



NCCARF

National
Climate Change Adaptation
Research Facility

Synthesis and Integrative Research
Final report

Climate change adaptation in the boardroom

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and Mark Baker-Jones



CLIMATE CHANGE ADAPTATION IN THE BOARDROOM

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Published by the National Climate Change Adaptation Research Facility

ISBN 978-1-921609-96-1 NCCARF Publication 25/13

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Please cite this report as:

Johnston, GS, Burton, DL & Baker-Jones, M 2013 *Climate Change Adaptation in the Boardroom*, National Climate Change Adaptation Research Facility, Gold Coast, 68 pp.

Acknowledgement

This work was carried out with financial support from the Australian Government (Department of Climate Change and Energy Efficiency) and the National Climate Change Adaptation Research Facility.

The role of NCCARF is to lead the research community in a national interdisciplinary effort to generate the information needed by decision makers in government, business and in vulnerable sectors and communities to manage the risk of climate change impacts.

The authors acknowledge the in-kind support from DLA Piper, the governance input from Dr Noel Purcell of Simply Good Business and valuable insights from Dr Peter Best at Cindual Pty Ltd. A thank you is also due to all the executives who participated in the project and who are working towards a more resilient future.

Gareth Johnston acknowledges the critique, support and friendship of the late Professor Frank Fisher (1943 – 2012) and his legacy of social transformation towards a more sensitive self-aware world.

Disclaimer

The views expressed herein are not necessarily the views of the Commonwealth or NCCARF, and neither the Commonwealth nor NCCARF accept responsibility for information or advice contained herein.

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Acronyms and Abbreviations

AODP	Asset Owners Disclosure Project
APS	Australian Public Service
APSC	Australian Public Service Commission
ATC	Austrade (Australia Trade Commission)
BITRE	Bureau of Infrastructure Transport and Regional Economics
CEO	Chief executive officer
CITB	Climate Change Adaptation in the Boardroom
CSR	Corporate Social Responsibility
ENSO	El Niño–Southern Oscillation
GFC	Global financial crisis
HNS	Hazardous and noxious substance
IIGCC	Institutional Investors Group on Climate Change
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunications Union
MNC	Multi-national company
NCCARF	National Climate Change Adaptation Research Facility
NGO	Non-government organisation
TNC	Transnational corporation
WSAA	Water Services Association of Australia

EXECUTIVE SUMMARY

Climate adaptation is recognised by many of the world's largest businesses as a global risk and one that requires critical attention. The World Economic Forum's 2013 Global Risks Perception Survey, identified the 'failure of climate change adaptation and rising greenhouse gas emissions as among those global risks considered to be the most likely to materialize within a decade' (p.16). Yet despite action by many transnationals and international firms, it seems evident that most Australian companies appear to be struggling to move forward in responding to climate change impacts, apparently paralysed by short-term profit-first thinking, uncertain political risks and a corporate culture unused to volatility and disruption.

Research approach

This project set out to communicate adaptation to climate change to the "big end of town" and to gather soft data, acquire information and present issues back to the National Climate Change Adaptation Research Facility (NCCARF), the funder of this research.

Our approach to the research challenge differed from a traditional technical, analytical or academic method. We used action-learning principles to engage a community in which we, as advisors to corporate Australia and as co-researchers, have social capital and standing. Through trusted information sharing networks, private closed-door meetings and one on one conversation with executives and senior management from over 100 companies we shared ideas, gathered, researched and refined information and tested our findings.

Findings

Our findings from the boardroom engagement include the following:

- 1) The Australian Government expects the private sector to adapt, yet little or no incentives exist to promote this behaviour.
- 2) Autonomous adaptation as practiced may only benefit the lead actor while creating disbenefit for others (including other corporations, society and the environment).
- 3) Market practices on current paradigms cannot be expected to meet greater societal adaptation needs.
- 4) Further adaptation research is required in some areas to help guide shape and monitor adaptation for the private sector.
- 5) A multiplicity of policy reform may be necessary, but crafting and implementing it is likely to remain beyond the capability of the Australian Public Service (APS) or individual Governments.
- 6) Highly sophisticated mining, gas and some Asian owned technology companies are leading the way with many opportunities missed by Australian companies.
- 7) Adaptation for the corporate sector is a key strategic issue, unlike mitigation and corporate social responsibility (CSR), as it benefits the corporate primarily.
- 8) Insurance dependency may only be a short-term risk transfer mechanism as, in its current paradigm, it can mask risk, create a false sense of security and may impede adaptation.

Our key findings from the scoping literature review include:

The science of climate change paints a challenging future: Recent publications show that there has been a statistical shift in extreme weather events. While the global community has agreed in principle to contain average global warming to within 2° C, many publications suggest the failure of tangible emissions reductions shows that global temperatures may reach 4° C or beyond, by 2100. It is clear that existing climate variability poses a challenge for many regions, sectors and companies. Experts have identified that Australia is extremely sensitive to climate change and the recent “Angry Summer” of 2012–13 has seen over 130 climate-related records broken during 90 days, resulting in considerable economic damage. As the frequency and intensity of high-energy events changes, many flow-on impacts will disrupt “business as usual”.

Increasing extreme events have triggered increasing awareness: After recent years of extremes, the private sector’s failings in assessing and managing existing climate risks is becoming increasingly evident. It is gaining considerable attention in the business media. The World Economic Forum has ranked failure to address climate adaptation as one of the top ten risks to the global economy.

Legal imperative: Climate change risk is distinguishable from other corporate risks because it can have a widespread impact on individual companies across a range of industry sectors. Climate legal risk is not an easily defined term and spans a range of issues including corporate law, regulatory risks, reputational risks, insurance risks and common law to name but a few. While specific climate change adaptation law is still in the embryonic stages in Australia (and globally), it is likely that the legal sector will be a key driver of change in the private sector.

Transport sector: A broad array of climate change-related challenges face the transport sector with considerable supply chain ramifications for businesses reliant on movement of people, resources and goods. Although aviation and weather are inextricably linked, this desktop study has shown that very little is known about the ramifications of climate change on the Australian industry. Further research is urgently required to explore and manage the potential for considerable cascading effects, especially on the tourism sector.

Some Australian supply chains are very long and thin given geographical conditions, trading partnerships, market participants and purchase power relative to other countries. The anticipated increases in weather-related disruptions to the road and rail sector will also challenge Australian businesses with impacts likely to affect the “just-in-time” deliveries as well as the movement of resources throughout the country and offshore. The same applies to Australian exporters and caution should be applied in markets with lower adaptive capacity. For the road sector, funding backlogs will compound any climate-related challenges, and capacity and cash flow issues associated with local government limitations.

Until recently, little was known about challenges facing the marine transport sector and, although more research is warranted, the recently published NCCARF reports (from RMIT) have provided considerable insight into the risks facing seaports and the valuable lessons to be learnt in managing the risks to that sector more effectively.

Finance and Asset Management: Climate risk management in this sector is gaining attention due to the pressure from groups such as the Institutional Investor Group on Climate Change (IIGCC), Asset Owners Disclosure Project (AODP), CDP (formally the Carbon Disclosure Project) and the Climate Institute. Research from the IIGCC (2012) shows that although Australian investors scored better than their international counterparts in a survey of climate consideration in portfolios, considerable barriers still exist. These include regulatory uncertainty, lack of liquidity in insurance markets, no agreed benchmarks or reporting mechanisms and limited availability of understandable data on climate change impacts. Key risks in investment and divestment approaches, which currently do not consider climate change risks, may expose directors and officers to liability and the company to other actions.

Insurance: As an economic shock absorber, the insurance sector has played an instrumental role in underpinning the modern economy. However, policy pricing is increasing, profits diminishing and climate-related events are causing an increasingly disproportionate percentage of payouts. Two benchmark surveys by CERES (2011; 2013) show that almost 90% of US insurers interviewed fail to consider a changing climate in their portfolio management. This disturbing trend gives the authors concerns about market failure. The “black box” approach of insurers, which is traditionally trusted by businesses, may catch organisations unaware if the insurers’ mathematics no longer work and premiums increase or insurers remove themselves from locations. In fact, this issue is currently materialising in Australia (due to the confluence of recent multiple extreme events and unchecked urban growth) and may challenge mortgage viability for some locations. If the ramifications of insurance availability filter into the lending sector, shareholders may soon be asking about the viability of their bank’s mortgage portfolio. This area requires critical attention and research.

Property and Real Estate: In Australia, an estimated \$81 billion of property is exposed to 1 metre of sea level rise; over 750,000 homes are within 200 m of bushland and over half a million houses are vulnerable to current flood boundaries. Combine climate change with urban population growth and it is easy to recognise that the property and real estate sector faces a phenomenal challenge. Presented with the challenge of short-term industry lobbying and political fear associated with private property values, the risks associated with adaptation trade-offs have resulted in a slow uptake of climate resilient development. As the extreme events increase, the population ages, and insurance affordability declines, it is likely that the public risk appetite will change and ultimately (albeit belatedly) a price signal will emerge. In the meantime, the “hot potato” of residential climate property risk will rest with the lenders, and the mum and dad investors. Given the fact that the Global Financial Crises (GFC) was triggered, in part, by a cascade of plummeting property values and a poor understanding of risk transfer, the climate impacts from the property sector may yet prove to be far reaching with consequences for local, State and Commonwealth governments and considerable growing exposure for retail lenders.

Utilities: The energy, water and communications sectors are the critical arteries of a functioning modern society. Highly interconnected economies require high levels of connectivity and resilient energy systems. The vast effects of Super-storm Sandy in the US show just how susceptible modern cities have become to extreme weather events; events that are likely to increase in frequency and intensity because of climate change. Much of

Australia's infrastructure is aged and has not been designed or operated in consideration of climate change.

Many of the infrastructure construction, maintenance and service providers to the utility sector are not factoring climate change into asset design, construction or maintenance, with subsequent costs to shareholders including governments and superannuation funds.

Conclusion

We hope that this report is of benefit to Australian organisations, policy makers, regulators and to researchers in adaptation science. This project shows that, on a whole, the Australian private sector is giving little consideration about the impacts climate change.

This project has identified that considerable research gaps exist, but has also provided direction for organisations and researchers. Individual corporations and private sector peak bodies urgently need to explore the risks and opportunities that climate change and associated responses bring. This is especially so for the ICT, aviation, energy, insurance and finance sectors.

PART 1: CONTEXT

About this Project

The impacts of climate change will be serious and pervasive, effecting almost every facet of Australia's economy, society and environment. Since decisions taken today will have long-lived consequences, there is need for action to start now. Roles and Responsibilities for Climate Change Adaptation in Australia Council of Australian Governments (COAG) 2012

This project is designed to communicate climate change risk and adaptation information to a diverse cross section of corporations and gather their views, sentiments and practices, and share this insight with the wider research community.

This project is not an academic research project and is designed as a communication project but with some research elements. Unlike traditional academic research, this project has followed an iterative process of building a high trust environment, setting rules, listening, researching, reviewing and reflecting back. Data is soft, based on dialogue, discussion and interview, together with academic review. Given the broad range of participants from differing companies, sectors, skills and perspectives, the outputs are more of a composite collage than a photographic snapshot.

The project draws heavily on the personal networks of the authors, who are experienced in engaging with large business organisations, have a background in climate change science and adaptation and are actively engaged in social, economic, cultural and management consulting practices. Our experience across many domains has taught us to apply adaptive thinking to our work or "adapting in adaptation in practice". We believe that our prior experience working with directors and boards has also helped to uncover many issues that would not have been exposed through a more traditional approach. An academic foundation to this approach can be found in action learning and action research principles (see Williams 1982 and Pelling et al 2008).

As recognised by the Australian government 'governments at all levels businesses, households and the community each have important, complementary and differentiated roles in adapting to the impacts of climate change (DCCEE 2012). These views are formed through recognition of the political realities and temporal limits on government action.

The private sector plays an important role in driving economic wellbeing, and enhancing the quality of life for all Australians. It also plays a critical role in reducing the most serious impacts of extreme weather related risks through the provision of insurance and other risk transfer markets. While some of Australia's business leaders have made substantial contributions to policy reform and played a significant role in global business communities, including the World Business Council for Sustainable Development and the World Economic Forum, the issue of private sector and climate change adaptation in Australia is still in the nascent stages in terms of how it is understood and how it is developing.

The project team was keen to focus on large corporates as our experience teaches us that small-medium enterprises (SMEs) generally struggle to find the resources, capabilities,

motives or to implement management systems that would enable them to lead in the development of risk management strategies. SMEs are also often, but not always, forced to comply with new industry norms, supply agreement contracts, policies and processes established by larger corporations. Large corporates wield significant power through market presence, policy perspectives and input on government policy, and can be well resourced, strategic and “have skin in the game”. In some cases, they are better equipped than many governments to deal with the impacts of climate change as they can plan beyond the limits of short-term political cycles, and can often raise and deploy capital more efficiently

For this project, the authors actively engaged senior executives from over 100 corporations in closed door high trust environments to discuss climate change impacts, adaptation and corporate strategy. Of those engaged, over 70 senior executives participated in the discrete private dining room boardroom lunch meetings while a further 40 agreed to face-to-face semi-structured interviews. The remainder were engaged by telephone.

The outputs in this project cover a range of information. For corporations, we present a picture painted by industry of barriers and enablers in adaptation together with some insight into better practices. We also present a summary of climate change risks and opportunities for several key sectors of the economy and hope that it will stimulate researchers, policy makers and corporate decision makers alike to delve deeper into the interconnected issues of climate change and the private sector.

Tweet About It



This report contains suggested Tweets (as per request of some of the participants of the Climate in the Boardroom meetings). The suggested Tweets can be copied and pasted but we do ask that the #CITB and @NCCARF be maintained in order for us to explore the readership of this document. Just look for the Twitter icon.

Recent economic and political climate in context

The economy, like most systems, is subject to expansion and contraction. Whilst some of this can be very volatile, Australia's people and its economy have benefitted from unprecedented long periods of growth, driven mainly by resource exports. Economic conditions, perceived and real, are a key driver of political behaviour.

Australians have grown accustomed to enjoying a wealthy lifestyle in relation to its geographic neighbours, its trading partners or even US and European peers. Consumption growth is the norm. This picture is almost unique in the developed world based in part on fiscal regulation, past reforms and budgetary controls but also in part to the mining sector's significant contribution to national accounts.

Australia is one of the few advanced economies to avoid a recession during the global financial crisis (GFC), supported by strong economic fundamentals at the onset of the crisis, a well-coordinated response as the crisis unfolded, and a mining investment boom fuelled by a surge in China's demand for commodities. Five years on, both the economy and the financial sector continue to outperform most of their peers. (International Monetary Fund 2012, p.5)

It could be argued that many of Australia's business leaders have never had to lead in a non-growth national economic environment, with only those in a few sectors such as manufacturing or experienced overseas directors having any recent experience of economic turmoil and volatility. Some of this growth has come at a high cost in terms of loss of biodiversity and damage to the atmosphere (MAP 2010) highlighting the impacts of short term profiteering and limited long term planning, and exposing serious risk management deficits. Recent slowing of growth in the post Global Financial Crisis (GFC) has had ripple effects on business confidence and in some quarters made businesses begin to question their long-term commitment to sustainability. As is shown by Barker (2012, p.1) 'for most Australian corporations, environmental sustainability is an operational issue. It affects marginal costs, branding and regulatory compliance, but is largely detached from core strategy.'

Some of these cascading effects have caused consumer, investor and business confidence to falter. Corporate Australia has been in a state of very low to low confidence over the research period from February 2012 to March 2013 (see NAB Surveys February 2012 – 2013; Dun and Bradstreet 2013). This has, in part, been driven by weak local market conditions, strong dollar hurting exports, global economic volatility and uncertainty in China, Japan and other trading partners, together with post GFC ripples such as the US "fiscal cliff", European recovery doubts and Middle East turmoil. Several reports during the research period indicated weakening profitability and uncertain forward outlooks. For example, the NAB's Monthly Business Survey for February 2012 stated that 'confidence retreats while conditions edge higher. Forward indicators remain weak. Retail, manufacturing and construction still struggling while services, transport and mining strong. Growth lowered locally'. November 2012's Survey indicated that there were 'signs of trouble ahead with confidence slumping to lowest level since April 2009'(NAB 2012).

In February 2013, the NAB's Monthly Business Survey suggested that "business confidence eased in February and remains below long-run average levels. Nonetheless, the general mood is more upbeat than it was towards the end of 2012. The fall in sentiment was broadly

based, especially in mining, wholesale and recreation & personal services. But finance/business/ property bucked the trend'.

In our view, while one index is not enough to give certainty, both anecdotal and other measures, such as lay-offs and delays in project commencement, suggest that many boardrooms and senior management are still stalked by fear of economic uncertainty. This gives rise to focus on immediate bottom line management and consideration of costs and cash flow and a discounting of emergent and other medium to long-term risks.

As well as the above economic uncertainty, it is also prudent to identify that this project occurred while the effects of the 2011 extreme weather in Queensland, Victoria and Bangkok were still being felt by some businesses including the agriculture, construction trades and car manufacturing sector as obvious cases.

The Australian Commonwealth Government, in its initial responses to climate change, has enacted legislation to increase renewable energy production and drive emissions reductions in the largest corporate emitters, but is to set clear directions for corporate climate change adaptation. State governments have also started, and then sometimes reneged, on climate change policy commitments as governments changed. In Queensland and Victoria for example coastal protection policies have been radically amended and diluted (e.g. see Arup 2012). Policy has proven to be a challenge for the Australian Public Service (APS) with the APS Commissioner Lynelle Briggs (APSC 2007, p.iii) describing climate change as a 'wicked problem' not in the sense of evil, but rather as an issue highly resistant to resolution". These challenges are not unique to Australia however with many nation states and multilateral agencies also failing to enact firm action.

Some poorly implemented, expensive policy failures in mitigation such as the "Rudd insulation scheme" (linked to deaths and house fires) have reportedly tarnished climate policy action and demoralised both politicians and public servants from driving sustainable change. Political debate has been fierce concerning climate mitigation and significant political capital has been generated on an anti-carbon tax platform. Anti-carbon tax or anti-climate action positions may be hard to unwind and therefore, by implication, no mitigation may mean no adaptation to many uninformed observers.

Outside the mitigation side of climate change, however, comparatively little evidence of public political or corporate discourse on adaptation has occurred. In part, there is no corporate imperative to give precedence to the public good given shareholder primacy theory (where shareholder interests should be assigned first priority) and is still the dominant corporate paradigm (Anderson et al 2007). Consumer concerns and advocacy action on corporate behaviour is commonly perceived to be a lesser concern, remains largely manageable by corporates, and in many cases is ineffective at changing behaviour. For some CSR is an adequate consideration for community appeasement.

The legal impetus

This section discusses the legal ramifications associated with climate change adaptation. Issues discussed in this section include legal risks, associated with regulatory requirements, insurance, litigation, corporation law and company reputation. A discussion about lawyers as a conduit for change is also presented.

An overview of climate legal risk

Climate change risk can be distinguished from other corporate risks because it can have a widespread impact on individual companies across a range of industry sectors. This is one of the unique characteristics of climate change risk, and why any risk mitigation strategy must deal comprehensively with a broad array of climate change impacts and yet respond to climate change risks particular to specific sectors. Because of the range of statutory and common law duties that apply across jurisdictions, the success of a company's risk mitigation strategy in dealing with climate change impacts will depend on the efficient and effective navigation of legislative and common law requirements.

Climate legal risk is not an easily defined term. It can perhaps be best described as the legal risk arising from the obligations and duties imposed in common law and under statute where that risk is affected by changes in the biophysical environment. Commonly, it is associated with corporate environmental risk, but it is important to realise that climate legal risk is not restricted solely to matters of pollution and liability for greenhouse gas emissions. As new cases and settlements emerge, it is becoming apparent that climate related litigation increasingly focuses on the sufficiency of corporate assessment of the financial consequences of climate change and the adequacy of disclosures to shareholders of the effects of climate change on the corporation.

Climate legal risk must be considered in terms of the direct impacts that climate change will have on the corporation (for example, flood impacts on physical assets), and in terms of the indirect impacts of climate change.

The direct impacts can be seen as those that have long-term effects resulting from the broader, less abrupt, changes in climate, such as global average temperature increases, or those that have short-term effects such as extreme weather events. Corporations have typically tended to consider only the legal risk associated with the short term direct impacts of climate change because those impacts are more detectable within the typical, albeit relatively short term, time frames and horizon periods within which many corporations operate. Few, except the most prudent, have sought to take into account the long-term impacts of climate change.

Whether long term or short term, it is not only the direct impacts of climate change that corporations need to be concerned about. The indirect impacts carry an equal, if not greater, threat to corporate resilience.

Although climate legal risk encompasses a multiplicity of legal risks, the primary risks can be conveniently categorised under four heads: regulatory, litigation, reputational and insurance risk. We consider each of these risks briefly below.

Regulatory risk

Regulatory risk is the risk that occurs from not complying with regulatory requirements, regulatory change or regulators' expectations. It includes the risk that a change in laws and regulations will materially affect the corporation. Failure to manage regulatory risk may result in regulatory sanctions being imposed. Corporations are faced with a range of regulatory mechanisms from federal to local government level. The regulatory mechanisms are not static. They are evolving as the challenges from climate change impacts increase and the

risks relating to climate change become more apparent. Although each change potentially increases the costs of development, in light of the penalties, ignoring the obligations can be even more costly, and these latter costs cannot be passed on to purchasers. Consequently, a primary legal risk for corporations in respect of climate change is the failure by directors to ensure the corporation complies with the statutory obligations and duties imposed on the corporation where those duties and obligations are affected by climate change.

The origins of corporate climate legal risk are found at federal level where corporations are potentially exposed to liability that is constitutionally created by commonwealth legislation. For example, there are over 30 statutes at federal level that potentially impose an environmental liability on corporations. At state level, there are an equal or greater number of statutes that impose environmental obligations and duties that are potentially affected by climate change impacts. Climate legal risk also appears under common law, through tortious liability in negligence, nuisance and trespass.

Corporations have voiced uncertainty as to whether directors need to take climate change in to account when complying with their duties under the Corporation Act (Cth) (Corporations Act). The Australian Corporations and Markets Advisory Committee in a statement in 2006 advised that there is no express statutory obligation for Australian directors to consider broader community interests, such as climate change, in discharging their duties as directors. Yet there is a growing body of thought, which holds that company directors who fail to inform themselves about the impacts of climate change and who also fail to take steps to mitigate climate risk, may then fail to meet the duty of care and diligence required under the Corporations Act.

The common law duty to act in good faith is also reflected in the statutory duties imposed on directors under the Corporations Act. If this duty is considered to include the future interests of the corporation, then directors should exercise their powers in a manner that ensures the long-term viability of the corporation, in which case, directors could be in breach of this duty if they ignore climate change risks that could have adverse long-term consequences for the corporation.

Although there is no explicit positive obligation to consider climate change affects in decision-making, there are a number of statutory reporting requirements which are imposed on Australian public companies. Periodic disclosure requirements, which apply to those companies listed on the Australian Securities Exchange (ASX), stem from the obligation of a company to release material information to the market on a quarterly, half-yearly or annual basis (as applicable). For example, if the company's operations are subject to any particular and significant environmental regulation under a law of Australia, the Corporations Act requires the company to include disclosure in the director's report for a financial year regarding the company's performance in relation to such environmental regulation. Essentially, this is likely to require providing details of any breach of environmental laws and is likely to extend to climate change impacts where the impact is subject to environmental regulation. Where there is an obligation to report on strategies and prospects of future financial years, given that environmental performance is a matter that could reasonably be required to be able to make an informed assessment about the business strategies and prospects for future financial years, may require companies to make disclosure about their climate risk in, for example, a disclosure document being prepared by the company to undertake fundraising activities.

Whereas periodic disclosure requires disclosure to be made over an appointed period, the obligation imposed on ASX listed companies to make continuous disclosure requires disclosure of information immediately if the company becomes aware of information that is not generally available but a reasonable person would expect the information to have a material effect on the price or value of the company's securities. Where information relating to climate risk specific to the company becomes available, the duty for disclosure may arise.

General environmental duties and best practice environmental management are imposed under some state environmental legislation, as too is the requirement to consider climate change in decision-making. Where a corporation's operations are subject to regulation under commonwealth or state legislation, the corporation must consider the consequences of failing to be informed of these obligations and duties, and the cost of noncompliance.

A secondary legal risk arises from the impact of government intervention at the global, regional, national or local level, via legislation and market mechanisms. It is a risk that legislative change and changing market mechanisms made in response to climate change may affect a corporation's duties and obligations.

Litigation risk

Litigation risk involves an assessment of the likelihood or probability that legal action may be taken against the corporation. It is becoming increasingly clear that climate change litigation will extend beyond pollution litigation. Just as climate change may trigger an increase in disclosure requirements, it also promises increasing liability risk to directors and officers for omissions and material representations. This can include claims by shareholders in, for example, the common law tort of negligence, as climate change litigation now involves those who have negligently allowed or encouraged exposure to climate change impacts.

Corporations also face the growing risk that legal action will be taken against them in relation to action or inaction on the part of the corporation for having either caused climate change or failed to respond to some duty that has been triggered by climate change. Therefore, in assessing its risk, a corporation needs to consider the material financial effect climate change will have on the corporation. It needs to carry out a discussion of the trends in greenhouse gas legislation and regulation that would have a material financial effect on the company's business and an assessment of what the financial effect would be. The corporation needs to be aware of the potential for involvement by the company in climate change litigation and assess any climate change related decisions by Australian courts and courts in any jurisdiction in which the company operates.

Insurance risk

An associated risk is insurance risk. As corporate liability becomes further defined through climate change litigation, the ability to obtain director and officer liability insurance may be affected. Directors need to ascertain whether they are sufficiently covered for fines and penalties incurred for liability sustained because of indirect impacts of climate change and to ensure that any exclusions do not include the costs of defending against litigation arising from climate change related claims. Disclosure obligations in relation to material climate legal risk should be made to insurers to avoid denial of indemnity in the event of a claim or the avoidance of a policy completely. Corporations also need to consider the climate related

insurance losses from property damage, disruptions to business operations, and health impacts on employees.

Reputational risk

Reputational risk has been defined as the risk that the trustworthiness of the corporation will be questioned. A corporation seen by its shareholders or investors to have failed to meet its obligations, statutory or otherwise, risks losing shareholder support. Damage to a corporation's reputation can therefore result in lost revenue or destruction of shareholder value.

Socially responsible financiers may take into account the action or inaction of corporations in response to climate change when making investment decisions. It is likely that following a series of catastrophic events, investors may increasingly factor in climate legal risk into long-term capital plans. Concern over whether a corporation has met its social responsibilities in respect of climate change could prompt a market response from investors that advance ethical investment. Fund managers, whose shareholders are seeking to achieve environmental objectives, by acting as third party environmental regulators may wield significant financial power.

A corporation's reputation may determine whether customers or suppliers that make decisions on the compatibility of their climate change policy and ability to ensure continuity of supply chain, choose to enter in contractual relations with the corporation. Those corporations that fail to respond appropriately to climate change risk may create a competitive disadvantage for themselves, resulting in diminished reputation and customer loyalty.

Corporate response to climate legal risk

It is important that when dealing with or interacting with the natural environment, corporations ensure that climate legal risk is an integral part of their risk management process. Moreover, in order to ensure a corporation is capable of responding to climate legal risk, the corporation must ensure that an effective climate legal risk management process is an integral part of the corporation's overall risk strategy.

Corporations require a climate legal risk management process to enable the corporation's directors and officers to identify the legal impacts that climate change will have on the corporation. A climate legal risk management process will enable those directors and officers to understand the legal risk so that they can make necessary disclosure when required, and they can implement appropriate governance and policy arrangements.

With climate change becoming a significant corporate environmental risk facing corporations and their shareholders, directors need to understand where their liabilities and legal obligations lie in order to ensure they discharge their various duties. The law, like nature, has little forgiveness for the unprepared and directors need to obtain sufficient information about climate legal risk to enable them to take appropriate steps to mitigate the risks and maximise the opportunities available to the company.

Directors who fail to disclose the financial impacts of regulatory trends, who fail to disclose the impact or potential impact on the business of environmental degradation resulting from

climate change risks, or who fail to take management steps to ensure that the company is properly prepared for climate change, both in terms of the business risks that the company faces and also in respect of business opportunities that the company could take, expose the company to legal action from shareholders and investors.

Company directors need to recognise and engage actively with the emerging climate change regulatory framework to protect and advance the interests of shareholders and investors. Failure to do so could lead to a number of adverse long-term consequences for the company. These consequences include not only the imposition of civil penalties on directors and officers of a company for non-compliance with climate change related legal obligations and duties but there is also a possibility that in the future it may also expose a company to legal action by its shareholders for such things as failing to consider the sustainability of investment assets or the failure to maintain a socially responsible corporate governance focus. This has recently been seen in the United States with shareholders taking legal action against companies for failing to comply with environmental regulations. Directors must therefore identify the climate change risks, identify the relevant regulatory frameworks that impose legal obligations related to climate change risk and develop and implement a strategy for dealing with those obligations.

Box 1. Litigation and extreme weather – lessons from Hurricane Sandy

With an estimated economic impact exceeding US\$50 billion it should come as no surprise that the legal ramifications of Hurricane Sandy are already emerging. All tiers of government and utility providers are likely to experience legal conflict surrounding preparedness and response. The private sector too will be directing and facing legal inquiry (e.g. where supply chains have been broken, the wordings of force majeure contracts may face intense scrutiny). As is often the case after extreme events, conflicts are likely to emerge between the insurer and the insured. Issues may include the meteorological definition of the event (e.g. hurricane or storm), the specific nature of the damage (e.g. wind versus flood) and the speed of assessment and payment, to name a few.

The fine print of insurance policies becomes increasingly important and contested during the aftermath of extreme events. For example, some businesses who evacuated (voluntarily or involuntarily) but were not physically evacuated may find that they are not covered for business interruption (Zola and Bourne 2012). According to a New York-based legal firm, lawyers are currently engaging clients about issues associated with:

- improperly denied claims;
- unreasonable delays in payment;
- undervalued claims and unfair settlement offers;
- improperly calculated deductibles; and
- deceptive or unethical practices by insurance adjusters and other insurance company personnel (Napoli Bern Ripka Shkolnik 2012).

While some litigation will be immediate, others will occur over time (especially after the results of government-lead post disaster reviews). As the outcomes from post disaster reviews emerge winners and losers of resilience planning will be identified and it is almost inevitable that class actions and/or independent litigation will ensue. According to the New York Daily News residential litigation has already commenced. A recent filing in the Manhattan Supreme Court sees a resident of a luxury condominium in New York's financial district suing his condominium board for US\$38 million for a range of issues including disaster planning and failing to claim insurance for common use areas (see Ross 2012). Prudent adaptation practitioners will be taking lessons from Sandy and other recent extreme events to consider how reactive regulatory impacts will affect their clients. Although litigation is difficult to completely avoid it is worth working with legal firms that have an established reputation, networks and experience with issues associated with climate change adaptation.

(Excerpt taken with permission from Burton 2012a)

Lawyers as a driver for change

Throughout this study and during the professional work of the authors it has emerged that the legal sector has been slow to inform the climate change adaptation discussion, and yet the law often acts as a driver for change in the private sector.

The slow response may perhaps be because the legal sector has yet to fully bring its attention to focus on the question of how corporations will implement adaptation to climate change and what the appropriate legal response should be to the uncertainties associated with the type, the occurrence, the scale and the location of the anticipated impacts.

The lack of a clear climate change adaptation legal framework, which adds to the uncertainty, may also account for the absence of attention given and limited steps taken to address climate legal risk. Unfortunately, attention to climate legal risk may ultimately come about in reaction to legal claims, insurance losses and recovery of reputation, rather than through proactive, early consideration of legal obligations and duties, and compliance with evolving regulatory requirements.



#CITB Legal sector will play an important role in driving climate change adaptation in the private sector #NCCARF

Project methodology

Although this was not intended or directed to be a primary research project, some qualitative data was collected. The project was focused on engaging with large Australian corporations (e.g. those in the top 200 ASX or unlisted transnationals). The project sample was composed of some mid-sized firms (<Au\$500 m), mostly large domestic listed (ASX) companies (>Au\$500 m) some with international trade, a few unlisted public companies, some multi-national companies (MNCs), some global companies and some transnational corporations (TNCs). Globals tend to have one unified brand and focus on high volume scale. Multi-nationals and transnationals differ mostly in that transnationals tend to be more complex and have delegated authority from a central headquarters to local organisations. Executives involved in the project ranged from chief executive officer (CEO) to senior executives in strategic roles, risk managers and sustainability and / or environmental leaders.

This project was focused on creating a high trust environment with the participants to achieve information sharing and recognising that climate change adaptation is not necessarily a “green” issue or action that is always benign. In a business sense, we believe it must impart some tangible value or benefit to the corporation to warrant action.

This view positions adaptation as a strategic issue and one that adds value to a company by creating opportunity or by reducing costs and risks. Such proprietary information is usually company confidential and for commercial reasons is rarely shared beyond the Board and senior members of management. As such, our project design approach was to engage senior executives with adaptation experience, risk officers and strategy specialists to determine what engagement suited them and their companies.

Based on our own trust networks and experience working with large corporations, we understood that any engagements had to take place in private, behind closed doors, if necessary, with no or few competitors and with little likelihood of attribution, identification or exposure. This approach is common in many other areas of risk and highly confidential environments including disaster management, business continuity management and security and intelligence communities.

We interviewed several large private unlisted property companies, some unlisted global private companies and some advisory firms. Some regulators, including offshore entities, and some foreign markets were also consulted to verify or acquire confirmation of claims and details. Some foreign, mostly Asian-based, lending institutions, Chaebol and Sogo Shosa type trading houses were also engaged given their increasing market exposure in Australia.

Firms involved in this project covered a wide range of sectors including beverage, agriculture and food processing, mining, oil and gas, retail and institutional lending, general and re-insurers, freight and haulage, aviation, ports, rail and shipping, manufacturing, property services, property development, financial services, hotels, professional services, energy, biotechnology and telecommunications. Some professional services firms such as engineering, architecture and valuation companies were also interviewed to clarify client commentary.



#CITB climate change adaptation is not necessarily a “green” issue or action that is always benign @NCCARF

Meetings took place in Boardroom style settings, set in the private offices of the major corporate law firm DLA Piper and recorded. Private meetings took place in offices of the corporates, third party locations or over the phone. Online written surveys were not that successful due to time, risk of attribution and disclosure. Some participants acted on their own initiative, some brought senior staff or technical experts and some were prepared to volunteer case studies and details. Care was taken to invite groups such that no direct competitors were present.

All meetings in the Boardroom took place under Chatham House Rules whereby all agree that ‘participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed’ (Chatham House 2012).

This approach is often used in the private sector to confidently share insights and challenges with those outside of a participant’s own organisation. Those who participated in the one-to-one qualitative discussions were assured of complete anonymity.

The Boardroom format involved the presentation of climate science from a leading scientist (see appendices), some adaptation insight (from Burton et al) and then the chair (a high profile company director) asked a series of questions. This allowed for free flowing discussions in two out of three board settings. Interestingly when a local politician attended one of the meetings more than half of participants privately expressed a reluctance to disclose strategy with the politician present and offered private meetings to discuss their

situation. All participants have been offered a pre-release copy of our research as an incentive to participate.

Of 200 invitations to participate, just over 55% participated either in board discussions, private interviews or in surveys. Testing of some non-participants revealed that these companies had a wide variety of reasons for not participating. Some executives were not permitted to discuss strategy locally, some had strategy set and managed overseas, many had not started thinking of adaptation, and some expressed concern at government funding of the project.

Following the communications phase, Johnston and Burton carried out desktop reviews, clarification sessions and further telephone or face-to-face interviews.

The third phase involved a review of additional literature, business media scans, technical journals and peer reviewed published papers covering a wide range of issues including governance, company law, corporate reporting, decision theory, risk management, adaptation science, CSR and business education.

The focus of our research has been on corporate adaptation actions as defined by the IPCC:

... adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. (IPCC 2007)

This project has not considered corporate mitigation responses except where climate variability or adaptation decisions impacts on corporate mitigation strategies, mitigation efforts compete with adaptation, or where mitigation and adaptation are integrated or closely connected in some way.

The world has changed. It is a more fragile and less stable place. (Joshua S. Friedman – Founding Partner, Co-Chairman, Co-CEO Canyon Partners, 2011)

Understanding Australian corporations – international companies, multi-nationals, globals and transnationals

As of June 2011, there were 2,132,412 registered businesses in Australia, with 826,389 employing staff. Of these, less than 1% of companies (about 6,000) had more than 200 employees (ABS 2012). As of December 2012, 2,168 companies were listed on the Australian Securities Exchange (ASX) (ASX 2012). Corporations, as defined in the Corporations Act include:

- (a) a company; and
- (b) any body corporate (whether incorporated in Australia or elsewhere);
- (c) an unincorporated body that under the law of its place of origin, may sue or be sued, or may hold property in the name of its secretary or of an officeholder of the body duly appointed for that purpose.

Company Boards are the main strategic management structure and highest authority composed of senior executive and non-executive officers known as directors. Division in authority between the executive board and senior management often varies according to size, purpose, ownership and other issues.

Directors are selected for skills, experience, connections, professional and/or industry knowledge and other reasons. Male directors in Australia average between 60-69 years old with females 50-59. In Australia, board representation of women is increasing on a decadal basis (however, new appointments declined in 2012) from a low base and is currently at 15.4% for ASX 200 companies (Company Director Resource Centre 2012). This figure is equivalent to the UK (FTSE 100 15%), substantially lower than representation on Australian universities (33%) or Government boards (30 June 2012, women held 38.4%) and lower than the USA (16.1%) (Australian Institute of Company Directors 2012).

Corporations differ culturally in many ways from government or not for profit sectors. They face scrutiny, competition and tests that few governments or not for profits encounter (see Box 1). By their design, corporations need risk to create rewards and the current post GFC climate may be too challenging to attempt to do more than meet quarterly fiscal objectives.

Box 2: Corporate governance

Corporate governance describes the framework of rules, relationships, systems and processes within and by which authority is exercised and controlled in corporations. Understood in this way, the expression 'corporate governance' embraces not only the models or systems themselves but also the practices by which that exercise and control of authority is in fact effected. (Justice Owen 2003, p.xxiv)

The ASX Corporate Governance Council in its Corporate Governance Principles and Recommendations with 2010 amendment (2010, p.10) lays the foundations for corporate governance using eight principles. The principles are:

Principle 1: Lay solid foundations for management and oversight

Principle 2: Structure the board to add value

Principle 3: Promote ethical and responsible decision-making

Principle 4: Safeguard integrity in financial reporting

Principle 5: Make timely and balanced disclosure

Principle 6: Respect the rights of shareholders

Principle 7: Recognise and manage risk

Principle 8: Remunerate fairly and responsibly

Of these principles, we considered that at least four are material to climate adaptation (Principles 3, 5, 6 and 7).



#CITB At least 4 of the ASX corporate governance principles are material to climate change @NCCARF

Where climate change is politicised, as it has been in Australia, adaptation by association then becomes a more difficult risk issue to raise, manage and treat by Australian companies.

It is important to note that foreign owned companies, some of whom do not have the same “skin in the game” as domestic companies, dominate many of Australia’s peak industry groups. Some are pro-regulation and some against. In regards to climate change mitigation, it has been reported that the majority of the peak bodies also opposed climate regulations (Taylor 2011).

Over the year-long project period, there has however been a marked acceleration in adaptation activity, enquiry and risk awareness from a very low base; nevertheless, researchers remain unsure if this is translating into action beyond initial limited risk assessments. Some boards see adaptation as a key strategic issue and therefore will not disclose or publicise activities, whilst others are content at “tick and flick” engineering based risk assessments.

PART 2: ENGAGEMENT FINDINGS

Reason for engagement

At the meetings, the authors asked participants their reason for participation. There was a broad range of reasons. Some, who recognised climate change as a challenge, were looking for further information to “sell it in to the company” or were looking to expand their networks with people interested in the issue.

Three participants stated that they specifically saw climate change impacts as a potential opportunity for their organisation and wanted to gauge how others perceived it. Two participants in one meeting stated that they were concerned about insurance risk. Many said that they were attending to get a better understanding of the issues.

Most of the participants stated that they had a good to very good understanding of sustainability, climate change mitigation or CSR.

Understanding of climate change risk, adaptation and opportunities

The majority of corporations engaged were struggling with adaptation and the risk treatment of uncertainty. The researchers encountered a very wide range of climate change adaptation responses from the participants. These ranged from ignorance and denial, short-term risk transfer through to very sophisticated long term planning. The most sophisticated responses to climate change risk management were those in the resource sector who were accustomed to working in extreme environments and who apply climate science through downscaling.

Across the sample, sensitivity, vulnerability and levels of exposure clearly differed widely. However, most organisations in our sample confused carbon mitigation with climate adaptation. Only a very small minority (<10%) of participants stated they were using climate science or adaptation science in adaptation planning. This minority of participants was very aware of climate change risks. These participants were aware of the current adaptation policy milieu in Australia and quoted the Productivity Commission’s draft report on Barriers to Climate Change Adaptation (Productivity Commission 2012) and relevant land use planning climate change-related policy. At least two of these companies maintained internal climate change adaptation personnel.

During the discussions, it was evident that many businesses lacked an incentive to do the “heavy lifting” expected from government, society or others. Many said that they would welcome level playing fields in legislation and encourage policy that benefits all. Regardless of the regulatory pressure, it was recognised by the majority that many could still benefit from early action, competitor mistakes or slower responders – although most also admitted that they had yet to investigate the pathway towards climate change risks or opportunities.

Unsurprisingly, in a fear driven post-global financial crisis environment, most Australian mid-tier businesses are not focused on what many see as “altruistic aims” but focus rather on their narrow corporate purpose often with trade-offs for sustainability, resilience or longer-term risk and opportunity planning. There is very little internal or external pressure to consider climate adaptation and few are asked by investor groups or by regulators to either consider or disclose climate risk or climate adaptation strategies.

Our general observation suggested that the composition of boards varied widely between types of companies but in Australian companies that attended it was obviously dominated by males aged in their late 50s to over 60. This composition is typical of the Australian Boardroom.

The male directors tended to articulate and discuss climate very differently from female directors. We were unable to determine from the sample and the environment why the marked contrast existed. We generally found the female directors much better informed and aware of operational risk but were left outside of strategic decision-making. Males being generally more senior in the organisation were focused on strategic issues, often confused carbon mitigation with adaptation and were less articulate in their conversations about climate change risks and opportunities. These observations are discussed further on as evidence from risk decision-making research suggests that major differences do exist (Bart and McQueen 2013).

This difference appears to be material to risk decision-making and many scholars and management experts are suggesting that as board diversity increases so does risk management. This may be significant given the low numbers of female directors in Australian corporates and warrants further consideration and research.

Many corporations in the sample, mostly Australian mid to large companies, seemed to be very short term focused, are led by boards with low diversity, traditionally defined skill sets, older usually male dominated thinking and expressed a limited treatment of climate change risk. Some of our interviewees from Australian mid-tier organisations reported that they felt the older male board and senior management was limiting discussion of climate change and risk issues. This has been found in other organizational structures and Government departments (Kang *et al* 2007). Most MNCs and especially TNCs have a wider diversity of skills, culture and talent available and often more sophisticated systems, processes and people capable of developing and implementing ongoing adaptive responses. These resources, plus a subsequent mindset orientation towards foresight, anticipatory planning and risk, appear to give a strategic advantage over competitors.

The key climate-related risks

A limited number of key concerns were identified during the meetings. A possible reason for this is the fact that many of the organisations had yet to do a comprehensive analysis of their risks. Another possible reason is that some did not want to share commercially sensitive information with other participants. Most participants discussed the recent Queensland floods and Victorian bushfires, as many had been directly affected, and some assumed that under climate change these risks were likely to continue or become worse. Other risks that were identified included:

- Risks to critical infrastructure
- Insurance risk (increased risks and insurance withdrawal)
- Litigation
- Loss of productivity

- Increased operational expenditure
- Loss of business to more prepared competitors
- Rapid regulatory implementation and/or change

Of particular interest is that only one participant stated that the issue of non-carbon related climate change risks was included as a key performance indicator (KPI).

Key barriers

We asked participants to identify and discuss key barriers to action on adaptation. Each of the barriers was identified and examined post interview against public statements, corporate reports, media, commentary and academic papers on corporate adaptation.

There were three key barriers identified for inaction at the organisational level.

1. “Isn’t Climate Change a Carbon issue?” Mitigation vs. adaptation confusion

Many of the participants confused mitigation actions with adaptation and many did not understand climate science, realise the “locked-in” changes, or the climate system models. Many who came from a carbon role or were internal managers promoted to manage CSR assumed that their mitigation efforts were enough. Some were unable to comprehend the scale of change, localisation impacts or the relevance for their business. Many suggested that trade-offs for reputational gain or carbon tax reductions came at cost to adaptation action.

Consequence – Carbon-only focussed business may be exposed to impacts risk including their mitigation efforts if their staff and executives fail to understand the more complete climate picture that needs to include adaptation. Several participants have misrepresented themselves to markets, superfunds and investor groups in claims that they have been addressing “all climate change risks”. Many had not considered implications for flooding, fire or disease on carbon offset schemes.

Recommendations – Government and industry to develop a high-level risk and opportunities assessment for business pitched at each sector with simple guides.

State Governments to develop risk maps and hazard tools for each state at a regional level. ASX to develop standardised language for climate change risk disclosure reporting to require adaptation and risk mitigation rather than just emission reduction focus.

2. “It’s not a risk issue for us” Not on the risk register or captured by horizon planning

Several participants felt that climate change would not affect them because they were not physically exposed (‘I am not near the beach’), had not ever had any clients or investors asking for risk disclosure or because they were currently adequately insured. Many had never considered the issue of impacts with one Head of Risk for a multi-billion dollar

organisations saying, I had never thought about it nor been asked about it'. Other senior executives said they operated in short cycles and because they would sell assets every seven years, they therefore would respond when climate change happened.

Recommendation – Director level explicit accountability for climate risk disclosure. ASX Corporate Governance Guidelines to explicitly mention climate change impacts and adaptation.

Government should communicate realities of limits in insurance markets.

3. “Our Board doesn’t recognise climate change; I can’t even talk about it”

A few participants stated that it was difficult to even mention the issue to their Board. A range of influences beyond market and regulatory responses affects board recognition and treatment of risk. One participant stated:

The thought of having to raise more support and funds for adaptation or taking on more work appals me ... carbon compliance is bad enough, so I’ll keep my head down until I’m told otherwise.

Another stated, ‘I tried many times to get the board to look up but culturally they are blind or dumb to anything they’ve not seen before’.

Consequence – The consequences of not presenting issues to the board are considerable; these include litigation and legal compliance risks as well as risks associated with the capital and operational expenditure, and loss of market opportunities.

Recommendation – Utilise the legal sector and /or peak industry groups. Do not bring climate change in as a green or CSR issue. Have information prepared that is aligned to recent extreme events and use that as a segue into the climate issue.

Other considerations for change agents, executive leaders and researchers

The wide range of responses to our interviews suggested that whilst each company had a range of common general issues, many had differing viewpoints, context and understanding of climate change when considering their specific corporate adaptation response. Many thought of weather extremes when thinking of climate impacts. Some attributed Queensland floods and Victoria bushfire directly to climate change. Unsurprisingly some of the responses align with direct recent extreme weather events. For example, a few Brisbane participants expressed sensitivity to floods whilst some from Melbourne were more sensitive to bushfire risk, with each giving little consideration for the other's situation.

Sydney executives considered flooding and bushfire risks as relatively remote or separate and therefore a non-issue for them except where their non-Sydney offices or branches had suffered loss. For many of the largest companies, including banks, insurers and real estate,

the Queensland flood and cyclone losses and Victorian bushfire losses were immaterial or manageable and not a motivator for change. In contrast, some leaders of locally significant businesses in Queensland or in Victoria, which had suffered relatively more significant losses or who were personally familiar with the hazards, clearly expressed that their views of climate change had been altered.

It was recognised by some participants that climate change was just one of many elements to consider. This was summed up by one executive who suggested that there are "too many issues on their plate personally to consider other issues". Another senior manager with a leading services sector organisation stated, "Until I'm told to respond to climate impacts or our assets are flooded, I cannot invest time, energy or resources in responding to this".

During the course of the engagement, following initial research and through interviews, it became apparent that most managers, senior executives and many board members lacked the "systems view" that many academic research teams, a few consultants and the more sophisticated management systems employ in dealing with "wicked" problems.

Some executives who had explored adaptation mentioned several management innovation and change models (e.g. Senge 2008) and commented on difficulties in applicability between concepts or theories and their own business environment. Many executives saw compartmentalised thinking within companies as a personal benefit as it focused on efficiencies, core skill sets and narrow objectives. Some executives were rewarded for excelling within these functional silos and others suggested that it was safer to stay in these spaces than risk personal or business failure by trying to work across or with other domains in a subject area they were uncertain about.

A few participants recognised that barriers affecting the consideration of climate change adaptation were related to the role of power and function. They raised issues of access, resources, time, influence, reach, agency and authority as primary concerns within their organisations. Other participants stated that the challenges were more associated with knowledge limitations, technical barriers and the complexity of managing risks related to uncertainty. Others did not know where to get relevant information, whether it was reliable and in what form the information would be useful.

For a few, the barriers to adaptation implementation seemed to arise from a failure of understanding their organisation within the larger environmental framework. For example, a senior executive of a professional property services firm stated, 'What has climate change got to do with me, my role or the business? It is not my problem'.

PART 3: AN OVERVIEW OF SECTOR-SPECIFIC ISSUES

This part of the report provides a brief overview of the relevant opportunities and risks for the following critical sectors: insurance, transport (aviation, rail, road & shipping), finance and asset management, property and real estate and utilities (water, electricity, information communications). The scoping review of each of these sectors aims to:

- provide a scoping overview to stimulate questions and further investigation;
- act as a catalyst for discussion (within organisations, between organisations and between researchers and the private sector); and
- provide interested academics with relevant future research areas.

What is evident in the following chapters is that much of the Australian private sector is in the embryonic stages of understanding the direct and indirect impacts of climate change. This scoping review of key sectors shows that much more publicly available research is needed to better ascertain the climate change risks and opportunities facing these key sectors of the Australian economy. It would be fair to say that much of the assessment of climate-related issues facing the private sector has been done internally, limiting the ability for public information sharing.

There are five key overarching issues associated with climate change that are likely to be the crucial drivers for business risks and opportunities, as listed below.

Shifting populations – climate change will stimulate populations to shift. From slow planned retreat through to climate-related unplanned migration. The estimates range from 25 million to 1 billion people by 2050 (IOM 2012). Whatever number materialises, it will be large enough to affect local, national and global markets. Rapid urbanisation, in part driven by declining rural economies generates both risk and opportunities and globalisation will increasingly place demands on Australian resources including food production, land and water.

Technological innovation and interdependence – the speed of current technological innovation means that it is difficult to identify the impacts on and opportunities in what is likely to be an increasingly hyper-connected economy. Five years ago, few would have thought that an online reputation would help secure post-disaster accommodation or that the insatiable demand to be online, no matter what, would help spike the share prices of generator manufacturers after Hurricane Sandy (Businessweek.com 2012).

Nexus between mitigation and adaptation – adaptation will need to occur in a carbon-constrained world. Some engineering approaches to adaptation (e.g. sea walls and flood defences) are likely to be carbon-intensive. Furthermore, low carbon technologies present new risks. During the 2011 Queensland floods the previous rapid uptake of home-based solar electricity posed electrocution risks to residents gaining rooftop harbour from raging waters and also those involved in post-disaster recovery (Department of Justice and Attorney General 2011).

Insurance – the global economic coalface of climate change impacts. Insurance can be both an early driver for adaptation action and provide a backstop for the unmanageable. Insurers, however, it has been argued that insurers use imprecise catastrophe models to value risk and can react quickly to emerging risks through increasing prices, changing contract wording and withdrawing from locations (Mills 2012) – whereas businesses, relying solely on insurance as a risk transfer, may be left stranded overnight.

Regulation – as the climate changes, so too will regulation. New land use planning, design, disclosure, asset management, insurance and lending regulations are very likely to emerge in the short-to-medium period. Specific climate change adaptation –related regulation may however be slow to emerge in less developed nations (or at least well implemented) resulting in continued supply chain exposure, auto adaptation and potential mal-adaptation.

Introduction to the climate change challenge

There is a plethora of scientific research that suggests we are entering a world where new extremes are to become the norm. Current average global temperatures exceed those in the past 4,000 years (Marcott et. al. 2013) with temperatures still increasing. Over the past 100 years, the average near-surface global temperature has increased by over 0.7° C (Figure 1).

At the 2009 Climate Convention Conference, member countries committed to limiting warming to 2° C above pre-industrial levels by 2100 – although global emissions continue to increase making this target difficult to achieve.

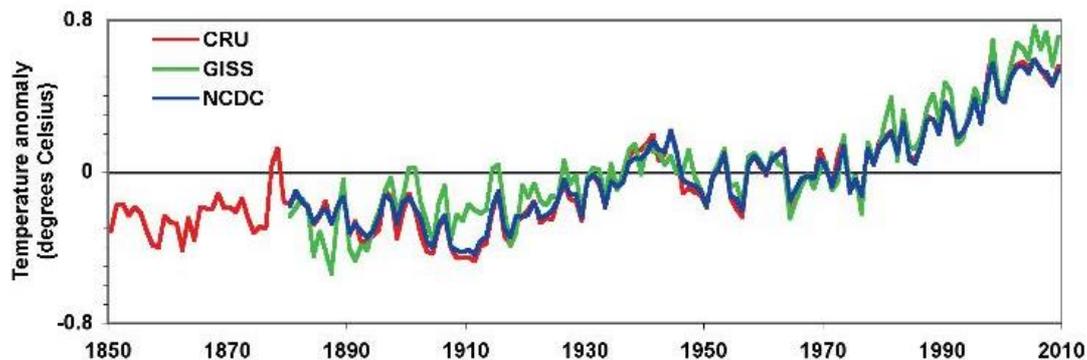


Figure 1: Global Surface Temperatures Relative to the 1951-1980 Average. CRU is data from University of East Anglia Climate Research Unit; GISS is data from Goddard Institute for Space

The future climate very much depends on the amount of anthropogenic (human induced) emissions and how the natural environment will respond. This is dictated in part by population growth, technological uptake, energy source and level of deforestation. Other uncertainties include natural elements that affect climate feedback loops (e.g. cloud cover, ice albedo, and desertification). Depending on the level of emissions growth, combined with the natural forcing responses, the projections by the Intergovernmental Panel on Climate Change (IPCC) for average global warming are between 1.1° C and 6.4° C, compared to the 1980-1999 average (Solomon et al (eds.) 2007) ([Figure 2](#)).

In fact, recently the World Bank reported that even if international agreements on greenhouse gas (GHG) abatement are reached it may be too late to contain the warming to

2° C and that there is already a 20 per cent chance of reaching 4° C under current GHG commitments.

It is important to note that the distribution of temperature change over the past century has not been uniform with the northern latitudes maintaining the strongest average increase. This disproportionate trend is likely to continue into the future (Lemke 2012; Koenigk 2012).

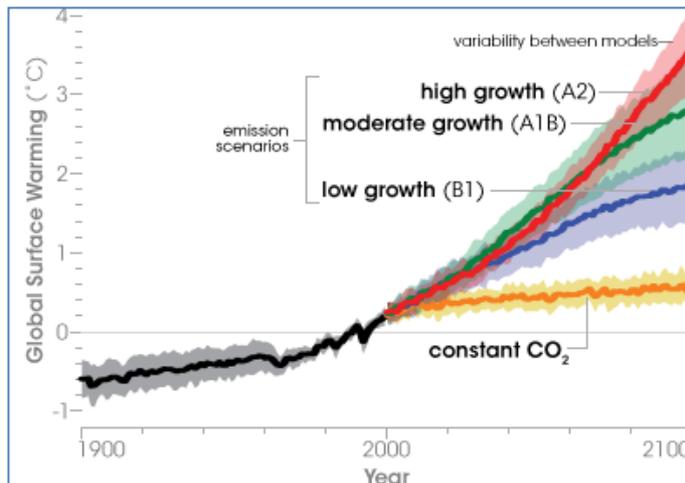


Figure 2: Temperature projections to the year 2100 based on a range of emission scenarios and global climate models. Scenarios that assume the highest growth in greenhouse gas emissions provide the estimates in the top end of the temperature range. The orange line (“constant CO₂”) projects global temperatures with greenhouse gas concentrations stabilised at year 2000 levels. Source: NASA Earth Observatory, based on IPCC Fourth Assessment Report (2007).

As well as historical climate data there is also a wealth of evidence from changing natural systems that supports the notion that global temperatures are increasing. These include glacial melt, sea level rise, decreased Arctic sea ice (especially in summer), increased West Antarctic temperatures and changes to ocean salinity (Australian Academy of Science 2010).

Although there are natural influencers on the climate, the human influence is much stronger (Hegerl *et al* 2007). Of particular concern are the positive feedback mechanisms that may exacerbate global warming. These include the rapid reduction of ice (which reflects infrared radiation back to space) and the melting of permafrost (which in turn releases methane into the atmosphere). In 2012, the summer Arctic sea ice melt reached a new record and is outpacing original projections. According to the US National Oceanic and Atmospheric Administration (NOAA) the Arctic may be entering a new climatic state:

Large changes in multiple indicators are affecting climate and ecosystems, and, combined, these changes provide strong evidence of the momentum that has developed in the Arctic environmental system due to the impacts of a persistent warming trend that began over 30 years ago. (NOAA 2012)

The changes described above are materialising faster than initial estimates. In 2005 it was projected that Arctic summer sea ice melt would occur sometime between 2070 and 2100. Recent projections estimate that this may now occur between 2040 and 2100, although some ice models show melting before 2020 and as early as 2014 (PIOMAS 2012; Wadhams in Guardian 2012) ([Figure 3](#)).

September 16, 2012 (summer minimum)

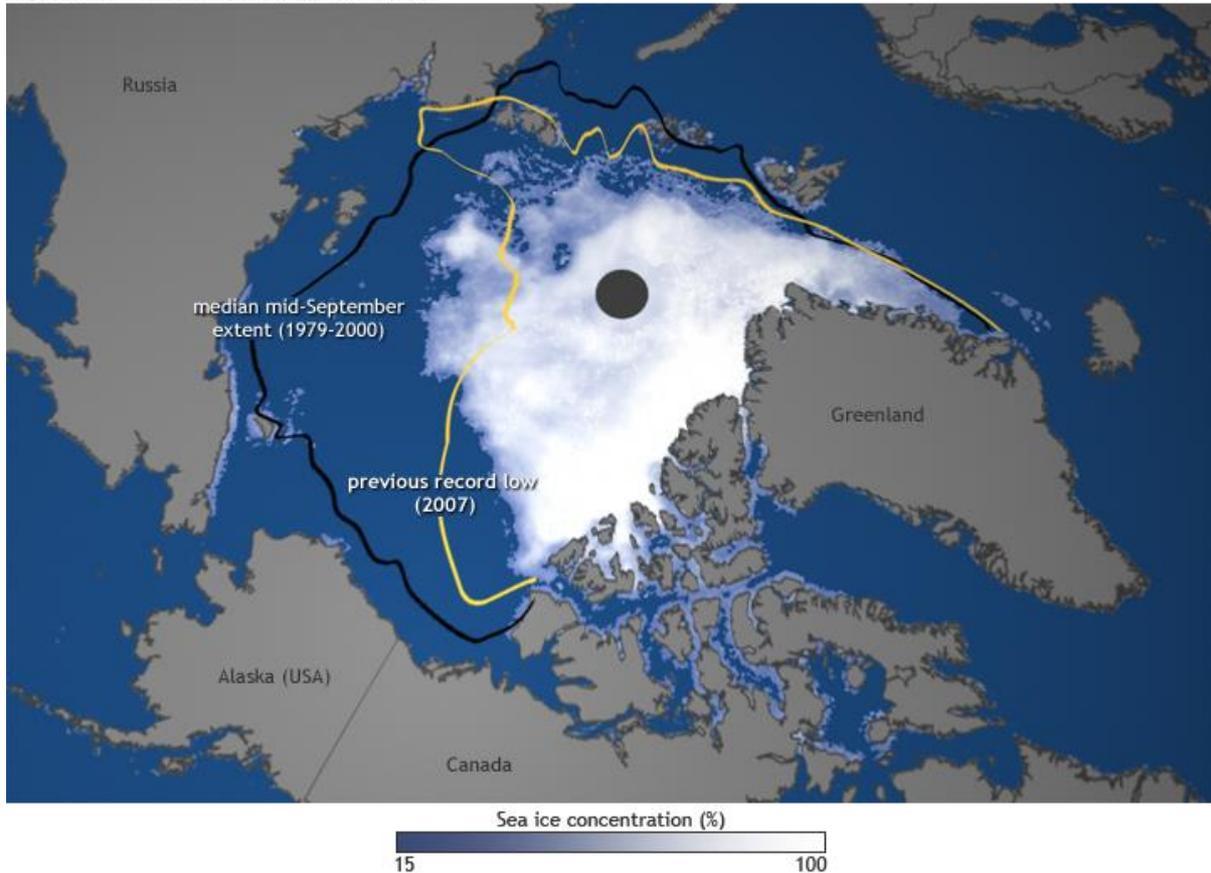


Figure 3. Arctic Summer Sea Ice Melt. “By the time the summer melt season came to an end in mid-September, the ice extent had shrunk down to just 1.3 million square miles (3.41 square kilometres), setting a new record low that was 18 per cent smaller than the previous record and nearly 50 per cent smaller than the long-term (1979-2000) average.” (NOAA/National Snow & Ice Data Center 2012)

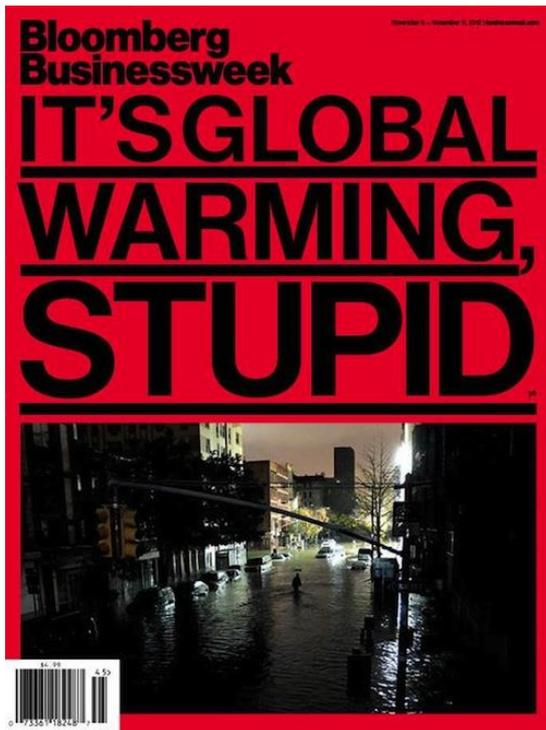
While popular media has fostered a lively debate between climate change deniers and believers there is overwhelming scientific consensus which attributes climate change to the increased anthropogenic (human induced) activities.

A recent press statement by the secretary general of the World Meteorological Organisation shows that climate change is no longer a future problem, but a present one:

Climate change is taking place before our eyes, and will continue to do so as a result of the concentrations of greenhouse gases in the atmosphere, which have risen constantly and again reached new records. (Reuters 2012)

The above is supported by the findings of a recent article in *Nature Climate* by Coumou and Rahmstorf (2012) who argue that the assortment of global climatic extremes experienced in the past decade is evidence of human-induced warming. These include the 2003 European Heat waves, the Black Saturday Bushfires in Australia 2009 and the Russian heat wave of 2010, all of which beat the previous extreme temperature records by over 2.4° C.

The authors argue that "many lines of evidence ... strongly indicate that some types of extreme event, most notably heat-wave and precipitation extremes, will greatly increase in a warming climate and have already done so" (Coumou and Rahmstorf 2012, p.4).



There is a growing body of science that expresses that, if left unchecked, climate change will have disastrous consequences for the natural environment and ultimately our human systems, which depend on this natural environment.

The recent two years of extreme events in the US (25 events with more than US\$1 billion in damages each) finishing with the "Frankenstorm" Hurricane Sandy has seen a shift in reporting in business media about climate change (Figure 4) and a growing recognition for better risk management.

Figure 4: Front cover of Bloomberg Businessweek following Hurricane Sandy

The ramifications of climate change and extreme weather impacts are likely to challenge current insurance pricing and availability, lead to a rapid emergence of adaptation regulation and result in a shift in corporate responses to the emerging risks.

Although the potential economic losses from the physical impacts of climate change are estimated to be over \$4 trillion per year by 2030 (DARA and Climate Vulnerable Forum 2012), climate change adaptation is still off the radar for many in the private sector. For example, two consecutive surveys of US Insurers showed that only a fraction were aware or actively managing climate change risks (Leurig 2011; Leurig and Dlugolecki 2013); a review of asset managers showed that few considered climate impacts and a study of institutional investors showed that only 26% were considering climate change risks (IIGC 2011); and a UK survey of FTSE 100 companies showed that while 80% recognised climate change as a material risk less than 50% incorporated it into their strategic planning (Carbon Disclosure Project 2012).

It is therefore not surprising that a recent report by the World Economic Forum has identified failure to adapt to climate change as a high-risk, high-impact issue in its Global Risk Landscape 2013.

New information around climate science emerges frequently, often faster than policy and business planning can adapt. For example, the emerging science surrounding "megafloods" caused by Atmospheric Rivers is likely to re-shape the definition of flood risk. Although the science of Atmospheric Rivers has only emerged in the past fifteen years, the findings highlight the potential for catastrophic risk, especially in the western states of the US (Dettinger and Ingram 2013).

Dettinger and Ingram describe an Atmospheric River event over 43 days in 1861-62 in California:

The deluges quickly transformed rivers running down from the Sierra Nevada Mountains along the state's eastern border into raging torrents that swept away entire communities and mining settlements. The rivers and rains poured into the state's vast Central Valley, turning it into an inland sea 300 miles long and 20 miles wide. Thousands of people died, and one quarter of the state's estimated 800,000 cattle drowned ... scientists who recently modelled a similarly relentless storm that lasted only 23 days concluded that this smaller visitation would cause \$400 billion in property damage and agricultural losses. Thousands of people could die unless preparations and evacuations worked very well indeed. (Dettinger and Ingram 2013, p.66)

The authors state that a long term Atmospheric River like the above could result in long-term damage of US\$700 billion, dwarfing the records set by Hurricane Katrina and Superstorm Sandy. Applying a climate change perturbation to Atmospheric River modelling for California sees peak seasons and multi-years Atmospheric River events increasing, which increases the flood hazard season (Dettinger 2011).

Like the US, Australia is also prone to extreme weather events. The series of extreme events that occurred in the summer of 2012/2013 was coined by the Climate Commission as the "Angry Summer". In the associated report, Professor Will Steffen stated that during the 90 days of summer over 130 weather-related records were broken throughout the country (Steffan 2013).

The Angry Summer report stated that the series of extreme weather events shows that "climate change is already adversely affecting Australians" (Steffen 2013, p.1). Although individual events cannot be attributed to climate change, Professor Will Steffen reminds us "all weather, including extreme weather events, is influenced by climate change. All extreme weather events are now occurring in a climate system that is warmer and moister than it was 50 years ago. This influences the nature, impact and intensity of extreme weather events" (Steffen 2013, p.1).

Recommended Reading

To gain a deeper understanding of the climate change science and phenomenon the authors suggest the following literature:

IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp. Available from http://ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf

Helen Cleugh, Mark Stafford Smith, Michael Battaglia, and Paul Graham (Eds.) 2011. Climate Change: Science and Solutions for Australia. CSIRO PUBLISHING, 168 pp, available from <http://www.publish.csiro.au/pid/6558.htm>

Steffen, W (2013) 'The Angry Summer' The Angry Summer', (Published by the Climate Commission Secretariat (Department of Climate Change and Energy Efficiency)

World Bank (2012), 'Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided', (A Report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics), available from http://climatechange.worldbank.org/sites/default/files/Turn_Down_the_heat_Why_a_4_degree_centrigrade_warmer_world_must_be_avoided.pdf

Transport

The transport sector is a critical component of business success and a strong economy. Mobility supports business flow and the development of opportunities whereas deficient systems impede functionality, open the way for competition and threaten operational viability. Australia's vast expanse means that roads, rail, aviation and shipping form a critical web moving goods and people. Climate change is likely to extend the occurrence and intensity of extreme weather exposing businesses to macro-economic and micro-economic effects.

The transport sector plays a critical role in economic supply chains and a business is only as strong as its weakest link. In many cases "force majeure" clauses in supply chain contracts are used to overcome uncertainties associated with extreme weather. As awareness of climate change increases, and extreme events and improvements in climate variability forecasts occur, the term "unforeseeable" (which is the foundation of many force majeure clauses) may be challenged (see Fogarty 2011).

As businesses look for opportunities to reduce their carbon footprint, they also may introduce new climate-related issues into their risk portfolio (e.g. flood and weather risks to electric vehicle charging stations).

Those who are heavily reliant on transport services should seriously consider the resilience of their supply chain networks and identify short-term and long term adaptation solutions. This chapter provides an insight into how climate change may affect the Australian aviation, shipping, rail and road freight elements of the transport sector.



#CITB Business opportunities to reduce carbon footprint may also introduce new climate-related issues in their risk portfolio @NCCARF

Aviation

The global aviation sector plays a powerfully influential role, underpinning economic activity through the movement of freight, mail and passengers. The industry supports over 50 million jobs and is estimated to have a \$2.2 trillion dollar economic impact. In 2010 almost 2.7 billion aviation passenger trips were made and approximately \$US 5.3 trillion of cargo was transported. The projections for growth are considerable, with an anticipated 28,000 new aircraft required for the estimated annual 7 billion passengers and increased freight demands expected by 2031 (Airbus 2012).

While the issue of greenhouse gases has increasingly gained prominence (with the sector contributing 2% of global emissions), considerations of climate change impacts and adaptation in the aviation sector is in the nascent stages. Weather and aviation are inextricably linked. In the US, weather is responsible for 70% of flight delays and over 20% of accidents (Kulesa 2003). Although the aviation sector manages extreme weather risks on a daily basis, climate change presents considerable risks that will require continued analysis and strategic consideration.

Potential climate change-related challenges that the aviation sector face include:

- changes to existing risk framework assumptions;
- increase in weather-related accidents (especially during take-off and landing);
- increased damage to airport installations;
- risks to airport-based staff health and safety (e.g. baggage handlers);
- in-flight comfort (turbulence and thermal comfort changes);
- reduced payload (i.e. extreme temperatures limits take-off payload);
- engine performance and maintenance regimes;
- disruption to passenger, freight and staff access to airports;
- cascading impacts from supply chain disruption;
- changes to flight patterns and increased flight disruptions;
- adaptation regulations affecting land uses, operations and capital expenditure;

- issues associated with airport maintenance and runway risks (e.g. sea-level rise);
- increased insurance / insurance withdrawal; and
- reduced value-return from certain aircraft (e.g. the need to sell aircraft with poor thermal comfort earlier than anticipated).

The challenge for the industry is the deep and complex networks and sensitivities to supply chain ripples. Even if local airports become more resilient to extreme events, the Australian aviation sector is still exposed to the risk management practices in other countries (like during the Bangkok floods). Although the aviation sector is exposed to climate-related incidents, it also maintains a considerable ability to respond rapidly after extreme events. This is compared to other transport sectors (e.g. fixing a runway post-extreme event may be faster than fixing complex road networks). As such, the aviation sector can play a critical role in post-disaster responses (e.g. moving supplies, emergency personnel, trade people).

Australian perspective

In Australia there has been a step change in domestic passenger movement over the past decade, with current monthly figures being between four and five million passengers per month since 2004 (BITRE 2010) ([Figure 5](#)). Almost 50% of the 23 million international arrivals in Australia during 2009 were for tourism, highlighting the sensitive link between the two sectors.

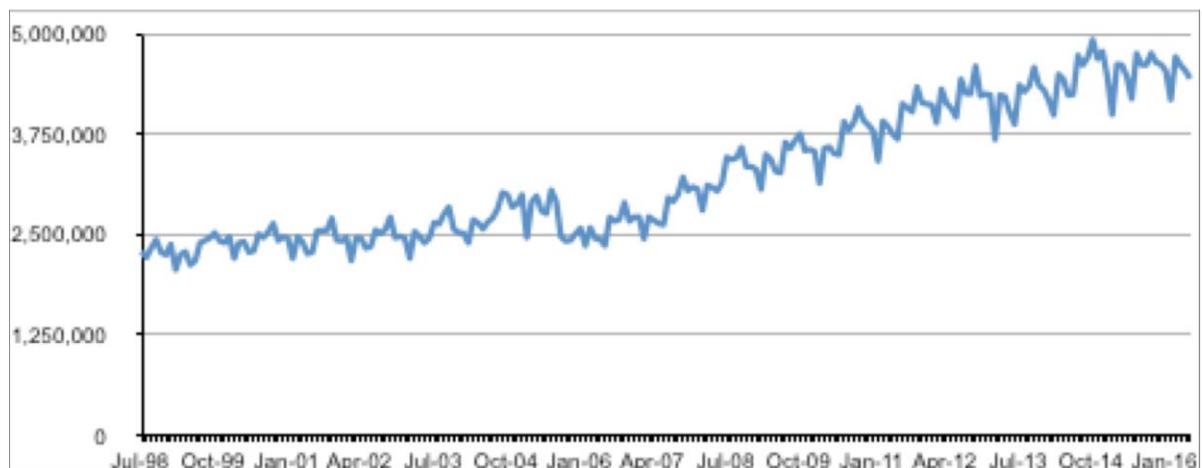


Figure 5: Monthly Australian passenger numbers (top routes) July 1994 – June 2011 (source, graph created from BTRE 2004 -2012 monthly data)

Australian Government projections show that the aviation sector will continue to grow with 'passenger movements through eight capital city airports forecast to increase overall by 4.2 per cent a year over the forecast period to 235 million in 2029–30' (BTRE 2012, p.xiv).

Although passenger numbers and flights are anticipated to grow considerably over the coming decades there is little documented research about the impacts of climate change on the Australian aviation sector as a whole. There has been some initial work in examining the effects on airports (often through Environmental Impact Assessments) with the research

showing that many are recognised as being exposed to the impacts of climate change (especially sea-level rise):

Sydney airport is the busiest airport in Australia, handling 31.9 million passengers and nearly 300,000 aircraft movements in 2007. The airport is almost entirely surrounded by waterways, with Botany Bay to the south, Botany wetlands in the east, Alexandra Canal to the north, and the Cooks River to the west. A sea level rise of 1.1 metres combined with a storm surge would inundate parts of the airport, interrupting operations and causing damage to infrastructure. (DCCEE 2011, p.8)

The risks in the quote above can be replicated for Brisbane ([Figure 6](#)), Cairns (which is at risk from current extreme tides) and many other coastal airports (including the territories such as Cocos and Lord Howe Islands).



Figure 6: Brisbane Airport (sea level rise plus HAT), indicative only (DCCEE 2011)

As has been identified in recent Australian Government literature there has not been a comprehensive review of Australian airports exposure to the effects of climate change.



#CITB little is known about the climate change impacts facing the Australian aviation sector @NCCARF

At present researchers are limited to publicly available investment disclosure information to identify potential effects that climate change may have on the aviation sector. For example, reporting by Australia's largest carrier, Qantas Group, to the Carbon Disclosure Project (CDP) highlights the fact that some large aviation organisations recognise that they are exposed to current climate and future climate change risks. Some of the risks that mentioned by the Qantas submission to the CDP include:

- changes to jet stream and weather patterns;
- changes to the natural environment (resulting in reduced tourism demand); and
- natural disasters (e.g. floods and cyclones).

Although these risks were identified, Qantas expressed into their CDP submission did not anticipate any opportunities and stated 'potential physical changes resulting from climate change are unlikely to present any potential to generate substantive change for the Qantas Group' (QANTAS 2011, p.26).

Commercial sensitivities make obtaining information on specific risks to the aviation sector extremely difficult.

However as a result of CITB discussions, some aviation sector participants reported that several regional airports, including one of those deemed most critical for heavy lift operations by both the private sector and Australian and foreign militaries, face increasing weather impacts including delays and loss of operational availability. Despite the airport operator's own requests for relocation and against a growing body of weather related evidence, several Government agencies have opposed any relocation with "cultural denial of climate change" cited as one reason. This "culture" exposes both national defence and disaster recovery efforts to increasing risk.

Suggested research

The National Aviation Policy White Paper published by the Australian Government in 2009 made little mention of climate change impacts, with the policy focus being on the issue of controlling greenhouse gas emissions.

Personal communication by the research team with the Australian Government also failed to identify any publications or policy direction about the issue of managing climate change risks in the aviation sector. Given the dynamic relationship between tourism and aviation, as well as increasing role the sector has in supply chain flow, the limited policy consideration by the Australian Government is a threat to the industry's strategic risk management direction.

This preliminary scoping review of the aviation sector has identified that little Australian-specific information is available that identifies the risks and adaptation options in the aviation sector. This dearth of publicly available information and research should be of concern for the sector and those that rely on it. Potential research that would be of interest includes:

- examples of aviation sector impacts during extreme events;
- siting options for new airports under climate change scenarios;
- a collation and analysis of non-identifiable specific-risks for all aviation companies who fly to and in Australia (to overcome commercial sensitivities);
- an overview of the risks and adaptation actions occurring in critical airports (national and international);

- a review of relevant aviation standards and regulations through a climate change lens; and
- a review of integrated climate change risks between roads, marine, rail and aviation.

Rail

Rail is a cost effective and energy efficient form of freight and large passenger movement. Although there has been a decrease in global rail lines, the tonnage of rail freight is experiencing considerable global growth, especially in developing countries. However, rail networks are static, inflexible and, in general, ageing, making the sector vulnerable to the impacts of climate change.

There has been a reasonable degree of research exploring the climate change-related risks for the rail sector in recent years. International reports such as publications from the US Transport Authority (2009) show that climate change presents a range of challenges to the rail industry, as listed below:

- derailing / accidents;
- rail bucking from extreme temperature;
- passenger thermal comfort;
- damage to above and below-track assets;
- reduced load freight capacity / train speed limitations;
- bushfire risks (including causing bushfires);
- increased maintenance costs;
- increased insurance / insurance withdrawal;
- disruption to energy infrastructure and supplies (e.g. electricity brownouts);
- increased resources needed to create new routes (especially in coastal and high flood risk areas).

As well as the above, the rail network often forms part of an intermodal network and is exposed to the climate-related challenges facing the road, marine and the aviation sectors.

Australian perspective

The Australian rail network spans some 33,000 kilometres with approximately 10% electrified. In terms of tonnage, the predominant use of the rail network is to move iron ore and coal from mines to ports. However, as more than 600 million passenger journeys occurred in the urban rail networks during the 2010–11 period, rail also plays an important role in the movement of people in our cities. This is especially so in Sydney and Melbourne where they represent 14.5% and 10.1% of daily commuter mode share respectively (BITRE 2012).

Historically the Australian rail networks have been exposed to considerable climate-related impacts. The following two examples show that the ramifications can result in risk to human health and safety, cause environmental harm, expose legal risks and affect business staffing.

Table 1: Example of climate-related rail disasters

Date	Location	Event	Event
Dec 2011	Edith River, near Katherine, NT	Tropical Cyclone Grant	Floodwaters cause train derailment, resulting in one injury and 1,200 tonnes of toxic cargo spill into the Edith River. The ATSB report into the incident calls for “robust systems in place to monitor and mitigate the risks of severe weather events.”
Jan 2009	Melbourne	Heatwave	1300 commuter train journeys cancelled in one week due to buckling rail lines, carriage air conditioner failures, overheating braking systems and power outages.

A simple comparison between iron-ore and coal rail distribution networks and historical tropical cyclone occurrences show the current exposure to just one type of extreme event (Figure 7).

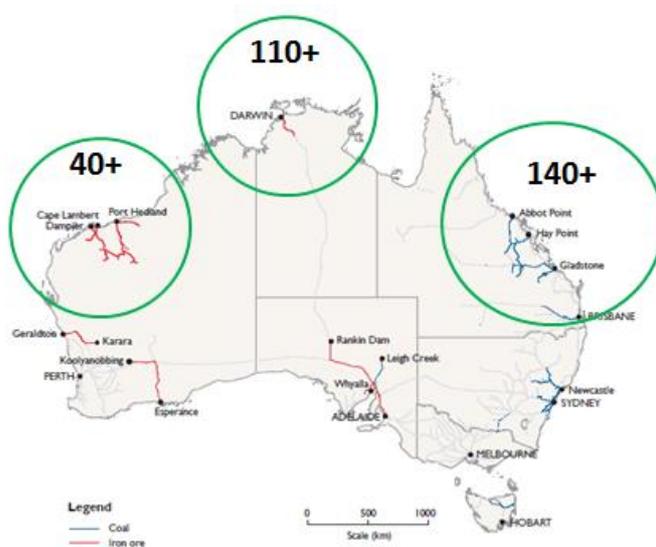


Figure 7: Number of tropical cyclones since 1910 in the leading coal and iron-ore rail freight networks (sources BTRE 2012 and BOM)

Given the historical impacts from extreme events and the vast expanse of the network (across differing climatic areas) it is not surprising that the initial research anticipates costly impacts for the sector. For example, the Australian Government estimates that between 1200 km and 1500 km of rail lines are at risk from 1.1 m sea level rise, with the majority of the risk being in the state of Queensland (Figure 8). The replacement value of the national lines at risk is estimated to be between \$4.6 billion and \$6.5 billion (DCCEE 2011).



#CITB Most of Australia's coal and iron rail freight networks are located in high cyclone risk areas @NCCARF

According to a recent assessment by the Climate Institute (2012), the Australian rail sector is under-prepared to manage the effects of climate.

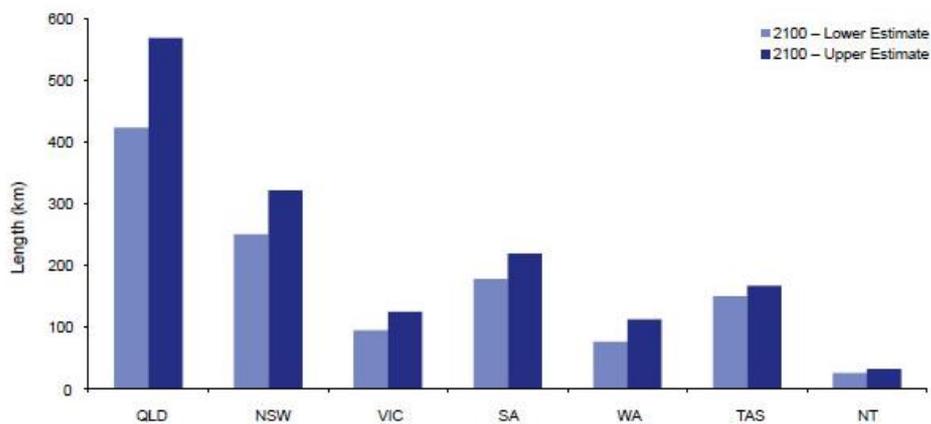


Figure 8: Kilometres of Australian rail network exposed to 1.1m of sea level rise (DCCE 2011)

Recommended research

To better understand the challenges and opportunities that climate change presents the rail sector, the authors recommend that further research is required to investigate the following:

- the impacts of current climate variability on rail design and maintenance;
- climate change risks associated with new and emerging technologies (e.g. high speed rail, automated systems, hybrid locomotives);
- integrated climate change risks between roads, marine, rail and aviation; and
- avenues to collate flood, bushfire and sea level rise exposure and make publically available.

Road freight

Current extreme weather already presents a significant challenge to the global road freight network and the effects of climate change will further exacerbate this. The growth of internet-based retail and just-in-time delivery has increased the exposure of the economy to road-based freight disruptions. Some of the problems facing the road freight sector include:

- increased maintenance costs for road infrastructure (e.g. combination of increased temperatures with heavy rainfall increases damage to bitumen);
- short and long term disruption to road networks from flooding;
- increased fuel use for passenger and freight cooling (from increased temperatures);
- increased fleet insurance costs;
- damage to assets (e.g. hail damage to vehicles);
- litigation (e.g. surrounding force majeure definitions);
- increased cost associated with supply chain agreements;
- disruption to fuel supply lines (e.g. Victoria);
- unforeseen risks for new and emerging technologies (e.g. temperature and vehicle charging stations);
- market risks (supply chain agreements requiring redundancy planning);
- regulatory risks (especially associated with infrastructure design standards);
- increased accident risks (although this may be offset by improved vehicle safety technologies);
- increased risks to construction and maintenance staff.

Australian perspective

The road transport network is an important keystone of the Australian economy. The road transport system dominates the movement of goods and is responsible for shifting over 70% of the total freight moved in Australia (1.7 billion tonnes). The responsibility of maintaining Australia's 800,000 kilometres of roads and associated infrastructure (e.g. over 37,000 bridges) is shared between the Federal, State and Local Governments (with a small proportion of roads also managed by the private sector e.g. toll roads). Maintaining the road networks is expensive and these costs are anticipated to increase due to climate change. It is likely that regional areas may be disproportionately affected by climate-related impacts on roads, as there are often limited alternative routes when disruption occurs (Taylor and Philp 2010).

Managing effective road networks under a changing climate is further challenged by the fact that approximately 80% of Australian roads fall within the remit of local governments. Funding backlogs, capacity and cash flow issues mean that local government authorities may not be able to keep pace with the anticipated impacts and required maintenance regimes (Serrao-Neumann et. al. 2011).

Australian roads are exposed to a range of climate-related variables. According to the Australian Government “between 26,000 and 33,000 km of roads are potentially at risk from the combined impacts of inundation and shoreline recession for a sea level rise of 1.1 metres (high end scenario for 2100)” (DCCEE 2011, p.7) ([Figure 9](#)).

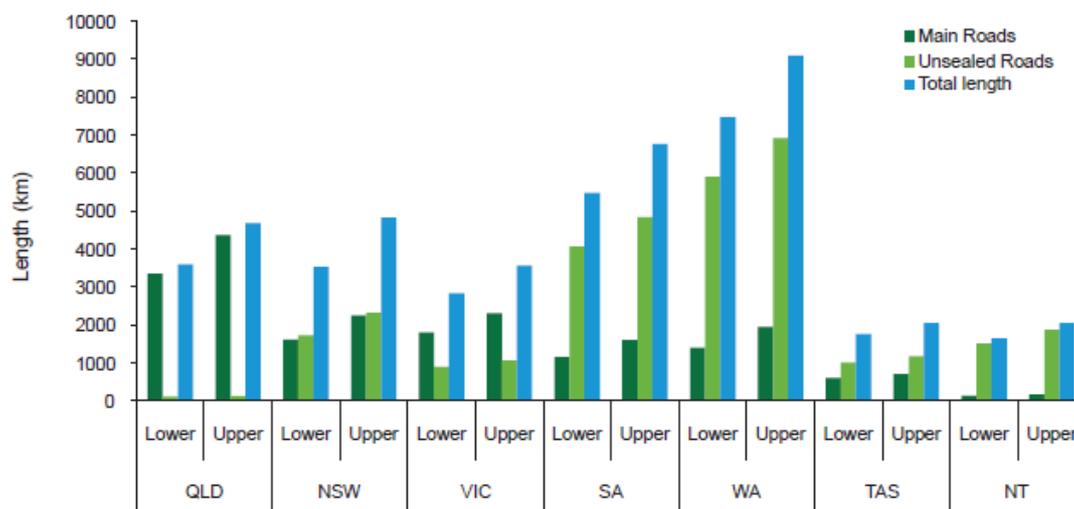


Figure 9: Estimated length of road infrastructure at risk from the combined impact of inundation and shoreline recession for a 1.1 metre sea level rise (DCCEE 2011, p.7)

Recommended research

- Identify and map the risk for roads connected to critical infrastructure (e.g. ports).
- Explore the climate change risks associated with new technologies (e.g. hybrid vehicles, electric charging stations).
- Explore long-term options for remote, low traffic and high maintenance cost roads including abandonment, transfer to private sector and new materials.

Marine transport

International and domestic shipping is an important cost-effective bulk carrier of goods, with approximately 90% of international trade travelling by sea. In 2010, over 8.4 billion tonnes of goods were loaded onto merchant ships globally. In an increasingly globalised world with population growth and increased containerisation of goods, this is anticipated to grow substantially (UNCTAD 2011; IMO 2012). At present, the climate has a strong effect on the industry with 17% of maritime hazardous and noxious substance (HNS) spills being caused by adverse weather conditions (IMO 2012, p.32). As well as the economic damage, HNS spills also damage the natural environment.

Climate change is anticipated to exacerbate the current challenges to the shipping industry. Risks include:

- reduced access to a port from storm-related disruptions;
- degradation of marine structures;
- increased maintenance;
- access to new trading routes (e.g. in NE and NW Passages in Arctic waters);
- short term disruption to fuel availability;
- reduced load capacity in low water lake and river systems;
- increased potential for inactivity (due to disruptions in supply chain);
- increased fuel use;
- less costs on ice breaking; and
- increased number of spills.

Australian context

Being an island nation shipping forms an important component of Australian international and national economic trade. In 2010/11, over 880 million tonnes of freight were exported and just over 90 million tonnes imported (Figure 10). Coastal freight (i.e. domestic freight) for the same period exceeded 100 million tonnes (BRTE 2012).

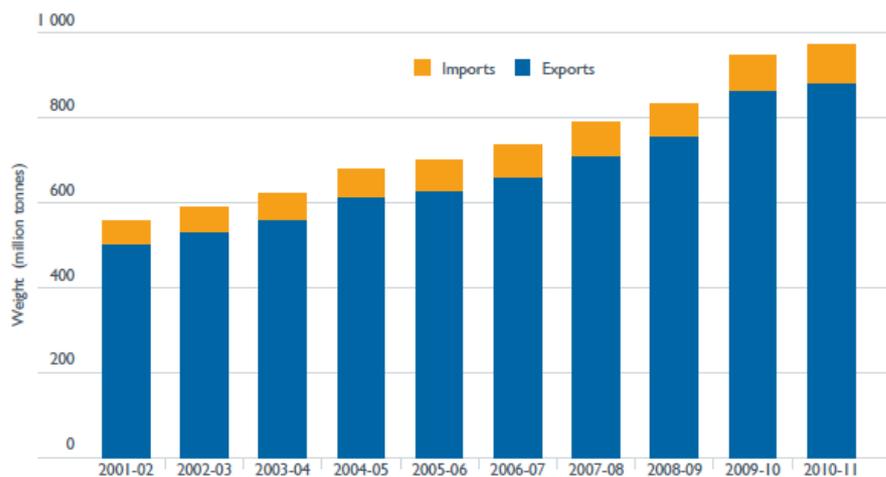


Figure 10: Weight of Australia's international sea freight (BITRE 2012, p.2)

The movement of goods in Australian waters is likely to be affected by the impacts of climate change. According to the Department of Climate Change, these include:

- increased runoff and siltation requiring increased dredging;
- disturbance and distribution of currently entrained heavy metals and other pollutants;

- increased high wind stoppages under Occupational Health and Safety requirements;
- delays to berthing and cargo handling; coastal flooding; and
- required engineering upgrades to wharfs, piers, gantries and other cargo handling equipment. (DCCEE 2009)

As well as the above, impacts also include heat related stoppages (stevedores stop work at 38°C), increased port closures from tropical cyclone risk (especially so in the Northern parts of Australia) (DCCEE 2009) and disruption to intermodal transport (Chhetri 2012). Modelling undertaken for the Garnaut Review on Climate Change showed that climate change will have a considerable impact on port productivity and operational and capital expenditure ([Figure 11](#)).

State	Productivity		Capital expenditure		Operational expenditure	
	2031–2070	2071–2100	2031–2070	2071–2100	2031–2070	2071–2100
Vic	4 per cent	5 per cent	9 per cent	11 per cent	7 per cent	8 per cent
NSW	4 per cent	5 per cent	11 per cent	13 per cent	7 per cent	8 per cent
WA	7 per cent	10 per cent	11 per cent	15 per cent	8 per cent	10 per cent
NT	5 per cent	9 per cent	6 per cent	10 per cent	6 per cent	9 per cent
Qld	8 per cent	11 per cent	13 per cent	17 per cent	9 per cent	11 per cent

Figure 11: Economic cost increases from climate change impacts on ports (DCCE 2009, p.121)

A NCCARF-funded report into understanding the risks to seaports in Australia (McEvoy et al 2013, p.57) identified that the ‘seaward-side of operations and the supply chain hinterland found to be most affected by climate variability (vulnerabilities which will intensify under a changing climate) ... [and that whilst] ‘hard’ infrastructure assets can be made more resilient by changing design and maintenance regimes, it is the functional resources (including the workforce) that are likely to become increasingly vulnerable.’

Box 3: The Queensland Floods and the Port of Brisbane

During the 2011 Queensland Floods, the Port of Brisbane was shut down for ten days (from 11th January through to the 21st of January 2011). Although the Port infrastructure itself was not damaged, over 1 million cubic metres of silt was deposited from the Brisbane River throughout the port area, reducing some of the depths by almost one metre. Furthermore, over 400 floating pontoons were washed down and out into the mouth of the river and became a hazard to shipping. The entire finance impact of the floods associated with dredging and disruption to intermodal transport was nearly \$AUD 500 million (Queensland Flood Commission 2012; Chhetri et al 2012).

Finance and asset management

The Global Financial Crisis (GFC) continues to ripple through the world's economy. It is a stark reminder that when the financial sector faces adversity the impacts flow through a broad geography and timeframe. The GFC has provided an interesting insight into what happens when interconnected risk management and risk transfer go wrong. Recent parallels between the US sub-prime mortgage collapse and emerging climate change risks have been made:

The recent sub-prime crisis, which the world's financial markets are still reeling from, was a great illustration of systemic risk unravelling. Ask any asset owner if in hindsight it would have liked a hedging strategy against the US housing market given their exposure. Any asset owners would respond positively. The same bubble is currently being created in our investment portfolios in terms of unmanaged climate change-related risks and the inevitable convergence of climate science and carbon regulation. (AODP 2012, p.10)

Notwithstanding the above, climate change risks are only being recognised by some. A recent survey by the Institutional Investor Group on Climate Change (IIGCC) showed that there is an increasing recognition by some institutional investors that climate change poses a challenge, although the level of those amending portfolios based on climate change risks was still low (26% of respondents) (IIGCC 2011). Furthermore, an alliance of institutional investors representing more than \$25 trillion in wealth and assets presented an open letter to the governments of the world's largest economies stating that "current policies are insufficient to avert serious and dangerous impacts from climate change" (CERES 2012).

Indirect impacts from climate change (e.g. those on health and well-being) can also affect investment portfolios. As shown by Mercer "for institutional investors, health impacts and population migration can potentially have an impact on long-term liabilities and affect assumptions around mortality rates" (Mercer 2011).

Australian perspective

Australia's \$1.7 trillion investment management industry is the fourth largest by value in the world (ATC 2010). The industry has experienced considerable growth in the past two decades, with the industry's assets under management doubling since 2003 (ATC 2010) (Figure 12).

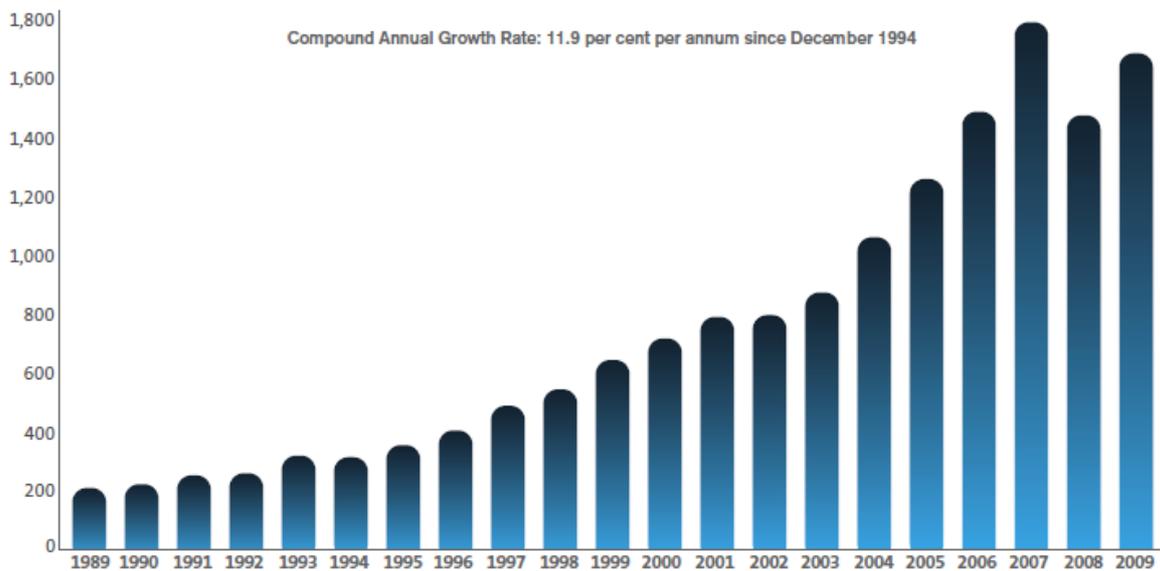


Figure 12: Australia’s Managed Funds – December 1989 to December 2009 (ATC 2010, p.10)

Although Australian investors scored better than their international counterparts did in the IIGCC Survey on Climate Change, considerable barriers still exist. According to a submission to the Productivity Commission's Investor Group on Climate Change (IIGCC) (2012) the barriers for adaptation investments include:

- uncertainties about the extent and timing of climate impacts on physical assets;
- uncertainty around the likely future regulatory responses of governments to climate change impacts;
- constraints on the efficient use of capital;
- inconsistency in existing regulation at different levels of government;
- limited availability of reliable and understandable data on climate change impacts;
- lack of liquidity in insurance markets to manage climate change risks; and
- the lack of an agreed benchmark or reporting mechanism to describe asset resilience to investors (IIGCC 2011, p.1).

A pressing issue for the finance sector includes stranded assets brought about from climate-related regulatory change. This happened for a short period during the rollout of the Queensland Coastal Plan and associated State Planning Policy in 2012. The Plan prohibited development in areas deemed to be in medium and high-risk areas from sea level rise, leaving some investors with large parcels of land without affordable development options (Burton et. al. 2011). The Plan has since been suspended with the change of Government in Queensland allowing development in those hazard zones.

Anecdotal evidence is also emerging in Australia about the risks that lenders face associated with insurance pricing and withdrawal. Most lenders in Australia have policies to ensure that mortgage holders maintain comprehensive insurance. However, some insurers

have recently pulled new policies and heavily increased old policies for certain locations (e.g. Roma and Emerald in Queensland) (news.com 2012; Suncorp Group 2013). The responses available to lenders are fraught with challenges. They could call in the uninsurable mortgages, whereby risking instantly devaluing their portfolio and introducing reputational risks. If they chose to delay assessing the issue or publically disclosing their associated risks they may receive a raft of responses including potential shareholder and / or ASIC action. As yet little is known about this issue (or at least publically discussed). This area requires further research and is a good example of how impacts could potentially ripple through an economy. It is of considerable concern that the majority of Australian (and global) actors in the finance and asset management sector are yet to undertake a comprehensive review of climate change risks.

Through the author's engagement with and research into superannuation funds, institutional lenders and fund management actors, it is clear that Australian finance sector climate risk management knowledge is limited.

Recommended research

The finance and asset management sector is in the embryonic stages of climate risk consideration and so there are a wide array of areas that require further research. These include:

- exploring options available to lenders if a location becomes uninsurable;
- exploring the level of climate change adaptation content in business education (e.g. masters of business);
- examining the costs and legal issues caused by trade-offs between short to medium term portfolio yields and long term value;
- examining the incentives against consideration of climate change
- exploring specific education and regulatory disclosure options for fund managers
- researching the level of influence that powerful lobby groups may have in curtailing or delaying adaptation regulation; and
- explore potential regulatory and non-regulatory incentives that will promote adaptation actions.

Insurance

Every sector of the economy telegraphs climate risks to its insurers. In turn, climate change stands as a stress test for insurance, the world's largest industry, with U.S. \$4.6 trillion in revenues, 7% of the global economy. (Mills 2012, p.1424)

The above quote highlights that the global economy cannot afford for insurers to be caught out by climate change. It seems as though the pressure that climate change is placing on insurers is increasing with a considerable increase in weather-related payouts occurring in some areas over the past two decades, especially in the US ([Figure 13](#)).

The insurance industry receives both praise and disdain for its approaches to climate change risks. On the positive side, insurers (especially re-insurers) are widely recognised as pioneers of climate change risk reporting and public awareness with progressive insurance providers having worked closely with their clients to implement adaptation strategies (Mills 2012).

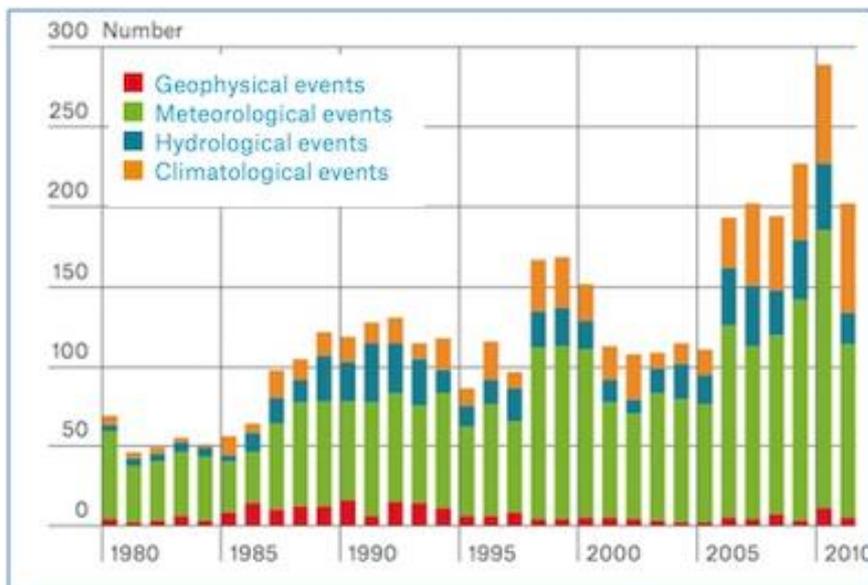


Figure 13: Natural catastrophes in North America 1980-2011 (altered from Munich Re 2012)

For the private sector insurance can be a useful risk transfer mechanism (see Box 4) as well as a force that could erode the timing or nature of climate change adaptation actions. If not managed effectively the latter could send ripples through the economy (which is also discussed in the Property and Real Estate section of this report).

Box 4: Insurance as an adaptation mechanism

By spreading losses among people and across time, insurance reduces the catastrophic impact of disasters, and enables a timely recovery. By reducing the burden of loss and damage (if not the average loss), insurance is thus an adaptation measure.

In addition to providing timely capital after a disaster, insurance can and should be linked with risk reducing, preventive activities.

Prudently employing a combination of insurance measures with risk reduction, including, among other measures, early warning, education, infrastructure strengthening, and land use regulations, can greatly reduce the immediate losses and long-term development setbacks from disasters.

In addition, by creating a secure investment environment, insurance instruments can enable productive risk taking on the part of individuals and governments, and in this way mitigate disaster-induced poverty traps. (Warner et al 2012, p.13)

Insurers often promote their services as a climate change adaptation option. However, they have the flexibility to change pricing, wordings and policies over time as climate change unfolds (Mills 2012). Furthermore, critics have shown that US insurers are not adequately incorporating climate change risks into their policy creation. For example a 2011 review of 88 US insurers showed that less than 13% (11 insurers) had formal systems in place to identify and manage climate change risks (CERES 2011) – when this was reviewed a year later (with 184 participants) it showed that the proportion had remained unchanged at 13% (24 respondents) (CERES 2013).

Unbeknown to many policyholders, insurance is an inexact industry that is loaded with large-value risk. As shown by Guy Carpenter (2011) the black box approach to catastrophe modelling has limited forecast accuracy:

When a cat model says ‘Your 100 year return period loss is \$1,117,243,572,’ what it really means is that your 100 year return period loss is about a billion dollars, but it could be 600 million dollars or maybe two billion dollars...or something like that. Guy Carpenter (2011)

Australian context

Given its sheer size and array of climatic drivers Australia faces a broad array of climate related perils. Like many other parts of the world Australia has also seen an increase in weather-related claims.

According to Munich Re Australia’s weather-related insurance losses have increased fourfold over the past three decades (Munich Re 2012). Weather is the primary driver of Australian Catastrophe events and is responsible for nine of the ten highest normalised losses over the past 45 years (Crompton 2011) ([Table 2](#)).

Table 2: Ten highest ranked normalised insured losses (AUD\$ million) (Crompton 2011, p.8)

Rank	Event	Year	Location	State	Loss (AUD\$ million)	Normalised loss (2011) (AUD\$ million)
1	Hailstorm	1999	Sydney	NSW	1700	4296
2	Tropical Cyclone Tracy	1974	Darwin	NT	200	4090
3	Earthquake	1989	Newcastle	NSW	862	3240
4	Flood ^a	1974	Brisbane	QLD	68	2645
5	Flood	2010/11	Multiple	QLD	2400	2529
6	Hailstorm	1985	Brisbane	QLD	180	2063
7	Ash Wednesday Bushfires ^b	1983	Multiple	VIC/SA	176	1796
8	Severe Storm	2007	Multiple	NSW	1480	1742
9	Tropical Cyclone Madge	1973	Multiple	QLD/NT/WA	30	1492
10	Tropical Cyclone Yasi	2011	Multiple	QLD	1300	1352

Given the above it is not surprising that some insurers in Australia, who are unhappy with the lack of structural defences, have ceased creating new policies in areas that have been determine by them to be too great a risk. For example:

Suncorp has recently stopped issuing new policies in Roma and Emerald. The decision was based out of our concern that, despite repeated severe flood damage, flood mitigation was not being addressed as a priority. The high levels of flood risk and lack of effort to reduce this risk, led Suncorp to significantly increase insurance premiums, which in turn places high cost pressure on the residents of Roma and Emerald. (Suncorp Group 2013, p.15)

Currently Australia still maintains a comparatively high insurance penetration (as a percentage of GDP) and has recently been ranked in a Lloyd's insurance publication as a Tier 1 ('Better Insured'). Almost 50% of the country's recorded losses between 2004 and 2011 were insured, with uninsured losses almost totalling US\$10 billion (Lloyd's 2012).

Although Australians are, at present, comparatively well insured the issue of underinsurance and the non-insured (especially with small-medium enterprises) continues to have negative impacts on local economies after an extreme event. The resilience of a company can be eroded by relying too heavily on insurance as the primary risk transfer mechanism:

... reliance on insurance pricing signals alone may have undesirable impacts. In particular, it may increase levels of non- and under-insurance, which historically puts pressure on government to provide compensation. In addition, the statement assumes that insurers and reinsurers will be willing to provide cover, which may not be the case. For example, premiums have increased significantly in north Queensland since the recent floods and cyclones, and insurers usually do not cover sea surge. There is always the possibility that insurers and reinsurers will withdraw from unprofitable markets. For example, some insurers currently do not write business in north Queensland. (Institute of Actuaries 201, p.2)

Recommended research

- Explore the potential cascade of effects if insurers withdraw from a specific location or sector (e.g. affects mortgages).
- Research how alternative insurance mechanisms could suit climate change adaptation (e.g. parametric insurance, weather derivatives and multi-year insurance).

Property and real estate

The property sector is highly exposed to both risks and opportunities associated with climate change. Property developers are highly exposed to regulatory change that may affect landholdings that were purchased before the known climate change risks emerged. As the science and subsequent risk awareness increases (e.g. sea level rise on coastal properties or bushfire risk in peri-urban or suburban areas) so too is the likely government response (e.g. requiring developers to assess the potential climate change risks of a development).

The world is experiencing a period of phenomenal urbanisation. In 2011, approximately 52% of the global population resided in cities. By 2030, this is projected to be almost 60% and almost 70% by 2050. From a climate change impacts perspective this means that the densification of populations will see more people exposed to singular extreme events, dwindling supplies of broad acre land and competing interests for land. Cities are the heart of economies and calls for technical adaptation options (e.g. sea walls) and planned retreat to protect economic activity will need to be managed with competing expectations of protecting scenic amenity (e.g. maintaining natural beachfronts), natural values (e.g. wildlife corridors) resource extraction (e.g. coal seam gas) and food security (e.g. good quality agricultural land).

As cities expand so to do the risks associated with an increase in impervious surfaces. These include urban heat island risk and localised flooding. The opposite can also be true as shown by the International Federation of Red Cross and Red Crescent Societies (2010) who argue 'when it comes to the impact of natural disasters, well-run cities can be among the safest places on earth (p.8)'.

Australian perspective

Given Australia's prevalence of coastal settlements, it should come as no surprise that much of the climate-related discussions (and regulatory responses) in the property and real estate sector centre around sea level rise. According to the Australian Government, 274,000 Australian homes are currently at risk from a 1.1 m increase in sea level and a 1 in 100-year event. The value of commercial properties exposed to the same risk Australia-wide is in excess of \$81 billion ([Figure 14](#)).

Although some in the property sector call for homogenous land use planning thresholds for sea level rise there is no uniform rate of rise occurring. In fact, quite considerable disparities exist ([Table 3](#)).



Figure 14: Summary of Australian Property and Coastal Risks (image D Burton from DCCEE 2011 data)

Table 3: Tidal gauge measures of annual sea level rise 1993–2011 for selected coastal major cities (Department of Infrastructure and Transport 2012, p.153)

City	Sea level rise (mm)	Total average change (mm)
Perth	9–10	162–180
Darwin	8–9	144–162
Adelaide, Townsville	4–5	72–90
Hobart, Wollongong	3–4	54–72
Melbourne	1–2	18–36

However, Australian properties are exposed to a broad range of climate-related hazards, not just sea level rise. For example, over 9% of residential dwellings (750,000 homes) are located within 200 m of significant bushland (Chen and McAneney 2010) and a broad array of weather-related catastrophes has resulted in large insurance costs (see [Figure 15](#)).

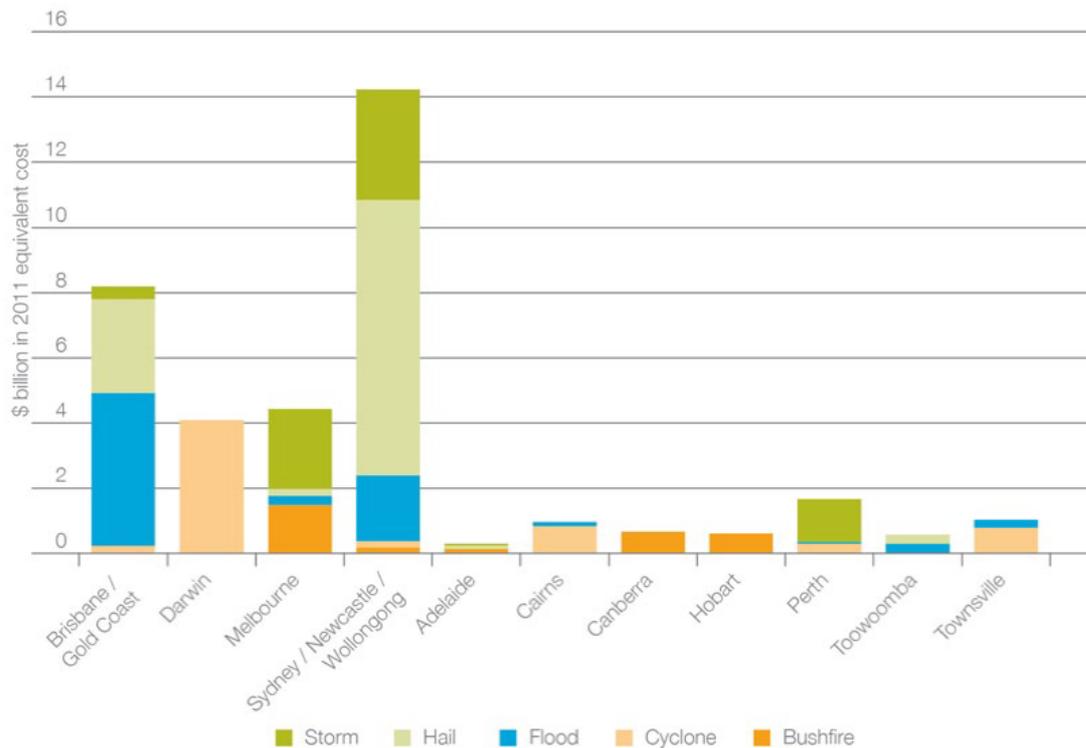


Figure 15: Insured costs (payments) of severe weather events in selected major cities 1967–2011 (Department of Infrastructure and Transport 2012, p.155)

The opportunities for the property sector will form over time in line with market demand and insurance pricing, as is described below:

... it is quite easy to see opportunities arising for those in the property sector. The combination of more extreme events, higher insurance, new regulation etc. will ultimately see a market shift in an increased demand for climate-resilient communities. If it can be argued (and that shouldn't be too difficult) that a climate-resilient property is more likely to get affordable insurance than a neighbouring exposed one in the near future, then it would be fair to assume that market forces will do the rest. (Burton 2012b)

Opportunities like the above are already emerging. For example the Green Building Council of Australia (GBCA) has rolled out its Resilient Communities report in 2012 and the property development giant Lend Lease is committing to building development where they have stated they will have "resilience plans in place for all our projects and assets that respond to anticipated extreme weather events and long term climate change impacts" (Lend Lease 2012).

Recommended research

- Investigate 'willingness to pay' for resilient properties (to support market shift and developer buy-in).
- Identify areas for future development and issues like transferrable development rights, should planned retreat become a serious component in Australian adaptation.
- Evaluate climate change education in the design, construction and property funds management sectors.

- Explore collaborative knowledge sharing in resilient design, construction and whole of life insurance products.
- Explore legal liabilities and other trade-offs associated with autonomous adaptation (e.g. homeowner built sea walls).
- Explore Government property investment policies to drive new standards and market behaviour.

Electricity sector

A well-adapted electricity sector is critical to a functioning economy. The electricity network is interconnected with the climate. In some cases, it uses the climate directly as a source for energy (e.g. photovoltaic and wind) and in others it draws on the climate-sensitive natural resources for cooling (e.g. nuclear). Electricity demand is inextricably linked to the climate – with peak demands associated with extreme hot and cold temperatures. Therefore, any changes to the climate will affect electricity generation and distribution.

The broad range of electricity generation is vulnerable to the impacts of extreme weather and climate change, although some are more vulnerable than others are. For example, photovoltaic technologies have a limited exposure to changes in temperature and wind speed whereas the fossil fuel-based technologies are exposed to changes in air temperature, water temperature, water availability, floods, heat waves and storms ([Figure 16](#)).

Technology	Δ Air Temp	Δ Water Temp	Δ Water Availability	Δ Wind Speed	Δ Sea Level	Floods	Heat Waves	Storms
Coal	1	2	1-3	-	-	3	1	-
Oil	1	2	1-3	-	-	3	1	1
Natural gas	1	2	1-3	-	-	3	1	1
Nuclear	1	2	1-3	-	2a	3	1	-
Hydropower	-	-	1-3	-	-	3	-	1
Wind	-	-	-	1-3	3a	1	-	1-3
Photovoltaic	1	-	-	1	-	1	1	1
CSP/Solar tracking	-	-	2	2	-	1	1	2
Biomass/Biofuel	1	2	2	-	3a	3	1	-
Geothermal	-	1	-	-	-	1	-	-
Ocean	-	1	-	-	1	N/A	-	3
T&D grids	3	-	-	1	3a	1-2	1	2-3
End use	2	-	-	-	-	-	3	-

CSP = concentrating solar power, Δ = change in, T&D = transmission and distribution

^a Higher severity in coastal or low-lying areas.

Notes: 3 = severe impact, 2 = medium impact, 1 = limited impact – = no significant impact, N/A = not applicable

Figure 16: Climate change risks by generation technology (ADB 2012)

Australian perspective

Although the proportion of off-grid and distributed energy generation is growing the majority of Australia's electricity comes from a centralised model. Of this, a large proportion comes from fossil fuel technologies (coal and gas) ([Figure 17](#)). As was shown in the previous figure, these technologies are vulnerable to the effects of extreme weather and climate change. Almost 65% of Australia's electricity generation relies on fresh water for cooling, with the

non-hydroelectric generators consuming 271 GL of water in 2004-2005 for this purpose (Smart and Aspinal 2009).

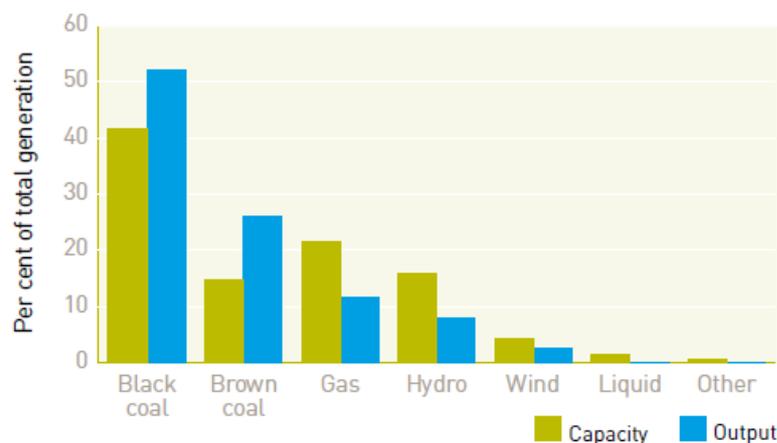


Figure 17: Registered generation in National Electricity Market, by fuel source, 2011 (AER 2012, p.27)

As coal is the dominant provider of Australia’s base load the critical challenges come from extreme weather impacts on mines and resource transport, increased demand combined with decrease availability of water for cooling, and impacts associated from extreme temperatures (see NCCARF 2012).

As temperatures increase and the extent and number of extreme temperature days increase (as is expected throughout Australia), electricity demand increases (due to domestic air conditioner use). Higher temperatures also reduce the efficiency of electricity generation and the thermal stress places considerable stress on transformers, circuit breakers and cause line sagging (and subsequent outages). For the private sector, the main risks arise from load shedding (deliberate switching off electricity) or blackouts (e.g. circuit breaker triggers). The 2009 heatwave in Victoria (and subsequent electricity outages) is estimated to have caused \$800 million in economic loss (Queensland University of Technology 2010).

According to the Climate Institute, the Australian Electricity sector is “underprepared” for the anticipated climate change-related challenges (Climate Institute 2012b).

Box 5: New Energy Sources, New Risks

If Australia is to significantly reduce its greenhouse gas emissions it will need to shift away from fossil fuel intensive generation and into alternative sources and/or explore carbon capture and storage. This shift introduces new risks for energy supply and distribution from emerging energy technologies. For example, increased Solar PV uptake, combined with increased heat days may lead to an increase in the risk of local system failure. This is because the house-based Solar PV generation to feed back into the grid requires increased voltage. Street transmission lines were originally designed to feed energy into houses – not from them. Too many Solar PV systems feeding in a street can close a system. In Australia rooftop solar PV is estimated to generate 15,000 GWH by 2031 (AEMO 2012).

Recommended research

- Undertake a detailed climate change risk assessment of the Australian energy sector, including transmission, distribution and generation.
- Explore the opportunities associated with “island mode” energy supply for high risk localities (e.g. solar P.V. systems for at risk communities / business centres).

Information communication technology

According to the ITU, as of 2011, there are approximately 6 billion mobile phone subscriptions in the world and a third of the World’s population was connected to the Internet (ITU 2012). The global economy is becoming more and more IT dependent and the network economy is emerging:

Looking across today’s global networked society, one of the most notable differences is the manner in which value is created. While industrial economies are based on controlling the supply of scarce resources, networked economies create value by abundantly connecting individuals, functions and endpoints. As each new person and device is connected to a network its collective value grows exponentially. (World Economic Forum 2009)

As well as the transformative opportunities described above, the network economy is also threatened by the impacts of climate change. The rapid growth of the network economy is likely to be outpacing assessments of climate change risks. If we are not sure how the network economy and “big data” will emerge in the coming years, how can we assess the future climate-related impacts?

The Achilles heel of the ICT network is reliable energy and this is where the majority of the sector’s climate change risks are likely to emerge. Other issues also include location of infrastructure (e.g. sea level rise and broadband cabling), extreme weather risks to data storage centres (e.g. flood and cyclone risk), reduced quality of wireless signals from increased rainfall and temperature, workforce availability and stability, and increased energy needs for databank cooling during extreme temperature days (Horrocks et al 2010; Wong and Schuchard 2011).

Australian perspective

The Australian ICT industry represents almost 8% of Australia’s GDP (ACS 2011) and supports much of the nation’s economy. According to the ABS (2010) over \$81 billion of orders were placed on the web during 2009. The Internet is entrenched in the Australian lifestyle and economy with approximately 12 million internet subscribers and almost 10 million mobile phone subscribers being registered in 2012 (ABS 2012).

Extreme weather poses a considerable risk to the Australian ICT network. As mobile phone communication towers are often located in isolated areas, they are exposed to bushfire and cyclone risks. For example Cyclone Yasi affected 680 Telstra and 87 Optus cell towers (from loss of power) (Gooch et al 2012). There is a dearth of publically available information about climate risks and the Australian ICT sector.

Box 6: Hurricane Sandy and the ICT Network

At present, there is a strange conflict between the amazing ability of information communication technology (ICT) systems to help communicate warnings, direct emergency response and facilitate post-disaster recovery against the backdrop of the fragility of these systems to extreme weather events. Hurricane Sandy brought out the best and the worst of information communication. Twitter and other social media sites allowed those affected to share stories with friends, loved ones and voyeurs alike. Post event it has helped inform residents about anything from food drops and accommodation through to road closures and public transport route changes. However, social media only works if there is a functioning ICT and electricity network. At its peak over 8 million customers in New York lost power, 25% of cell towers were affected and data centres were disabled, affecting internet services around the globe.

If the lessons from Hurricane Sandy are to mean anything, those with established reputations and feedback on certain web sites are likely to have a higher adaptive capacity (at least for accommodation). For example those that had established Airbnb reputations were in a stronger position to gain accommodation as their public web-based reputation and feedback is already available (<https://www.airbnb.com> 2012).

(Excerpt with permission from Burton 2012a)

Box 7: Telstra managing extreme weather risks

Telstra has recognised that as it mainly self-insures, it considers being resilient as an important part of business (Mallon et al 2009).

- Ready: Prepare our people, customers, infrastructure and business.
- Respond: Determine the impact on our people, customers' infrastructure and businesses.
- Restore: Prioritise the restoration of service in co-ordination with emergency service organisations.
- Repair: Develop solutions that restore services as quickly as possible to isolated communities – this may involve temporary fixes.
- Reconstruct: Work to permanently repair or rebuild infrastructure damaged by the event.

According to the organisation, every two years Telstra Operation's Emergency Services Liaison Officers (ESLOs) come together to ensure our disaster response processes and policies are in synch with emergency agencies (Telstra 2012).

Recommended research

- Identify climate change risks and opportunities for the Australian ICT sector.
- Review mobile and fixed network resilience and redundancy.
- Explore case studies of extreme events and lessons learned.
- Identify international 'choke points' that could affect the Australian ICT networks.

Water

According to Hanjra and colleagues (2010), a global water crisis is looming. The combination of rapid urban population growth and climate change presents a phenomenal challenge to the water industry and all those who rely on the industry's services. The ripples of climate change are also likely to be felt through the private sector from the natural environment's response to changing water regimes (e.g. impacting agribusiness and tourism).

By 2025, it is estimated that approximately 3 billion people will live in areas under water stress or water scarcity (Hanjra et al 2010). Considerable uncertainty exists about the extent of rainfall patterns, distribution and intensity under a changing climate. A range of climate change-related variables are likely to affect the water sector, these include:

- changes to average annual and seasonal temperatures;
- increased extreme heat events (and new maximum temperatures);
- decreased average seasonal and annual rainfall;
- increased intensity of extreme storms;
- changes to rainfall patterns;
- sea level rise;
- increase intensity and frequency of extreme storm surges;
- changes in the Atmospheric River event frequency; and
- changes nature and timing of climate drivers (e.g. ENSO).

As well as the direct impacts from the above climate variables, the water sector's infrastructure (e.g. pipelines, pumps, treatment works, access roads etc.) may also be exposed and vulnerable to the physical impacts of climate change. For example, decreased soil moisture may lead to pipe shifting (resulting in increased leak risk) and increased rainfall may see pump stations flooded (Defra 2012).

Australian perspective

Australia has considerable rainfall variability, which has made managing water security a challenging issue. For some locations, like the south west of Western Australia there has been a considerable step change in water availability. As shown by NCCARF (2013) "the average flow rate into Perth's dams has declined steeply: the 2006-2010 average was 57.7 GL/year compared to an average of 177 GL/year for the period 1975-2010" (Figure 18). It is anticipated that climate change will reduce rainfall in the region by 8-33% by 2050 (NCCARF 2013).

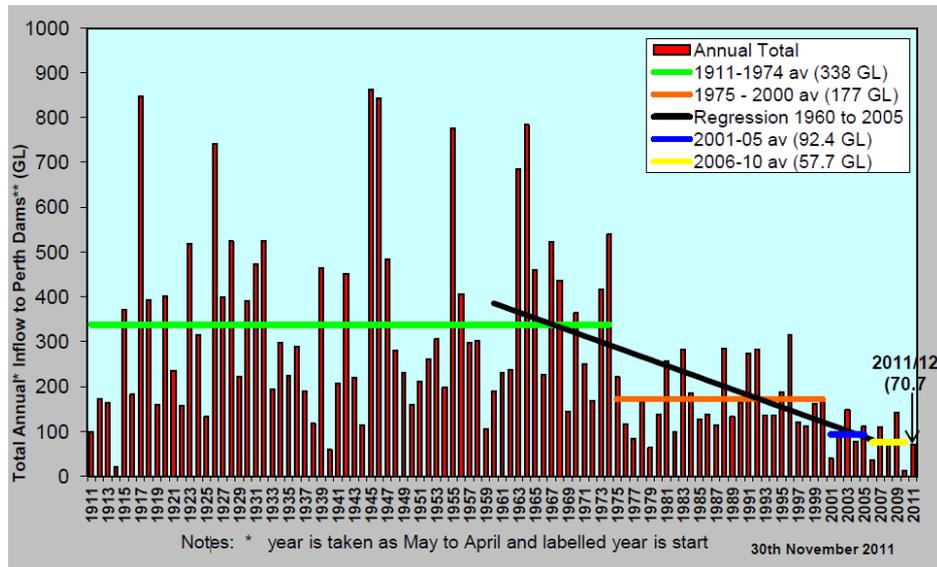


Figure 18: Step change in water availability in Perth 1911-2011 (WSAA 2012)

Water management is a contentious issue that has a high degree of political risk. For example, dams often come with environmental trade-offs and desalination plants are costly and can have a large energy footprint. Although a recent report by the Climate Institute (2012) stated that the Australian Water sector is in the relatively advanced stages of adaptation preparation, water security is still a critical issue. As is aptly put by AWA/Deloitte 'having enough water on average is no use if you've got a month without it' (2012, p.5) .

A recent survey of those involved in the water sector identified climate change as an issue:

"... there is concern that climate change will have a significant impact on the sector, and that the sector will need to innovate constantly to ensure that it is as efficient as possible to survive in an increasingly competitive and uncertain future" AWA / Deloitte (2012, p.53).

PART 4: COMPANY DIRECTOR'S CLIMATE ADAPTATION CHECKLIST

“As climate changes so too will risk” (Willows and Connell 2003)

This checklist is designed to help company directors start to understand how climate change affects them, their company and the market so that they can begin to better respond to risk and opportunities that emerge. Decisions made at the board level carry strategic, operational and legal weight so consideration of climate risks needs to be considered alongside other risks.

The checklist is not a complete guide but should serve as an aid in supporting better adaptation decision-making. Additional technical specialist support may be necessary remembering that existing company processes and procedures may also support your decisions. Decision makers need to consider a range of factors when forming a view, including, but not limited to, uncertainty, limits of data and models, over and under confidence levels, strategy, personal liabilities and legal requirements.

More detailed information, more complex frameworks and additional tools may be available within your organisation or from your industry peak bodies, local, state and Commonwealth agencies, academic institutions and consultants, but this information may need to be assessed, as it may be unreliable, inaccurate, incomplete or immaterial to the particular circumstances.

As climate change develops, new responses are likely to emerge. A director will benefit from a regular watching brief to maintain currency, build on knowledge and contribute to new learning.

Key questions to stimulate thinking are present below and grouped as follows:

- Director and board responsibilities;
- Company strategy and operations;
- Competitor, industry and sector-specific issues; and
- Market, regulatory and reputational issues.

Director and board responsibilities

Within some boards, directors may have specific responsibilities based on their skill, experience, qualifications, connections or roles. Some of these may have explicit duties and responsibilities but many will be implicit. Few companies have yet to identify climate adaptation and formalize responsibilities. Those that have identified climate change risk may elevate ultimate responsibility to the Chair, Chief Executive Officer or Head of Risk Committee. We suggest that a better practice may be to educate directors, develop operational capabilities and to review strategy and practices on a regular basis. Some companies have integrated responsibility with Chief Risk Officer roles while other distribute it across all functions.

QUESTIONS

1. How does climate change affect my director's role and responsibilities?
2. Do I understand, and have I quantified, my climate legal risk?
3. Who is responsible on my board for climate adaptation? Is this responsibility explicit, implicit or assumed?
4. How often do they report in detail on climate change adaptation?
5. How does the board respond? How are other boards responding?
6. Are the reports material, accurate and complete?
7. How is the business responding to these reports? Is action ongoing, planned or reactionary?
8. Does the responsible entity possess the required authority, agency and resources to understand climate influenced risks and opportunities?
9. How can we better understand our exposure, sensitivities and capabilities in managing climate risks and opportunities?
10. What additional support, information or resources are necessary?
11. What practices are others doing that we could mimic, adopt or adapt for our use?
12. How does our group culture constrain/enable our actions on adaptation?
13. How could reporting be improved? Is quarterly reporting adequate?
14. Are we meeting our legislative and regulatory obligations?

Company strategy and operations

Company strategy, often owned and driven by the Chairperson and CEO, may not currently consider the implications of climate change impacts on company operations, supply chain, market, competitors or regulators.

QUESTIONS

1. How is our strategy sensitive to climate change?
2. As issues emerge, how do we strategically respond?
3. What are our anticipatory planning horizons? Are these too short, too long or adequate when considering climate change?
4. Where does climate change fit with these?
5. With gaps in data, temporal and spatial differences, model uncertainties, reporting timetables, visibility constraints etc. how resilient are our assumptions? How can they be improved?
6. What are senior manager capabilities in responding to climate change?
7. Are their beliefs a constraint on action? Who are the champions? Who are the barriers/resistors ?
8. Are senior managers adequately trained or educated in climate change adaptation?
9. Do management policies reflect board positions? Which enable action and which can be improved?
10. What climate adaptation related information is unreported or missed?
11. Are KPIs, financial and promotional incentives constraining action or creating perverse activities?
12. Have we alternative suppliers/markets?
13. What substitution or replacement options do we have?
14. Can we re-write contracts to reduce risk and liabilities?
15. What training, systems and procedures can reduce our vulnerabilities?

Competitor, industry and sector-specific issues

Many peak bodies, industry or sectoral groups are yet to respond to climate adaptation in a meaningful way. Some have confused political beliefs and lobbying with good risk management principles and many are unrepresentative of progressive members' interests, often favouring the status quo. Examples include property industry lobbying against coastal protection measures that serve small narrow minority interests rather than broader interests. These actions generate their own risks and potential liabilities. Director education is also very limited with no formal education of climate change risks currently taught in Australian business schools. Monocultural learning may also be a risk in an increasingly complex and interconnected environment. It is therefore important for directors to look beyond their current often limited and short-term focus to look at competitor action and inaction, assess contiguous markets and learn from others.

QUESTIONS

1. How are our top competitors responding to climate change adaptation?
2. Are there overseas exemplars (good and bad) that can help us teach or from which we can learn?
3. What are professional bodies, institutes and peak bodies doing about adaptation?
4. Why are they acting in this way?
5. Are there benefits in acting beyond these positions? Does association cost our company reputation or create other risks?
6. What are emergent policy positions and what is government thinking?
7. What does a change of government mean for climate policies? Does this lessen or increase risks?
8. Thinking about new market entrants – are they doing things very differently?
9. What lessons can we learn from more climate-exposed sectors?
10. Where do learning, ideas and information sources sit?

Market, regulatory and reputational issues

Market shift associated with climate change impacts can be both a risk and an opportunity. Those who are better prepared to capitalise on adverse conditions will be well placed to increase their market exposure whilst competitors play post-disaster catch up. Regulatory change is likely, although the timing may be uncertain. Climate impacts can also affect the reputational risks of an organisation, especially those associated with environmental damage.

QUESTIONS

1. How might adaptation look in 5, 10, 15 years? Where does our strategy fit with these scenarios?
2. Where tensions are emerging and how is the floor divided?
3. Are there benefits in securing resources, people, knowledge and information that can be used to give a strategic advantage?
4. What are local, national and overseas regulators considering?
5. What are we currently disclosing? Do we need to improve disclosure through better reporting, would we disclose more or should we keep all activities company confidential?
6. Are industry inactions generating future liabilities for our company?
7. Are we tarred with same brush as others?
8. What does a leadership position look like? Who can help us achieve this?
9. Are climate shocks going to cost us market presence?
10. Can we create value from a well-adapted strategy?
11. What tools currently exist to help your organisation manage the effects of climate change?

“While the worst of the Thai floods has passed the disaster’s economic impact is becoming clearer. The central bank slashed economic growth expectations to 2.6 percent. An estimated 1,000 factories are submerged in a quagmire the size of Australia’s island state, Tasmania, or otherwise shut down due to supply-chain shortages, labour absences, transport roadblocks or other flood-related factors. Approximately 20,000 businesses and 780,000 jobs within Thailand are said to be affected. And there are many top-tier multinationals among them.” (Thailand’s floods: a message for regional business Mark Carroll, Australian-Thai Chamber of Commerce Feb 2012)

CONCLUSION AND WHAT'S NEXT?

The intention of this report is to stimulate discussion in the private sector and act as a catalyst for change. There are various frameworks that help organisations map climate change adaptation pathways. Some suggested reading on climate change adaptation is listed at the end of this chapter. There is no panacea for managing climate change risks but common themes emphasise that it is a dynamic process that will need to be evaluated at regular intervals. Businesses will need to place a climate change and extreme weather lens over the following themes:

- assets – impacts on premises, building design, construction, maintenance and facilities management;
- logistics – vulnerability of supply chain, utilities and transport arrangements;
- people – implications for workforce customers and changing lifestyles;
- process – impacts on production processes and service delivery;
- markets – changing demand for goods and services; and
- finance – insurance costs, availability and cost of finance, and investor pressure.
(Defra 2012)

Although a large list of climate change-related challenges are presented in this report, perhaps the most important finding is that, in general, there is a dearth of available research that explores the broad suite of emerging risks facing Australian organisations. Some of the recent NCCARF publications have touched on relevant issues but much more research is required, especially exploring the confluence of multiple sector vulnerabilities.

Regardless of Australian infrastructure readiness, many nationally-based companies are likely to be affected by the global disruptions to their supply chain as globalisation extends its footprint into developing areas with poor infrastructure resilience (think Bangkok floods).

This project has identified that considerable research gaps exist, but has also provided direction for organisations and researchers. Individual corporations and private sector peak bodies urgently need to explore the risks and opportunities that climate change and associated responses bring. This is especially so for the ICT, aviation, energy, insurance and finance sectors.

Suggested reading

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