higher temperatures can lead to rail buckling, and increase cracking in bitumen and asphalt seal. Once water gets into the cracks roads deteriorate rapidly, increasing maintenance costs. Roads in northern Australia are particularly vulnerable to both impacts.¹⁰⁰

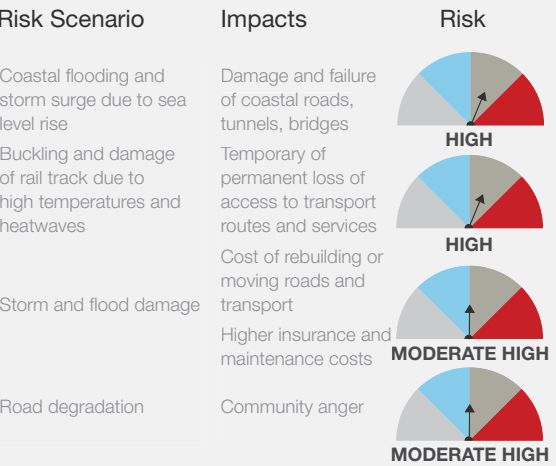
Sea-level rise and storm surge also puts at risk up to 35,000 km of coastal road and rail, worth \$60 billion. This includes 1,500 km of freeway and 1,500 km of rail and tramway, which are not only expensive to replace but have broader impacts on travel and transport capability. With more coastal freeway and railway than any other state, Queensland has the most transport value at risk.¹⁰¹



Impacts to major transport routes can cause significant knock-on effects, as they may impair evacuations and emergency responses, food and freight transport, as well as people’s ability to move freely.

Although road and rail interact with other forms of transport to provide an integrated supply network, there is no overall coordination of road and rail planning, construction and maintenance. State and local governments manage most road assets, with the federal government responsible for national roads. Some toll roads are the result of public-private partnerships. Though much rail infrastructure is managed by state and federal governments, a growing share is under private management. This variety of ownership, management and use is an obstacle to tackling climate risks in a holistic manner.¹⁰²

HOW BIG IS THE PROBLEM?



Risk ratings derived from the likelihood and consequences of such impacts under a high emissions scenario. These are ascribed to the sector as a whole – individual infrastructure assets’ risk profiles will vary substantially.¹⁰³

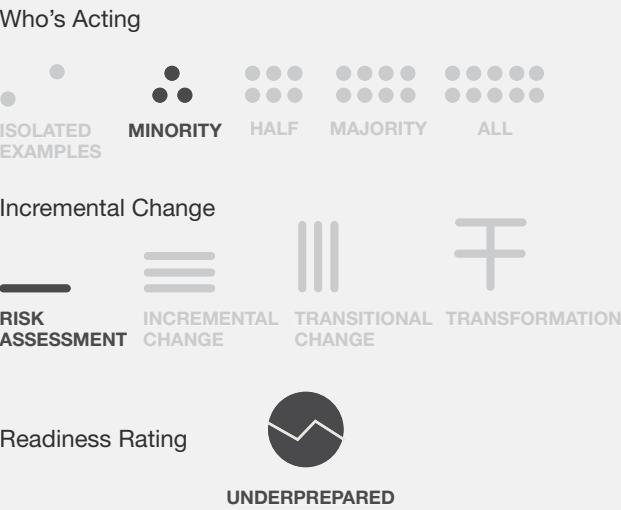
WHO IS DOING WHAT?

The lack of integrated planning in this sector makes it difficult to assess the degree of action underway to prepare it for the impacts of climate change. Infrastructure Australia’s National Land Freight Strategy discussion paper recognises the importance of accounting for the impact of climate change on road transport, while noting that existing freight planning documents’ consideration of the issue is ‘unclear’.¹⁰⁴ Examples of state-level climate adaptation policy exist: for example, proposals for new state roads and major road upgrades in Queensland must include a Climate Change Impact Statement, although the results are not required to be integrated into design and construction.¹⁰⁵ Road authorities in NSW and Victoria are integrating climate change considerations into projects (see Department of Transport Victoria case study, page 41). Broadly speaking, there is more adaptive activity in the road sector than in rail.

Infrastructure Australia notes that, *In the transport system in particular, metropolitan planning systems appear to give little credence to the implications of climate change and energy security when determining infrastructure investment priorities.*¹⁰⁶

In rail, the Australasian Railway Association notes that no climate change assumptions have been built into rail building standards to date and that large sections of current track infrastructure are not expected to be replaced or materially upgraded in the next 50–100 years.¹⁰⁷

ACTION INDICATORS



Case Study Department of Transport Victoria + VicRoads



Acting on assessments

The Department of Transport (DoT) Victoria coordinates policy and planning for the state's public transport and freight. Under Victoria's Climate Change Act 2010, each state department is required to produce a Climate Change Adaptation Plan. DoT Victoria is currently updating risk assessments for all areas of its operation to incorporate climatic change. This work is intended to provide comprehensive analyses of climate risks for DoT's transport operations and assets.

DoT Victoria will also assess the costs of managing climate risks through new, retrofitted or replacement infrastructure, and/or enhanced maintenance and emergency responses. The Department is developing an action plan to enable each division to manage its climate change risks, and has included climate risk management as one of the objectives of its new Transport Outcomes Framework (in development). DoT also commissioned AECOM to develop an on-line interactive training program on climate change. This is to be launched in late 2012 and made available to all DoT staff and all transport agencies and service providers in Victoria. It aims to educate staff about the key climate risks to transport infrastructure and the range of potential risk management strategies throughout the entire process from planning, through construction to service delivery.

Jim Betts, Department of Transport Victoria Secretary:

We need to be pretty clear about what our risks are to make sure that we target our intervention to make the really critical infrastructure as resilient as it can be. And [ensure] when we are building new infrastructure, that our policies, our guidelines and our engineering standards reflect the new world in which we are now living.

VicRoads, a separate agency under the transport portfolio, manages over 22,000 km of roads and 3133 bridges across Victoria. VicRoads has also undertaken parallel and separate climate risk work. Assessments of climate impacts on its road assets has led the agency to review its road design standards and specifications

Gray Liddle, VicRoads CEO:

Rather than thinking about this in the future, we need to actively think about it now. We need to understand what a temperature increase will do to the transport network. A resilient transport network is one that is reliable and the community doesn't have to worry about whether it is going to be there for them or not.

Case Study Sydney Water



Sharing solutions

Much urban water infrastructure already incorporates resilience-enhancing features such as redundancy, 'soft-fail' options and alternative operating modes. The sector is moving toward a more comprehensive approach, with collaboration between organisations, government and researchers to identify and implement smart adaptation.

Sydney Water has been an early adopter of climate change risk management for its infrastructure. In 2008 a qualitative risk assessment identified potential climate change risks, which informed the development of the company's Climate Change Adaptation Program.

The program's objectives are to:

- + Reduce the potential financial, operational and reputational impact of climate change on Sydney Water and its customers;
- + Improve internal understanding and quantification of climate change risks;
- + Deliver prioritised and costed adaptation response options; and
- + Inform future capital and operational investment.

Sydney Water is a case study within the Australian Government's Critical Infrastructure Protection Modelling and Analysis (CIPMA) Program. The CIPMA Program models the behaviour of 'critical' infrastructure assets—defined as those necessary to Australia's economic well-being or national security—under stresses or shocks including climate change.

The Sydney Water case study assesses how climate change impacts could affect water and wastewater systems through both direct impacts on Sydney Water assets but through interdependencies with electricity and telecommunications systems. The aim is to quantitatively assess the cascading impacts of climate change-related water and wastewater service disruption on dependent communities, businesses and other critical infrastructure assets.

Sydney Water is also a core partner in the development of a sector-wide project called AdaptWater. AdaptWater is a climate change adaptation quantification tool which calculates both the consequences of climate change hazards and the effectiveness of adaptation options in reducing risk. The tool has been expanded to cover elements of water utilities across Australia, and is now being rolled out across Sydney Water's assets.

This and further analysis informed the assessment that water supply infrastructure warranted a 'relatively advanced' readiness rating.

Finance

The finance sector is highly exposed to climate risk, but essential to adaptive action and can provide incentives to build resilience.



SECTOR SNAPSHOT

Several sectors of the finance industry are positioned to drive stronger responses to climate impacts. As noted in a landmark report by the International Finance Corporation, *Most investments will be channeled through financial institutions...there is a considerable opportunity, as well as a responsibility, for these institutions to take a leading role in adaptation to climate change.*¹⁰⁸

Several significant initiatives aim to build cross-industry awareness and skills in assessing and managing climate risk in lending and investment activities. These initiatives include the Carbon Disclosure Project, the Principles for Responsible Investment, the Investor Group on Climate Change, the Principles for Sustainable Insurance, the Equator Principles, the UN Environment Program Finance Initiative and the Asset Owner's Disclosure Project (AODP).

In 2012, the Carbon Disclosure Project (CDP) sent its annual request for disclosure on climate change to the largest 500 companies globally, on behalf of 655 investors with US\$78 trillion of assets. The survey asks companies to measure and report on what climate change means for their business and receives responses from 80 per cent of surveyed firms. This year the CDP found that:

Recent extreme weather and natural events have tested companies' business resilience and increased their level of understanding of the timeframes of the physical risks they associate with climate change. Physical risks are viewed as tangible and present, impacting companies' operations, supply chains and business planning.

*The majority of companies (81 per cent) report physical risks and the percentage of companies that view these risks as current has nearly quadrupled from 10 per cent in 2010 to 37 per cent in 2012.*¹⁰⁹

The insurance industry's exposure to the costs of extreme weather events makes it a key player in climate risk management. Insurance providers play an important role in transferring those risks, and could provide an incentive to reduce them. In principle, insurance products should provide a price signal to distinguish between high and low vulnerability to hazards and reward actions that reduce exposure to risks.¹¹⁰

In practice, annual premiums capture climate variability but do not factor in gradual changes in climate risk, as the insurance industry traditionally relies on historical climate data.¹¹¹ Purchasers of insurance via single-year premiums tend to assume that future cover will continue to be available and affordable. Following a major weather event, however, insurers often raise premiums drastically, causing price shocks, or even withdraw cover from areas.

Institutional investors are also potentially powerful drivers of climate risk management. Asset owners have a responsibility and, in many cases, a fiduciary duty to manage the long-term risks, including those associated with climate change. Currently, however, climate risk is under-priced. A survey of Australian funds completed by the AODP in 2011 found that the vast majority of surveyed funds (83 per cent) believe climate change is not currently being priced in asset valuations.¹¹²

Analysis by investment consultancy Mercer found that climate change is a systemic risk contributing up to 10 per cent of portfolio risk for a representative asset mix.¹¹³

ASSET CLASS	LISTED EQUITIES				FIXED INCOME			COMMODITIES		REAL ESTATE	PRIVATE EQUITY			INFRASTRUCTURE	
	GLOBAL	EMERGING MARKET	SUSTAINABLE	EFFICIENCY/RENEWABLES	GLOBAL	EMERGING MARKET DEBT	INV GRADE CREDIT	AGRICULTURAL	TIMBER	UNLISTED	LBO	VENTURE CAPITAL	EFFICIENCY/RENEWABLES	CORE/UNLISTED	EFFICIENCY/RENEWABLES
Regional Divergence	/	/	+	+	/	/	/	/	/	/	/	/	+	/	+
Delayed Action	-	-	+	+	/	-	-	/	+	-	-	-	+	-	+
Stern Action	+	+	+	+	/	+	+	+	+	+	+	+	+	+	+
Climate Breakdown	/	-	-	-	/	-	+	-	-	-	/	/	-	-	-

WHO IS DOING WHAT?

Australia makes up less than 2 per cent of the global reinsurance market, but over the last five years has incurred 6 per cent of global losses.¹¹⁴ Insurers are taking a range of actions in response, including raising premiums, withdrawing cover in some areas, developing new tools and government advocacy to encourage risk mitigation. These efforts have the potential to drive smarter climate risk management.

For example, after the Queensland townships of Roma and Emerald suffered three consecutive years of flood damage, Suncorp Group placed an embargo on new customers in the townships, to remain in place until the local councils arrange for flood defences.¹¹⁵ The Insurance Council of Australia is developing a tool to encourage improved resilience of residential homes (see property sector snapshot, page 31), and has called for improvements in land-use planning and development to better mitigate the impacts of extreme weather events.¹¹⁶ Companies are beginning to incorporate climate change into their modelling of future weather risk profiles, although, as IAG notes, 'A changing, less predictable climate has the potential to reduce [an] insurer's capacity to accurately assess, price and spread weather-related risk.'¹¹⁷

Westpac, National Australia Bank and ANZ have all made statements to the effect that they factor climate risk into their credit assessment process for debt and equity lending.

Institutional investors, including a superannuation industry worth \$1.4 trillion, are also taking a growing interest in climate risks, albeit from a low base. Only 11 per cent of Australian funds surveyed by the AODP rated the likelihood of climate change as high. No funds reported investment in assets to help manage climate impacts, such as flood barriers. No funds reported considering portfolio-wide exposure to physical climate impacts. However, 72 per cent of those investing in property consider climate-related factors.¹¹⁸ A more recent survey of global institutional investors notes that 26 per cent of respondents reported making changes to their investment strategy or decision making as a result of climate risk assessments.¹¹⁹

Figure 2.1

The table above shows Mercer's assessment of positive and negative impacts on asset classes of four climate change scenarios. Climate change produces almost entirely positive results under only one scenario, in which global coordination of mitigation policy produces a high degree of economic transformation (Stern Action). The most damaging scenario is Climate Breakdown, in which business as usual continues throughout the century, while the risk of catastrophic climate-related events increases and reaches critical levels by 2100.



Case Study Westpac

Westpac is one of Australia's largest financial services companies with around 38,000 employees, 12 million customers, and a market capitalisation of \$61.6 billion as at 30 September 2011.

Recognising risks

Westpac is one of Australia's largest financial services companies with around 38,000 employees, 12 million customers, and a market capitalisation of \$61.6 billion as at 30 September 2011. As a financial institution with lending and investment across all industries and levels of the economy, Westpac is exposed to the physical impacts of climate change and their consequences for customers, communities, and the market. For Westpac, climate risk impacts both directly on physical infrastructure and indirectly via investment and lending activities.

Managing operational impacts

The Westpac Group Property Risk and Compliance Framework addresses physical risks for the bank's operational infrastructure, including weather-related events. The Queensland floods of 2010-11 affected 150 Westpac branches, closing 50 branches completely, while several large commercial properties in Brisbane were inundated and 300 ATMs across Queensland suffered outages. More than 5,300 Queensland staff were affected and 70 personally impacted.

Climate change considerations are being built into the ongoing program of property refurbishment, including guidelines for site selection for example or changing air conditioning and energy consumption requirements in line with increasing average temperatures across Australia.



Helping customers manage climate risk

Westpac is also responding to climate risk impacts for customers. Following the spate of natural disasters in recent years, Westpac has developed the 'Bank in a Box'. This is deployed to emergency relief centres to provide basic banking services (such as cash) for affected communities when all other banking facilities are closed. The Westpac Disaster Relief Package includes discounted personal loan offerings, extended repayment holidays for business customers and incremental discounting for SME Business Lending.

Westpac also recognises that the impacts of sudden extreme weather events may linger for many months afterward, and that customers may need additional help. For small businesses in particular, it is often more than six months after the event when financial difficulties really bite, as short-term emergency assistance runs out and everyday business activity has failed to materialise. Following the Queensland floods, Westpac established a specific Customer Support Stream to address the ongoing needs of its 1.5 million customers affected by the floods. Westpac has also set up dedicated relationship managers, free financial recovery workshops, and an organisational mentoring program for small business customers who need assistance after major natural disasters.

Driving long term shareholder value

The Westpac Climate Change Position Statement for 2008-2012 sets out the bank's strategic response to the risks and commercial opportunities arising from climate change. Five streams of work focus on embedding carbon in risk policies and processes, developing products and services, engaging employees, advocacy and community engagement, and reducing the bank's emissions.

Carbon risk assessment has been specifically integrated into credit systems and processes, examining material regulatory, physical and market risk implications at an industry sector, company and transactional level.

Westpac has also undertaken dedicated education sessions on key impacts. For example, the Antarctic Climate and Ecosystems Co-operative Research Centre has educated Westpac Credit Officers on projected sea-level rises. Overall, in 2011-12, Westpac trained over 1,800 employees on the regulatory, physical, and market implications of climate change.

Case Study Melbourne

City Snapshot

With a current population of 4.1 million spread over 7,700 square km, Melbourne is projected to become Australia's largest city by 2030.¹²⁰ Climate change is projected to affect the area in four key ways: drought, increasing extreme temperatures and rainfall intensity, and rises in sea level.¹²¹ Local and state government agencies in Victoria are among the most advanced and most coordinated in Australia in preparing for the impacts of climate change. Metropolitan Melbourne's climate readiness is important to its residents but also to Australia more broadly. This is not just because of the city's size and economic significance, but because Melbourne's efforts to build climate change resilience act as an example to other cities across Australia.

Existing Initiatives in Melbourne

State and federal government agencies have commissioned several studies to determine the likely impacts of climate change on local communities and infrastructure. For example, AECOM developed an economic framework to evaluate different climate change adaptation strategies in terms of their costs and benefits.¹²¹ This framework was applied to two case studies in Melbourne, on the long term security of water supply, and impacts of temperature changes on metropolitan Melbourne's rail network.¹²³

Local councils in the metropolitan Melbourne area have taken proactive measures to identify and monitoring climate change impacts and plan for climate change adaptation.

The City of Melbourne's Climate Change Adaptation Strategy and Zero Net Emissions by 2020 Strategy are exemplars of how a local council can comprehensively respond to climate change.¹²⁴ In August, the City of Melbourne launched the Inner Melbourne Climate Adaptation Network, whose 20-30 active members include state government, water authorities, industry and scientific organisations and emergency services organisations. Other climate change policies include: research on cool roofs, Urban Forest Strategy, and Water Sensitive Urban Design Guidelines.¹²⁵





Given the limited sizes and resources of local councils in metropolitan Melbourne, funding segmentation and constraint is a barrier.¹²⁶ State and federal government agencies should increasingly provide funding packages to councils to unify their departments for climate change planning on an ongoing basis.

Through initiatives like the Network, there is scope to build collaboration between local councils and the private sector in this field. Greater levels of engagement and involvement of the private sector are needed to make metropolitan Melbourne climate-ready.



Figure 2.2

Key climate risks for Melbourne¹²⁷

CLIMATE CHANGE CONDITION	IMPACT
 DROUGHT	<p>A decline in number of annual rainy days of 6% by 2030 and 10-19% by 2070;</p> <p>A reduction in average stream flow of 3-11% by 2020 and 7-35% by 2050;</p> <p>Up to 50% less runoff into Yarra, Maribyrnong, Werribee and Bunyip Rivers by 2070</p>
 EXTREME TEMPERATURE RISE	<p>Higher average annual temperature, with an increase of 0.3-1.0°C by 2020, and 0.6-2.5°C by 2050</p> <p>An increase in annual number of days above 35°C from 9 days to 10-13 days by 2030, 15-26 days by 2070, and 16-33 days by 2100</p>
 INTENSE RAINFALL	<p>An increase rainfall intensity of 0.9% by 2030 and 3.0-5.9% by 2070</p>
 SEA LEVEL RISE & STORM SURGE	<p>A rise in sea level of up to 1.1 metres by 2100, which puts population of approximately 937,000 at risk from inundation by 2100</p> <p>Infrastructure and buildings in various Local Government Areas (LGA) of metropolitan Melbourne are at highest risk from inundation and shoreline recession out of all LGAs across the state of Victoria.</p>

Conclusion

Insights

This report has found that Australia is less prepared than it should be. Progress is being made but it is piecemeal, locked in past paradigms and uncoordinated. Leaders in climate risk management are hampered by disjointed information provision, policies and regulations; laggards face no or little penalties. The implications of climate impacts on interdependent systems, or on a broad spectrum of stakeholders, remain underexplored. The implication is ‘maladaption’, namely counterproductive efforts resulting in unnecessary costs, risks, and impacts to business, government and the community.

Government and business should urgently address the gaps in climate change adaptation in order to avoid unnecessary loss of life, incomes, and damage to major infrastructure assets.

The market is influenced by an unstated but widespread belief that the only possible action on climate change is expensive, extensive, time consuming and difficult. In the face of these barriers, no action is seen as the easiest path. In reality, there are many accessible steps that can be taken to prepare businesses for climate change. In the first instance, a risk assessment and 3-5 year plan to act or gather additional information is a prudent, responsible means of progression.

However, climate risk mitigation and planning is an ongoing, evolving and iterative process, not a once off. It is not simply about solving engineering problems; it requires attitudinal changes and institutional reforms, and attention to whole systems—within the business and in which the business sits.

In addition it raises questions of responsibility and fairness that the majority of Australians have barely begun to consider:

- + Who is responsible for existing infrastructure and communities in areas that will become more and more vulnerable?
- + Are there upper limits for protection of existing infrastructure, beyond which we must seek alternatives?
- + How do we ensure solutions to climate impacts do not hurt others?

Looking Ahead

Ultimately, however, these questions cannot be answered by any single sector. The solutions must be developed through sustained engagement across business, government, and the community, which must be informed by ongoing research.

National leadership is necessary to develop consistent approaches to climate impacts that transcend local government authority or state boundaries. This was recognised in the National Adaptation Framework agreed by COAG in 2007.

Five years on, progress is limited. The Commonwealth Government has set in play many valuable research efforts, involving NCCARF, CSIRO’s Climate Adaptation Flagship, DCCEE, and the Critical Infrastructure Program for Modelling and Analysis. But this information is not shared with stakeholders effectively. Methods of communication have been characterised as ‘information is just dumped out there...and hopefully someone will pick it up’.¹²⁸ This means that a sizeable part of the potential audience may be unaware of the available resources, information is often not linked to other relevant data, system-wide analyses are less likely to be made, and there is no widely agreed foundation for action.

This foundation is essential for Australia to implement the more difficult aspects of climate adaptation demanding of broad community support. Government and business should urgently address the gaps in climate change adaptation in order to avoid unnecessary loss of life, incomes, and damage to major infrastructure assets. Progress is being made but it is piecemeal, locked in past paradigms and uncoordinated. To address this we need to take decisive actions.

Action Plan

For Business

1. Assess exposure and vulnerability to climate risk impacts.

- + Identify material climate risks for your operations, supply chain, customers, employees as well as interrelated infrastructure systems.
- + Determine how resilient your business is to existing and future climatic variability.

2. Implement a Climate Risk Management Plan

- + Establish a 3-5 year plan to manage climate adaptation requirements and explore potential business opportunities and sources for competitive advantage.
- + Embed ongoing management of climate risk into core risk management frameworks, including appropriate staffing and resourcing.

3. Disclose material climate risks to the market

- + Ensure shareholders and investors are informed of material climate risks and risk management strategies to protect shareholder value.

4. Collaborate to build capacity

- + Participate in cross-industry and public discussions about climate risk to build understanding and resilience to emerging climate risk across the community.

NB:
This process equally applies to government asset owners

For Government

1. Refresh the National Climate Change Adaptation Framework

- + Work across Federal, State and Local Government jurisdictions to develop agreed approaches including standards and guidelines for including climate risk in planning, development and approval processes.
- + Coordinate between levels of government to improve consistency of adaptation action by agreeing practical requirements for infrastructure planning and development.
- + Develop sector specific guidelines for the assessment of climate risk on a consistent basis across key regulated industry sectors.
- + Investigate a national initiative to better identify emerging climate risk impacts for interdependent infrastructure networks.

2. Expand analysis of infrastructure interdependencies to climate risk

- + Expand the approach for ‘critical’ infrastructure taken by the Federal Critical Infrastructure Program for Modelling and Analysis (CIPMA) to all other key infrastructure assets and industry sectors.
- + Work with asset owners and operators of critical infrastructure to better manage cross-sectoral interdependencies and climate risk impacts.

3. Publish a National Resilience Report Card

- + Develop a national adaptation scorecard to measure the degree to which Australia is adapting effectively and report on progress against agreed targets.
- + Publish tools and resources for small business and the community to support effective adaptation at the local level.

4. Deliver Leadership Through Collaboration

- + Collaborate with government and private sector asset owners and operators to continue to build skills and capacity around identifying and managing climate risk effectively.
- + Establish a city-wide taskforce with private and public sector participation to better coordinate adaptation and climate risk management strategies for each of the major capital cities across Australia.

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The report *Coming Ready or Not: Managing climate risks to Australia's infrastructure* and associated content can be accessed at www.climateinstitute.org.au

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