INVESTING THROUGH AN ADAPTATION LENS

A PRACTICAL GUIDE FOR INVESTORS

Investor Group on Climate Change

NCCARF
National Climate Change Adaptation Research Facility

Australian National University

This report was authored by:

Dr David Rissik, NCCARF, Griffith University and Dr Michael H Smith, ANU

About the National Climate Change Adaptation Research Facility (NCCARF)

NCCARF works to support decision makers throughout Australia as they prepare for and manage the risks of climate change and sea-level rise. NCCARF is currently working on a three year program (2014-17) which focuses on the adaptation needs of decision makers and practitioners, especially in the coastal zone, as they deal with projected impacts such as more frequent and more intense heatwaves, increasing risk of flooding from rivers and the sea, and increasing coastal erosion. Based at Griffith University on the Gold Coast, NCCARF works across Australia to build resilience to climate change in government, NGOs and the private sector.

For more information on their aims and activities, visit **www.nccarf.edu.au** or contact **nccarf@griffith.edu.au**

About the Investor Group on Climate Change (IGCC)

IGCC is a collaboration of 61 Australian and New Zealand institutional investors and advisors, managing over $1 trillion and focusing on the impact that climate change has on the financial value of investments. The IGCC aims to encourage government policies and investment practices that address the risks and opportunities of climate change, for the ultimate benefit of superannuants and unit holders.

Visit **www.igcc.org.au** or contact **secretariat@igcc.org.au**

ACKNOWLEDGMENTS

IGCC would like to thank Dr David Rissik and Dr Michael Smith for compiling feedback from the IGCC *Investing through an adaptation lens* workshop and authoring this guide.

A special thanks to Mara Bun for facilitating the workshop on August 26th 2015, and to all of the workshop participants, whose thinking is reflected in this guidance note.

Thank you also to Crystal Fleming from IGCC for assistance in compiling this guide, and the members of the IGCC Research Committee for assistance in reviewing drafts.

CONTENTS

ABOUT THIS GUIDE

In August 2015, the Investor Group on Climate Change (IGCC) bought together investors, scientists and industry leaders to examine the investment implications of adapting to climate change. The workshop looked at emerging best practice across different industry sectors, liability and governance issues, and practical case studies from leading investors and companies to better understand the opportunities and the challenges. The outcome is this guide, which aims to capture investor feedback from the discussion and provide practical insights on how investors can and should be investing through an adaptation lens.

The guide has been structured as a snapshot of the key implications of climate change identified by workshop participants across a range of industry sectors, and the questions investors should ask to better identify and mitigate key risks.

Many of the issues identified were common across industry sectors, however investors in different asset classes will have varying time horizons, risk tolerances, degrees of control over companies' decisions and capacity to assess risks. This guide is aimed for investors with medium to long term horizons, but includes top-line questions that equity investors can also apply, particularly in their corporate engagement.

The guide also concentrates on asset classes where the risks are most material and where investors can have the most influence. It includes factsheets with key risks, interdependencies and opportunities, along with key investor questions for Direct Property and Direct Infrastructure, as well as high level risk considerations for Equity Investors in identified sectors.

Finally, workshop participants were asked to identify what information and tools investors need, in order to actively consider climate adaptation in their investment decisions. This guide provides an overview of information needed by investors and an indication of available tools and further guidance which can be used to support those needs.

The workshop and the resulting guide forms part of an ongoing process for IGCC and we will be further investigating some of the key questions that came out of the workshop to help investors better assess and manage climate risk. A more detailed report is available at **www.igcc.org.au**

Understanding climate adaptation for investors

Decisions and actions which are undertaken to prepare for the adverse consequences of climate change, as well as to harness any beneficial opportunities are known as climate change adaptation.

Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change above 4 degrees celsius.

Understanding vulnerability to different climate scenarios, interdependencies and capital plans is critical for effective adaptation planning.

Understanding interdependencies

One of the key workshop findings was the need to understand interdependencies. Interdependencies are the reliance between different sectors or concerns in terms of their impact from climate change, or in their response to it. For instance an asset may itself be well-adapted to withstand climatic impacts, however its supply chain may not.

Interdependencies can relate to built, community and natural factors, such as transport infrastructure, electricity grids and the effects of neighboring properties and communities.

Understanding interdependencies helps to understand the full risk associated with the asset including what strategies may be developed to reduce exposure and to ensure existing disaster recovery plans are adequate.

Finding the "sweet spot"

As this guidance document shows, numerous areas of climate change adaptation investment have: good returns on investment; significant climate change mitigation co-benefits; and, can contribute to reducing insurance premiums of companies that further helps the bottom line. These opportunities are increasingly being seen as the new sweet spot for climate change investment. This was highlighted at the workshop by experts from Mercer, ANU and Griffith University, and is evidenced further in this guidance document. Tables 1-4 in Appendix 1 highlight numerous adaptation/mitigation nexus investment opportunities across major asset classes and sectors.

Background

Climate change is occurring and is likely to have a significant effect on businesses, infrastructure and supply chains across the globe. Effects may be detrimental, but can also result in opportunities. Understanding potential changes to the exposure of investments, and to the way in which assets and businesses can be managed to reduce exposure, is key.

Australia has a highly variable climate, which already causes challenges for investors through droughts, heatwaves, floods, cyclones and intense storms. Climate change will increase the occurrence and severity of heatwaves and bushfires throughout the country. There will be major changes to rainfall in many parts of Australia with more extreme droughts and floods. Sea level is projected to rise by 0.8 metres by 2100 (Church et al. 2011[1]).

[1] Church, J.A., J.M. Gregory, N.J. White, S.M. Platten, and J.X. Mitrovica (2011) Understanding and projecting sea level change. Oceanography 24(2): 130 –143

Questions for all investors

Investors and stakeholders in the workshop identified several questions that should be asked across all industry sectors when undertaking due diligence. These questions relate to the vulnerability to climate change of the asset or organisation being considered for investment, or to the way in which an asset is being managed to reduce its exposure to a changing climate.

Key questions across all industry sectors

Climate change risk assessment:

- Have you assessed whether climate change will affect the asset being considered, and what risks and opportunities do you see?
- How detailed a climate risk assessment has been carried out?
- Has the asset been impacted by past climatic events, and what is your expectation about its exposure to future climate impacts?
- What data and information was used to carry out the assessment?
- What is the strategy or plan for responding to identified risks and increasing resilience?

Interdependencies and risks of maladaptation:

- Does the plan include consideration of interdependencies and the risks of maladapted outcomes (unintended consequences)?
- What is vulnerability of the business to climate effects on other assets that are linked to the performance of the asset being considered? eg supply chain

Capital requirements, cost benefit analysis:

- Has there been an assessment of the cap-ex and op-ex requirements to adapt to climate effects, and does it increase or decrease over time?
- How material are they?
- Has a cost benefit analysis been done?

Others:

- What are the specific risks to your industry sector? (see below for further industry related questions)

Further considerations for direct investors

For direct investors it is important to know details associated with any risk assessments that have been done and to be able to make sense of technical information underpinning climate related risk assessments. Factors of importance include an understanding of the time horizon of planning and the climate change scenarios that have been used.

It is useful for investors to know how to conduct simple vulnerability assessments to enable them to undertake or drive and manage appropriate risk assessments during their due diligence activities. In many cases these are conducted by consultants, but it is important to know what questions to ask in determining a consultant brief, and in assessing the quality of any work that is presented.

Understanding the exposure and vulnerability of the asset/business to past, current and future climate, with sufficient granularity, is particularly important for longer-term investments and future liabilities.

Using high level "country" scale data for instance can result in inaccuracies at finer scales. It is also important that climate risk is considered for every aspect of the organisation's business (local or international), and not just for a small number of high profile assets.

The results of risk analyses and associated management plans are important for investors to be able to develop effective advice for their organisations and shareholders about direct climate associated risks and any interdependencies.

Climate adaptation opportunity costs and benefits

Effective adaptation to climate risks can have tremendous benefits for organisations, but are often considered to be costly to implement. It is important to have a comprehensive understanding of the benefits and opportunities as well as the costs of ensuring greater resilience of the asset to current climate variability and the longer-term risks of climate change as well as the time frames at which expenditure may be required.

Investors should expect ASX300 companies which they invest in (or are currently assessing with a view to potentially invest), to have developed climate change adaptation strategies. This is because in many business sectors and asset classes there are:

- Material risks compounded by interdependencies from climate change, principally through more intense extreme weather events, that can harm the productivity, cash flow and share price of companies
- No-regret productivity enhancing adaptation opportunities which reduce companies' risk of negative impacts, from these same intense extreme weather events
- Opportunities to easily include adaptation enhancing design improvements as part of all new major property, infrastructure and resource projects (eg: new open cut mines could easily use overburden to reduce potential for flooding)
- Opportunities for adaptation measures to improve climate change mitigation and vis-a-versa.
- Opportunities for companies to take advantage of government supported adaptation programs (eg: The National Water Initiative which provides $2.9 Billion in new water efficient irrigation infrastructure to irrigators and agribusiness)
- Opportunities for companies to reduce their insurance premiums through undertaking adaptation measures.
- Opportunities for companies to gain competitive advantage, identify new products and build equity in their assets.

Adaptation and mitigation co-benefits

According to the IPCC 5th Assessment, investment in climate change adaptation has not yet been pursued at scale by the Australian business community. To date, investment in adaptation has been sub-optimal partly because some investors and business decision makers have seen action on climate change adaptation as a significant cost, rather than as a worthwhile profitable area of investment with good returns.

The prevalence of this belief has prevented some investors asking the right questions of company CEOs and boards and held back investment in adaptation as a whole. Any significant investment in new property, infrastructure, resource or manufacturing project should be reviewed through a combined climate change adaptation and mitigation lens to reduce long-term risk exposure and maximise profit enhancing opportunities. Examples of climate change adaptation opportunities which have reasonable returns on investment; climate change mitigation co-benefits; and can potentially help reduce company insurance premiums include:

- Reducing company exposure to increased peak demand electricity costs due to higher demand during summer heat waves by investing in improved company energy efficiency and onsite solar PV
- Reducing exposure of staff or tenants to risks of heat stress through:
  - Improving energy efficiency of property portfolios through profitable energy efficient "green building" new builds and retrofits (ie better insulation/draft proofing of building envelop, use of white "cool" roofs)
  - Use of more efficient, productive and better insulated, industrial, light industrial, and service sector equipment (ie furnaces, ovens, kilns, motor driven systems, cooking equipment, commercial washing machines)
- Reducing company exposure to risks from drought related water restrictions and greater competition for water resources through investing in improving water efficiency.
- Reducing vulnerability to supply chain disruption through diversifying supply chains and sourcing more resource inputs from recycled sources.
- Reducing risks of damage and loss of operation from extreme weather events to property, infrastructure and resource asset classes.
- Reducing risks of drought/heat stress negatively impacting farm productivity/asset values and the supply of agricultural ingredients to Australian manufacturers – through investing in more resilient farming practices.

The factsheets below provide an overview of climate related risks in key investment classes, and opportunities for each sector that are related to climate change effects. Tables 1-4 in Appendix 1 of the full report include more detail on the direct effects of climate change and interdependencies for each sector. These tables also include a succinct overview of cost effective adaptation opportunities for different asset classes and business sectors which have climate change mitigation co-benefits, highlighting the value of investors in encouraging investments in measures that can simultaneously realise adaptation and mitigation co-benefits and thereby reduce the risk of adaptation investments increasing greenhouse gas emissions.

Note that the tables are not comprehensive, and additional consideration is required for each specific sector and importantly for each investment decision.

CLIMATE CHANGE ADAPTATION - DIRECT PROPERTY INVESTMENTS

Introduction

The property sector is a capital intensive sector with long-life fixed assets and many supply chain and water requirements to enable operations. The property sector in Australia has always been vulnerable to asset damage and loss of operations due to extreme weather events such as cyclones, hailstorms, and flooding.

In addition, an estimated $159 billion worth of Australian buildings are vulnerable to sea level rise and storm surge. This includes more than 8,000 commercial, 6,000 industrial and 274,000 residential buildings around the country. In cases where losses could be attributed to insufficient planning, lawsuits could be brought with potential for financial and reputational losses.

The probability of these risks occurring and negatively impacting on the cash flows of property companies will continue to increase with climate change over the coming decades. Not only can climate change negatively reduce the value of property portfolios, it could also result in investors holding stranded assets through investing in companies that hold significant property portfolios in high risk regions of Australia vulnerable to sea level rise, flooding and bushfires.

When considering investment into a company holding a substantial portfolio of assets, investors need to know whether the organisation has considered the potential for stranded assets in their portfolio in the short, medium and long term, and how their stranded asset analysis is handled.

Consideration needs to be made as to whether all assets in a company's portfolio are handled in a similar way, or whether proper climate change assessment and adaptation focussed on "hero projects" only.

Understanding climate adaptation for property investments

Examples of adaptation are developing a shopping centre with additional insulation to ensure it can be cooled effectively during periods of extreme heat or installing additional storm water management systems to reduce damage to property.

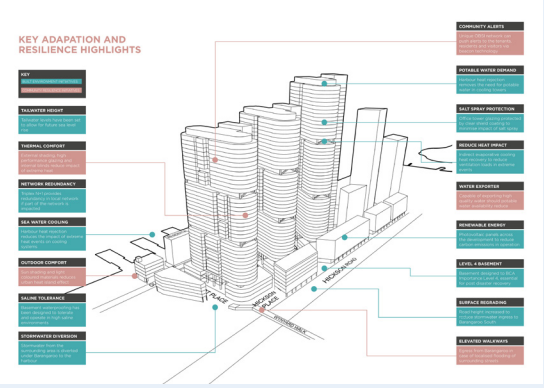
Understanding interdependencies

For example, an office building facility may be impacted directly by climate change. However, its ability to operate in a future climate will also depend on factors outside of its control, such as transportation and electricity infrastructure.

Key questions for property investors

- Is there a climate related plan containing adaptation and mitigation strategies for the organisation/asset?
- What stakeholder engagement that has been undertaken in developing and implmenting the strategy?
  - Is this strategy properly resourced and being implemented?
  - Does the strategy consider resource dependence to maintain assets?
  - Are there business continuity plans for the asset/business or investment that include a climate component?
  - Has the organisation considered the potential for stranded assets on their portfolio?
  - How is their stranded asset analysis handled?
- Is the insurance cover of the asset adequate for potential impacts from present and future climate driven events?
- Is climate change considered in the company's strategic plan and is it reported in company reports?

Best Practice Case Study



Lendlease's Barangaroo South Development

Barangaroo South is one of the world's largest waterfront urban renewal projects and will be a significant extension of Sydney's CBD. The development includes sustainable commercial office space, residential apartments, a hotel, shops, cafes, restaurants, public open space and cultural facilities. Once completed, it is expected that there will be 23,000 office workers and 33,000 visitors moving in and out of the area each day.

Climate Risk

The site developers (Lendlease) are acutely aware of the potential influence of climate variability and climate change, and the need to account for these in the designing and implementing a development that is adapted for a future climate.

Climate related risks for the developers and the community of Barangaroo include:

- Increased temperature
- Changes to rainfall – more intense storms and longer dry periods.
- Sea-level rise
- Severe weather events
- Changing relative humidity.

Eighteen climate related risks were considered for present conditions, climate in 2030 and climate in 2070. Eight extreme and high priority risk scenarios were identified and used to determine adaptation actions to be accounted for in the design and construction of the development, and in ensuring resilience of the users of the development.

Interdependencies

The site is located close to other businesses that could potentially be influenced by the development. The large number of people who will use the site need to be able to access the site and to use if effectively in all conditions. Many businesses and organisations will occupy the sites and require supply chains to be intact. Additionally a large clientele of the banking sector require sustainable premises in order to reflect their values.

Stakeholder Engagement

The significant size of the development has ensured that many stakeholders have been engaged through the development stages. This will continue into implementation when many stakeholders will be continual users of the development. Engagement has focused on reducing any impact of the development on neighbouring properties as well as to identify, design and implement actions that increase the long-term sustainability of the development.

Adaptation actions

An Adaptation Plan for the development was designed and is being implemented during the construction phase. In addition, a Community Resilience Plan was prepared to develop strategies to deal with a variety of non-structural risks, and support the long-term effective use of the development well into the future.

The significant range of adaptation actions include:

- Increasing shade, water availability, planting trees and using high solar reflectance materials to reduce heat impacts
- Upgrading stormwater systems to cope with increased extreme events, including facilitating continual, easy access into and out of the development. Care was taken to reduce any influence on neighbouring buildings as a result of the development
- Including a variety of approaches to reduce water use and ensure potable water supplies throughout long periods of drought
- Preventing any negative consequences which could arise from sea-level rise, including planning for a 0.9 metre sea-level rise factor over and above Sydney Harbour Foreshore Development Control Provisions.

Risks and opportunities identified by investors

For each industry sector, workshop participants were asked to identify the impacts of climate change. Summary examples of these impacts and responses to them for direct property investments are provided below.

For more detail on broader identified risks and forecast change, see the prepared Table 1. in Appendix 1 of the full version of this report. It is important to recognise that climate change effects will vary significantly spatially and temporally and will be dependent on the scale of green house gas emissions. Detailed information specific to your needs will assist decision making.

Examples of risks and interdependencies for direct property investments

Higher average temperatures will increase the occurrence of heatwaves around Australia, including the number of days with temperatures above 35 degrees Celsius. This can effect workforce operations, reduce productivity and increase costs of important considerations such as health care. In the long-term, property assets will require new design elements to ensure they are able to withstand high temperatures without excessive use of electricity. Interdependencies include the ability of workers and customers to access properties during extreme heat which can influence access to public transport, electricity supplies and pedestrian access.

Extreme rainfall events may exacerbate flooding in some regions of Australia. When combined with increased sea-levels and storm surge, there is major risk to properties. If these occur at increased frequency, assets may become uninsurable, tenants may leave and assets could become stranded. Retrofitting adaptation actions may be prohibitively expensive. Interdependencies include ensuring supply chains during flood events, loss of customer base following floods where suburbs may have been impacted, lack of access to businesses during floods influencing business continuity.

Droughts are likely to become more frequent and last longer in certain parts of Australia. This will present challenges with securing water supply, which could have adverse consequences to tenants. Interdependencies include increased electricity costs because of insufficient water for power stations.

Examples of opportunities for direct property investments

Workshop participants identified tools and resources needed by direct property investors to effectively assess climate risks and adaptation options.

Examples include:

- Shopping Centres and other buildings which are able to maintain supply chains and operate in extreme conditions such as heat waves, floods and cyclones, will attract additional clients and customers, thereby generating heightened revenue.
- Buildings reducing water and energy use will attract tenants who are able to make associated savings. They will also be attractive for corporate clients who are looking to support strong corporate sustainability principles.

What information and tools do direct property investors need?

Workshop participants identified tools and resources needed by direct property investors to effectively assess climate risks and adaptation options.

- **Climate Change Forecasts:** to determine how fast and where climate change is highly likely to increase risks to company assets and operations.
- **Check lists:** to prompt investors about what evidence they should be provided to give them confidence that the correct tools and benchmarks are being/have been used in risk management assessments and climate change management plans investors are provided with during any due diligence activities or in management reporting.
- **Reporting templates:** which set out expectations for information investors should be looking for when undertaking due diligence/risk analysis about an investment.
- **A Guidance document:** to take investors through an effective due diligence process which includes assessment of the effects of current and future climate related risk. This document could be used to support management of consultants undertaking any due diligence appraisals, or support in-house assessments. It could also include the abovementioned checklist and template. The document should highlight the need for transparency and should outline the minimum levels of required disclosure.
- **A disclosure dashboard:** Having a number of key indicators that must be reported on would provide certainty, both for investors and managers of assets, about what should be assessed and provided during due diligence. Guidance material can be developed to support the measurement and reporting of the indicators.

CLIMATE CHANGE ADAPTATION - DIRECT INFRASTRUCTURE INVESTMENTS

Introduction

The infrastructure sector has significant exposure to the effects of climate change. Infrastructure includes assets such as sea ports, airports, toll roads, light and heavy rail, and mobile phone towers. Climate variability and climate change has the potential to reduce the ability of these assets to generate revenue, either through direct effects (sea-level rise and port facilities, buckling of train tracks during heat waves), or indirectly such as lost workforce hours during construction as a result of cyclones or heat waves.

Infrastructure generally is associated with long lifespans (typically 40 years for energy and water systems, and as high as 90 years for bridges and 100 years for major transport routes), and requires significant investment early in the development, which must remain viable for long periods to create value. Understanding and accounting for climate change in planning, designing and operating assets can increase resilience to extreme events and effects of future climate and can present opportunities.

By understanding the risks of climate change, investors will be able to effectively consider the viability of assets of interest, or plan accordingly to increase the resilience of assets and the opportunity to create value from those assets.

Infrastructure assets have strong interdependencies with the needs of the community, with essential services and with large, medium and small business. Understanding these interdependencies can help to identify opportunities, but can also support the ability of Australia to function in the long-term.

Understanding climate adaptation for infrastructure investments

An example of adaptation in infrastructure is building a new port facility at an increased height above sea-level to ensure it remains viable in a climate affected future which includes sea-level rise and storm surge.

Understanding interdependencies

An example of interdependence is a port facility which may be impacted directly by climate change, and may be adapted to cope with climatic events. However, its ability to operate in a future climate depends on factors outside of its control, such as roads and rail and the adaptation by its clients to maintain supply chains.

Key questions for infrastructure investors

- How will climate change affect the company's ability to create value?
- What due diligence has the company taken/does it undertake when acquiring an asset/making an investment decision?
- What opportunities does the company see for itself in a changing climate?
- What is the company's planning timeframe and what climate change scenarios could affect its business over that time?
- Is the company considering adaptation risk as well as mitigation risk?
- How is the company integrating adaptation and mitigation into its planning and expenditure?
- What ongoing monitoring and reporting does it do? Eg oversight of asset management, monitoring of the implementation of operational risk policies and procedures.

Best Practice Case Study

Colonial First State Global Asset Management - Brisbane Airport, new parallel runway (NPR)

Brisbane Airport is the third busiest airport in Australia handling 22 million passengers each year, and likely to reach 50 million passengers per year by 2035. To meet the growing demand, a second parallel runway is being constructed. The airport is low lying and situated close to the environmentally, economic and socially important Moreton Bay. The long potential lifespan of an airport runway meant that in conjunction with several other ESG considerations, the airport owners and managers wanted to ensure that the impacts of climate change were accounted for in the development.

Risk Assessment

Risks associated with storm surge and sea-level rise were considered for this project. Based on the combined effect of tide level, storm surge effect and wave propagation, runway height of 1.8 metres above the minimum regulatory requirements for flood and storm tides and predicted sea-level rise was determined to be the most appropriate option.

Interdependencies

There was a need to consider the links of the runway to the airport apron as movement of airplanes between the terminals and runway need to be seamless. The placement of the runway was selected to ensure reduced impact on Moreton Bay which is a Marine Park and Ramsar site.

Stakeholder Engagement

Given the profile and complexity of the NPR project, the project required engagement with a broad range of stakeholders. A 22-month stakeholder engagement process was undertaken in order to understand stakeholder perspectives across a diverse range of issues. Consultation included the use of a range of materials and activities including:

- Information kits
- Project website
- Freecall information line
- Media announcements
- Print advertising
- Fact sheets
- Public information sessions
- Project displays in shopping centres and libraries
- Targeted briefings with key stakeholder groups.

Adaptation actions

The design level adopted for the new runway provides sufficient freeboard above the design storm tide level. Furthermore, the taxiways linking the new runway with the apron areas are also set above the 1 in 100 storm surge event. The selected height of the runway to cope with seas and storm surge well above design level is not anticipated to present concerns for the life of the project.

In addition to the height of the new parallel runway other climate change impact-related measures included in the design were the construction of tidal channels and the installation of a new sea wall along the northern boundary of the Airport.

Risks and opportunities identified by investors

Summary examples of key impacts for infrastructure investments and responses to them are provided below. For more detail on specific risks and forecast change, see the prepared Table 2. in Appendix 1 of the full version of this report.

Examples of risks and interdependencies for direct infrastructure investments

Higher sea-levels and storm surge will affect the operations of seaports and low lying airports. This can have a significant effect on tourism, business productivity across the country (and beyond), and also impact the ability to import and export goods. Smaller local ports are an important resource for the fishing sector whose operations could be severely impacted. Adaptation can include raising the heights of port facilities and runways. Most of these operations have strong interdependencies with roads and rail to ensure supply chains and staffing.

Extreme events can cause significant damage to power and telephone infrastructure. Over time these events are likely to be more severe and longer lasting. These can be costly and time consuming to fix. Challenges include a drive for technology disruption which could affect investments. Adaptation can include designing stronger cables and infrastructure, raising infrastructure above flood levels and burying wires rather than having infrastructure above ground. This infrastructure has significant interdependencies across a multitude of sectors because of the importance of power and communication for doing business and for maintaining general lifestyle of the community.

Examples of opportunities for direct infrastructure investments

There are opportunities to be gained from effective adaptation to climatic changes, which should also be considered for direct infrastructure investments.

Examples include:

- The ability to operate in extreme weather conditions enabling continued servicing of clients needs. This can result in significant competitive advantage for the infrastructure owner/operator.
- Addressing heat effects of employees can increase and maintain worker productivity and reliability, reduce sick days and work place accidents.

What information and tools do direct infrastructure investors need?

Workshop participants identified tools and resources needed by direct infrastructure investors to assess climate risks and adaptation options:

- **Climate Change Forecasts:** Access to easily understandable information about climate change and regional/local climate projections
- **Check lists:** Easy to use lists of likely risks and adaptation opportunities to use as checklists to determine whether or not companies have undertaken adequate climate change risk and opportunity assessments. A key risk register would be a useful tool to support investors to consider the relevance of those risks to the assets of interest.
- **Tools:** Easy access technical tools which can support investors to use the information to determine climate related risk and vulnerability of assets at different locations - risks based on the geography of the location, and specific to different industries.
- **Guidance Documents** - guidance to support investors to use risk assessment and management related tools effectively, or to manage consultants who may be doing the work on their behalf. This guidance can assist investors to interpret information provided to them by asset managers or by consultants.

Investors require transparency in the disclosure of information relating to the effects of climate change on assets, and on the adaptation in response to those risks.

Companies can be supported to help them establish appropriate governance structures that are required for them to be able to meet fiduciary obligations.

CLIMATE CHANGE ADAPTATION - LISTED EQUITIES

Introduction

Listed equities are companies (resources, agriculture, services, finance) that are listed on stock exchanges, and which are traded to realise short-term gains. Investors in equities generally focus on a short term time horizon of less than five years, while recognizing that superanuation funds have longer time horizons.

The short time horizons often associated with investor outlooks mean that investors may look at past and present climate effects and responses rather than a long-term future view. However, many of the companies that are listed, are susceptible to the impacts of climate change and need to adapt accordingly. Over time as the effects of climate change manifest, adaptation actions will be important considerations for investors about the viability of the equity.

Additionally, investor sentiment is an important consideration and demand for products that have considered and are resilient to climate risks are likely to increase.

Adaptation to climate change can also reduce risks to current extreme events, and increase the viability of short-term assets. This is an important consideration.

The workshop considered climate change implications for a number of different industry sectors. The below key questions and risks are drawn from across different sectors including: resources, services, finance and agriculture.

Understanding climate change adaptation for companies

An example of adaptation for the agricultural sector, might include farmers changing to varieties of crops with greater resilience to climate effects, to ensure that they are able to maintain production into the future.

Mining companies may design flood protection mechanisms to reduce the impact of flooding on their operations.

Understanding interdependencies

An example of interdependencies for either agriculture or mining could include needing transport routes to remain open to ensure stock or commodities can reach port facilities. They also need airports to remain open to enable fly in fly out workers or casual labour to reach remote sites with seasonal workforce requirements.

Key questions for equity investors

Resources

- Can asset owners or managers articulate the risks associated with the effects of climate change on their asset, and provide associated information on how risks were defined and assessed (including information about modelling, climate assessment and use of scenarios).
- Does a risk management plan for the asset include a cost benefit analysis of options and associated valuation for climate change adaptation options?
- Has the risk assessment for the asset included broader balance sheet implications of contingent liabilities (impacts of events) been taken into consideration? Have the impacts of these valuations on the assets (impacts for financing) been considered? Have the effects of climate change on discount rates been considered?
- Is the risk assessment accompanied by an implementation plan with actions and cost benefit analysis of these actions?
- What are the expected timeframes/lifespans associated with the asset/s of interest. The longer the operating potential of the asset, the greater the need for consideration of the effects of climate change, and an associated adaptation plan.
- Has an assessment been made of the future insurability of the asset?
- Have adaptation actions been determined with consideration of co-benefits such influence on carbon emissions?

Agriculture:

- How does the organisation approach and manage the risks associated with current and future climatic events?
- Are there specific strategies to manage climate related risks including approaches such as identification and use of new crops/genetic strains, the potential changes to water access and supply?
- Does the assessment of climate impacts identify lead times that may be required to determine effects of climate and change business practices before climate effects occur?
- What processes and investment are required for the business to be secured into the future?
- How many bad years can the business survive? Many agricultural businesses have been developed to cope with extreme events such as droughts and floods which may intensify in a future climate.

Services

- Are there business continuity plans for the potential asset/business or investment, that include a climate component?
- Is climate change considered in the company's strategic plan and is it reported in company reports?
- Is the insurance cover of the asset adequate for potential impacts from present and future climate driven events?
- Is there a climate related plan containing adaptation and mitigation strategies for the organisation/asset?

Finance

- What sort of disaster recovery plan has been prepared for each asset?
- What data and tools have been used that incorporate climate projections rather than just historical data?
- How has climate risk been incorporated into credit risk evaluation?
- What is the role of regulators? (Investors need to make prudent investment decisions now, but may be hamstrung by regulators. It is important that they understand the issues and are responding appropriately).

Risks and opportunities identified by investors

Workshop participants looked at the impacts of climate change on specific sectors of interest. Summary examples of these impacts and responses to them relevant to listed equities in the resources, services, finance and agriculture sectors are provided below. For more detail on specific risks and forecast change for key sectors, including resources, agriculture, see Tables 3-4. in Appendix 1 of the full version of this report.

Examples of risks and interdependencies for listed equities

Mining

Mining is highly reliant on water, requiring significant resources to maintain operations. For example, floods and droughts can result in challenges for open cast mines, which need to recycle and store sufficient water during droughts and need to pump out during floods. Flooding can halt operations, and pumping out water during floods can have downstream effects (salts and heavy metals) if not planned properly. This can result in significant costs and reputational loss for the mining operation. Adaptation options include investing in appropriate pumps for flood reduction, storage and water efficient design, water treatment facilities and recycling for drought periods. Interdependencies include reliance on road and rail and ports for transport and maintenance of supply chains.

Agriculture

Agriculture can be affected by a variety of climate drivers including heat and water availability. Extreme events such as floods and drought, can affect production, reducing ability to produce crops or feed livestock. Water efficiency and better water storage, as well as undertaking practices that increase soil water detention can help. Ensuring access routes and certain paddocks are above flood levels can help prevent livestock death during floods. Interdependencies include maintaining supply chains to markets, increased demand and associated costs for refrigerated transport.

Finance and services

Banks and the insurance sector are exposed to a variety of climate change effects. Increases in the magnitude and frequency of occurrence of climate extremes will put pressure on the sector. Increased costs of insurance will impact consumers who may opt out. The finance sector is exposed to property loss, businesses closing and unproductive farms. The sector needs to consider ways of influencing clients to increase their resilience to climate extremes. Interdependencies include the magnitude of risk exposure. Large scale and multiple events can impact these sectors considerably.

Examples of opportunities for listed equities

There are opportunities to be gained from effective adaptation to climatic changes, which should also be considered when assessing companies.

Examples include:

- In agricultural activities, certain crops may improve or become more viable as a result of a changing climate, while the viability of others may be reduced. Understanding these and making appropriate changes can lead to competitive advantage and new market share.
- Improved resource efficiency (water and energy) can deliver ongoing cost savings and greater productivity and revenue per unit of production.
- Companies which have invested in resilience are more likely to face lower operating costs on an ongoing basis, in the face of increasing adaption impacts.
- Well adapted assets will present a lower risk for financers and insurers which can reduce costs and increase the marketability of assets.

What information and tools do listed equity investors need?

Mining

- Access to common, open access data sets that allow sufficient granularity and detail. These can be used to support vulnerability/risk assessments.
- Valuation techniques to support investors to determine appropriate discount rates that can be used in long-term considerations.
- Tools:
  - that enable investors to determine interdependencies, including considerations across disciplines. The tools should enable fit-for-purpose consideration, as one size is unlikely to fit all. These should include frameworks for interdependency sector (general checklist).
  - support investors to conduct adaptive capacity assessments (knowledge, finance and organisational capability). These tools and guidance need to be augmented with education and training.
  - to enable assessment of changes to carbon emissions that may result from adaptation options that are being considered.
  - to determine where maladaptation may arise and guidance than can help investors to learn from any maladaptive outcomes that arise

Agriculture

- Access to easily understandable, long-term climate forecasts that reflect the likely conditions that will affect agricultural production in the upcoming decades as well as well into the future. These should include changes that may result from El Nino Southern Oscillation (ENSO) which have big implications for agricultural production and markets within and outside of Australia. These forecasts should be provided with suitable guidance material and should support the needs of short-term, medium-term and long-term investors.
- Climate information and associated guidance should be sufficiently granular to facilitate assessment of whether any diversification strategy (eg geographical diversification) by the agricultural concern is appropriate.
- Freely available industry level / regional tools that enable local issues and benchmarks to be mapped. These can then be used to inform assessments of risk. Issues include impacts from all aspects related to climate variability and change including from cyclones, heat, rainfall and their flow on effects such as water availability and salinity.

Services

- A standardised method risk assessment aligned with ISO31000, AS Standard for Climate Change Adaptation. This would give certainty to investors and to asset owners and managers about what information they should hold and what process they have gone through to assess and manage risk.

Finance

- support or tools that support them to evaluate investee companies' approach to adaptation risk. This may involve a combination of the following:
- A level of very specific expertise around climate modelling & interpretation
- Standardised approaches to climate/adaptation projections
- General knowledge of risk & probability metrics sufficient in some situations (Monte Carlo simulations, etc)
- Regular meetings with risk managers based around a series of clearly articulated information needs
- Sector specialists (banks) could develop knowledge of climate risk specific to their area can that then incorporate geographical knowledge

TOOLS AND RESOURCES

Asset Owners – Climate Change Investment Guides

Global Investor Coalition, (2014) **Climate Change Investment Solutions: A Guide for Asset Owners.** (See Section 4 on Climate Change Adaptation) IIGCC.

Mercer, (2015) **Investing In a time of Climate Change**

Asset Managers - Climate Change Risks and Adaptation Opportunities Guides by Asset Classes and by Sectors

Smith, M. (2013) **Climate Change Risks, Adaptation and Mitigation Opportunity Analysis** – Guides for Mining and Mineral Processing/ Oil and Gas/Property/ and the Industrials, Materials and Manufacturing Sectors. Investor Group on Climate Change, ANU and Cbus

Investor Group on Climate Change (2013) –**Quick Reference Guide - Managing Investment Risks From Climate Change: Property And Construction Sector**

Asset Managers – Climate Change Risk Exposure and Adaptation Information – by Company

Asset managers should be mindful of existing disclosures by companies on climate risk and current actions on climate change. Many companies will have disclosed at least some climate risk and implementation of adaptation opportunity information. Carbon Disclosure Project company responses can be found at the following **link**

Examples of Leadership by Investors on Adaptation

Global Investor Groups on Climate Change, UNEPFI, PRI – (2014) **Financial Institutions Taking Leadership on Climate Change**. See Section 3.3 Leadership in Adaptation Finance and Investment Pages 24-26)

Further resources

Bank of England (September 2015), **The impact of climate change on the UK insurance sector: A Climate Change Adaptation Report** by the Prudential Regulation Authority

The Bureau of Meteorology provides significant resources about climate variability and climate change.

Climate Change in Australia has resources on climate change projections for Australia for a variety of regions across Australia.

The **National Climate Change Adaptation Research Facility (NCCARF)** website has significant resources about all aspects of climate change adaptation. NCCARF continues to develop simple tools, fact sheets and guidance material to support decision makers in all sectors.

CONCLUSION

Investors face many unique challenges when assessing climate adaptation risk across the economy, as their perspective can be both short and long term, close to the everyday operation of the asset or two steps removed from the underlying investment. But the one consistent theme which emerged across all asset classes and industry sectors is that adaptation poses financial risks to investment which need to be appropriately managed.

This guide, and the workshop which generated many of the key insights on how investors should be looking at adaptation, is drawn from the expertise and practical hands-on knowledge of our members and the industry and community representatives who attended the IGCC workshop in August 2015. We thank them for their time and their contribution and hope that we have adequately captured their feedback.

This guide is part of an ongoing stream of work which IGCC are undertaking, and will form the basis of further research as we continue to build up our understanding of the knowledge, tools and resources needed to effectively invest through the adaptation lens.

Table 1: Direct Property Investments

Climate Change Phenomena	Forecast Change	Direct Risks and Interdependencies	Adaptation Strategies with Mitigation Co-benefits
HIGHER AVERAGE TEMPERATURE	0.6 – 1.5°C (2030) 2.2 – 5.0°C (2070)	**Direct Risks:** Heat stress causing disease and higher mortality rates. Increased run hours to maintain comfort resulting in higher energy, maintenance costs, and reduced HVAC equipment lifetimes. Larger HVAC capacity. **Interdependencies:** Higher summer "peak-time" electricity demand and costs. Higher pressures/costs on the health system from heat stress. Productivity losses	**Buildings**: Passive solar design, orientation and features Passive cooling techniques Cool roofs to increase albedo Energy efficient building "thermal" envelope, insulation, double glazed windows, Energy efficient fans & air-conditioning powered by solar PV. **Precinct Level Opportunities** Green landscapes and spaces - cool pavements, permeable landscapes and shade trees Urban water sensitive design – cool landscapes
MORE DAYS OVER 35°C (tropics)	7 to 11 days per annum in 2000 69 days per annum by 2030 308 days per annum by 2070		
MORE DAYS OVER 35°C (temperate climate)	Hot days in Melbourne (>35°C max.) increase by 20 – 40% (2030), 30 – 90% (2070 B1), 70 – 190% (2070 A1FI).		
MORE INTENSE CYCLONES	60% by 2030 140% by 2070	**Direct Risks:** age to buildings and disruption of operations Flooding Higher levels of water borne disease Loss of business turnover due to building damage and potential customers avoiding high risk areas **Interdependencies:** Loss of electricity supply from the grid – loss of refrigerated food Increased insurance premiums and costs Productivity losses	**Buildings** Seal the building envelope and roof (ie fix any leaks) Zero gaps under doors or garage doors Energy efficient windows + window treatments – blinds, sun shades, storm shutters [ii]. Pitched roof Energy self-sufficiency **Precinct Level Opportunities** Effective stormwater and flood management strategies including - Increased capacity of rain gutters, stormwater pipes etc - Rainwater and stormwater harvesting - Permeable landscapes - Swales, constructed ponds, infiltration galleries and retention ponds. Energy self-sufficiency – solar PV and cogeneration + micro-grid storage Solar powered street lighting.
MORE FREQUENT HAILSTORMS - FLOODING	Hailstorms in the Sydney basin have occurred approximately once every 5-8 years over the last few decades. Modelling estimates a 20% increase in frequency by 2050 [iii]		
MORE INTENSE EXTREME RAINFALL EVENTS	Despite overall decreases in rainfall (see below), rainfall and stormwater events will become more intense creating a greater risk of flooding		
DROUGHT	Up to 3 times more frequent in northern Australia and 0 – 5 times more frequent in southern Australia. By 2070	**Direct Risks:** Inadequate water Increase in water costs Water restrictions Larger water storage capacity, alternative water sources **Interdependencies:** In droughts, higher electricity costs due to insufficient water for power stations	**Buildings and Precincts** Design new & retrofit existing buildings/precincts with water efficiency features Improve efficiency of water usage that also enhances energy efficiency Landscape with drought tolerant plants - Develop low carbon alternative water supplies – eg through rainwater harvesting with energy efficient pumps
HIGHER RISK OF BUSHFIRES	Increase in days with very high and extreme fire danger index by · 2 – 30% (2020), · 5 – 100% (2050)	**Direct Risks**: Damage to property and assets Business interruption to customers see above leading to productivity losses **Interdependencies:** Electricity supply disruption Increased insurance costs Difficulties in gaining insurance	**Existing Buildings and Precincts** Insulate and seal buildings to prevent ember attack Avoiding burning of buildings reduces emissions and prevents the need to rebuild (which uses energy and materials with often high embodied energy). Review current fire breaks and reduce bushfire loads around property Fire safe landscaping + water sprinkler system **New Buildings and Precincts** Future construction in low bushfire risk regions Best practice bushfire building codes - Build appropriate fire breaks - Fire safe landscaping
STORM SURGES COMBINED WITH SEA LEVEL RISES	Sea level rises: 26 to 98cm by 2100 [iv]	**Direct Risks** : Flooding and damage to property Increased costs from need to invest in flood prevention Business interruption Reduced land and building value Restrictions on building approval to address sea level rise	**Existing Buildings and Precincts** Planned retreat for existing stock built below 1.5 metres above sea level **New Buildings and Precincts** No new buildings on land at least 1.5 metre or less above sea level Design and build so building materials can be recovered and reused upon dismantling When rebuilding and relocating incorporate low carbon urban design, public transport etc.

(Source, Smith, M based on analysis based on company Carbon Disclosure and Corporate Annual Reports plus the IPCC Assessment as well as the IGCC/NCCARF Adaptation workshop 2015.)

For more information see:
IGCC Property and Construction Sector – Climate Risks and Opportunities Investor Guide @ **http://www.igcc.org.au/Resources/Documents/property_assessing_climate_change_risks_for_investors.pdf**
And the IGCC Property Sector Quick Reference Guide - Managing Investment Risks from Climate Change @ http://www.igcc.org.au/Resources/Documents/Managing%20Risks%20Guide_Property%20and%20Construction.pdf

Table 2: Direct Infrastructure Investments – Transport, Telecommunications, Energy and Water Infrastructure

Climate Change Phenomena	Forecast Change	Direct Risks and Interdependencies	Adaptation Strategies with Mitigation Co-benefits
HIGHER AVERAGE TEMPERATURE	0.6 – 1.5°C (2030) 2.2 – 5.0°C (2070)	**TRANSPORT INFRASTRUCTURE** **Direct Risks** - Train tracks warping Tarmac and road surfaces melting/degradation of roads. Higher energy costs (eg air-conditioning of transport vehicles) Heat impact on equipment efficiency – Increased maintenance or replacement costs **Interdependencies** – higher risk of loss of electricity due to higher peak electricity demand impacting rail and tram systems. **TELECOMMUNICATIONS** **Direct Risks**– Overheating of exchanges and base stations higher **Interdependencies** - Risks of loss of electricity due higher peak demand. **ENERGY INFRASTRUCTURE** **Direct Risks** - Higher peak electricity demand resulting in higher capital investments and higher electricity costs Reduced efficiency of fossil fuel power stations, LNG plants and higher operational costs Reduced efficiency of solar panels. **WATER INFRASTRUCTURE** **Direct Risks** - Higher demand for water from customers **Interdependencies** - Risks of loss of electricity due higher peak demand.	**TRANSPORT INFRASTRUCTURE** **Reducing risks of train track warping** Painting train tracks with white reflective paint reduces rail temp by 5-10 degrees celcius. Check the stability of the track and replenish the ballast that surrounds the sleepers, and re-tensing continuously welded rail Measure and monitor rail temperatures. **Reduce risks of road surfaces melting** Use asphalt surfaces made of polymer modified binders which raises the softening point of the asphalt to around 80C **Higher air-conditioning loads** Trucks are being made that use solar PV to power air-conditioning **TELECOMMUNICATIONS** Reduce risks of overheating through investment in renewably powered cooling systems. Reduce peak electricity demand through utilising telecommunications to cut electricity demand as much as 6% nationally through smart meters, peak demand management, and energy efficiency [v]. **ENERGY AND WATER INFRASTRUCTURE** Greater investment in peak demand management and end user energy/water efficiency, as well as renewable energy to reduce risks of peak electricity and water demand exceeding supply.
MORE DAYS OVER 35°C (tropics)	7 to 11 days per annum in 2000 69 days per annum by 2030 308 days per annum by 2070		
MORE DAYS OVER 35°C (temperate climate)	Hot days in Melbourne (>35°C max.) Increase by 20 – 40% (2030), 30 – 90% (2070 B1), 70 – 190% (2070 A1FI).		
MORE INTENSE CYCLONES -FLOODING	60% by 2030 140% by 2070	**TRANSPORT** Flooding of underground metro rail systems Flooding of transport routes Not being able to evacuate all city residents if needed Associated storm surge closing ports Supply chains disrupted Not being able to meet client contract requirements (risk to reputation and stakeholder confidence) Greater risks of hailstorms damaging cars **TELECOMMUNICATIONS** Storm damage to above ground transmission Exchange station flooding of exchanges, manholes and underground pits **ENERGY** Coal mine flooding increasing input costs to power stations Substation flooding **WATER** Dam overflow adding to flooding impacts and potential liability related to this. Stormwater infrastructure damage	**TRANSPORT, TELECOMMUNICATIONS, ENERGY** Flood proof urban underground metro systems and underground telecommunication, energy and water infrastructure. Adopt flood prevention strategies for all major transport routes, telecommunication stations, energy sub-stations, coal mines. Reduce risks of storm damage to above ground telecommunications and electricity transmission by keeping trees clear of them. Ensure redundancy – eg: multiple transport routes available Manage subsided areas to ensure drainage effective Use advanced supply chain and logistics management approaches to plan for and have redundancy options for any major disruptions to supply chains. **WATER SECTOR** Review climate and weather models and potentially run dams at lower levels of capacity to reduce risks of overflow. Augment existing stormwater infrastructure with urban water sensitive design approaches to reduce risks of stormwater overflow and flooding.
MORE FREQUENT HAILSTORMS - FLOODING	Hailstorms in the Sydney basin have occurred approximately once every 5-8 years over the last few decades. Modelling estimates a 20% increase in frequency by 2050 [vi]		
MORE INTENSE EXTREME RAINFALL EVENTS	Despite overall decreases in rainfall (see below), rainfall and stormwater events will become more intense creating a greater risk of flooding		

Table 2: Direct Infrastructure Investments – Transport, Telecommunications, Energy and Water Infrastructure (continued)

Climate Change Phenomena	Forecast Change	Direct Risks and Interdependencies	Adaptation Strategies with Mitigation Co-benefits
DROUGHT 	Up to 3 times more frequent in northern Australia and 0 – 5 times more frequent in southern Australia. By 2070	**TRANSPORT INFRASTRUCTURE** My reduce capacity for water borne forms of river based transport **TELECOMMUNICATIONS** Higher energy costs due to water shortages causing higher costs of water for power stations. **ENERGY INFRASTRUCTURE** Inadequate amounts of water impact can negatively impact highly water intense forms of energy infrastructure eg: fossil fuel power station, coal seam gas. **WATER** Inadequate amounts of water can risk security of urban and rural water supply.	**TRANSPORT INFRASTRUCTURE** Diversify transport options **TELECOMMUNICATIONS** Reduce peak electricity demand through utilising telecommunications to cut electricity demand as much as 10% through smart meters, peak demand management, and energy efficiency [vi]. **ENERGY INFRASTRUCTURE** Invest in energy efficiency and less water intensive forms of energy supply eg wind power, solar PV, dry cooled concentrated solar thermal energy. **WATER INFRASTRUCTURE** Invest in water efficiency and diversify water sources in cities. In rural areas invest in water efficient infrastructure and renewable energy to meet higher associated energy demand for pressurized rural water irrigation systems.
HIGHER RISK OF BUSHFIRES 	Increase in days with very high and extreme fire danger index by · 2 – 30% (2020), · 5 – 100% (2050)	**TRANSPORT INFRASTRUCTURE** Risks of roads, rail transport routs being cut off **TELECOMMUNICATIONS** Bushfire damage to telecommunication towers in bushfire prone areas **ENERGY** Higher risk of electricity polls and transmission lines sparking bushfires **WATER** Risk of contamination of dam reservoir waters from ashen embers from bushfires	**TRANSPORT INFRASTRUCTURE** Plan for a diverse range of transport options. Ensure public transport options to enable the poor and elderly access to transport options to evacuate high bushfire risk zones quickly. **TELECOMMUNICATIONS** Create a bushfire asset protection zone around the Communications Tower to reduce risk of direct bushfire damage. **ENERGY INFRASTRUCTURE** Energy efficiency and local sources of renewable energy reduce the need for long transmission lines. **WATER INFRASTRUCTURE** Water efficiency, demand management and diversification of water sources.
STORM SURGES COMBINED WITH SEA LEVEL RISES 	Sea level rises: 26 to 98cm by 2100 [vii]	**TRANSPORT INFRASTRUCTURE** Damage to road and rail transport infrastructure adjacent to coast Degradation and failure of tunnel/bridge structures close to coast Degradation and corrosion due to salt infiltration in groundwater Damage to ports and jetties including water overtopping of sea wall protection. **TELECOMMUNICATIONS** Water damage to exchange stations, and flooding of exchanges, manholes and underground pits **ENERGY** Substation flooding **WATER** Saltwater infiltration of coastal aquifers Higher flooding risks of stormwater and sewerage infrastructure system.	**TRANSPORT, TELECOMMUNICATIONS, ENERGY INFRASTRUCTURE** Sea walls, planned retreat of coastal infrastructure over time. **WATER INFRASTRUCTURE** Saltwater infiltration of coastal aquifers can be reduced by managed coastal aquifer storage of urban stormwater. When stormwater and sewerage infrastructure approach the end of their life they can be rebuilt at higher elevations or relocated further from exposed coastal locations. Corrosion from salt water intrusion may accelerate the need to replace damaged assets.

(Source, Smith, M, 2015 based on analysis of Carbon Disclosure Reports, Corporate Annual Reports, and the IPCC Assessments as well as the IGCC/NCCARF Adaptation workshop))

Table 3: The Resources Sector (mining, oil and gas)

Climate Change Phenomena	Forecast Change	Direct Risks and Interdependencies	Adaptation Strategies with Mitigation Co-benefits
HIGHER AVERAGE TEMPERATURE	0.6 – 1.5°C (2030) 2.2 – 5.0°C (2070)	**Direct Risks:** Heat Stress - heat fatigue Higher energy costs (eg air-conditioning, chilling costs in LNG plants and air-conditioning costs)) Increased working conditions discomfort leading to staff-retention issues Spread of tropical disease Higher risk of spoil piles self-combustion - Increase in wild/bush fire hazard – leading to smoke hazard Heat impact on equipment efficiency – Increased maintenance or replacement costs	Heat stress prevention plan [ix] Improve efficiency of underground cooling systems Generate hydro-electricity from the fall of cooling water down piping used to cool underground mines to power air-conditioning. Coal mining spoil self-combustion monitoring, prevention and mitigation strategies Passive solar and passive cooling design of mine site accommodation for staff. Use of cool roofs and other techniques to manage extreme heat. Eg: Onsite solar powered air-conditioning for accommodation. Use of reflective white paint on metal surfaces exposed to sunlight Introduce more intensive equipment/infrastructure maintenance programs to reduce heat and dust related wear and tear damage
MORE DAYS OVER 35°C (tropics)	7 to 11 days per annum in 2000 69 days per annum by 2030 308 days per annum by 2070		
MORE DAYS OVER 35°C (temperate climate)	Hot days in Melbourne (>35°C max.) increase by 20 – 40% (2030), 30 – 90% (2070 B1), 70 – 190% (2070 A1FI).		
MORE INTENSE CYCLONES	60% by 2030 140% by 2070	Damage to infrastructure and equipment Operations disrupted - productivity losses and higher costs from evacuation. Associated storm surge closing ports Supply chains disrupted Flooding of pits and transport routes - preventing production and movement of product Not being able to meet client contract requirements (risk to reputation and stakeholder confidence) Risks from water pollution events with current and older abandoned mines Costs of managing (storing, cleaning, moving) large volumes of polluted water Increased costs to recover from flooding Reduced revenue caused by long-term closure . Danger of flooding in subsided areas	Adopt flood prevention strategies – reduces energy pumping costs, risks of lost production and damage to company assets. Store flooding waters to improve resilience to drought eg: Managed aquifer storage of flooding waters. Designing tailings storage facilities to meet requirements of the life of operations to cope with increased/extreme flooding events Plan construction and decommissioning activities to address risks of potential flooding events under new climate regime. Stock pile product outside of potential flooding area to provide continued delivery Ensure multiple transport routes available Hedging or insuring to reduce overheads of risk
MORE INTENSE EXTREME RAINFALL EVENTS	Despite overall decreases in rainfall (see below), rainfall and stormwater events will become more intense creating a greater risk of flooding		
DROUGHT	Up to 3 times more frequent in northern Australia and 0 – 5 times more frequent in southern Australia. By 2070	Inadequate supply to operate critical processes (such as extraction, processing, dust suppression); Loss of production capacity and failure to meet contractual commitments Inability to adapt equipment and infrastructure to a reduced supply, or to lower quality alternative supply Water supply cost increase Increased competition for water Vegetation loss further increasing dust, erosion, drying increasing possibility of bush/wild fire Increased dust causing issues for health and infrastructure/transport	Mining - More energy and water efficient comminution and froth floatation Use of in-pit crushers and conveyors or conveyor belts for materials movement to reduce water requirements for dust suppression from using haul trucks. Storage and reuse of flooding waters le: Managed aquifer storage of flooding waters Vegetation rehabilitation using drought-resistant plants to stabilize soil Dust suppression programs that use little water (a challenge though, during times of drought)
HIGHER RISK OF BUSHFIRES	Increase in days with very high and extreme fire danger index by · 2 – 30% (2020), · 5 – 100% (2050)	Higher risks of coal mine fires Smoke hazard reducing air quality leading to health risk Smoke hazard reducing visibility at site or on service roads increasing transport and production risks	Improve bushfire management plan Build appropriate fire breaks Reduce bushfire fuel loads Use fire-retardant vegetation in revegetation plans Coal mining spoil fire monitoring, prevention and mitigation Reduce risk of pipeline leaks and explosions. Work with Rural Fire Service Monitor air quality and smoke and implement policy that informs drivers and plant workers of possible smoke danger and hazard reduction plan

(Source, Smith, M, 2015 based on analysis of Carbon Disclosure Reports, Corporate Annual Reports, and the IPCC Assessments as well as the IGCC/NCCARF Adaptation workshop) For more information see the IGCC Mining Sector and Oil and Gas Sector – Climate Risks and Opportunities Investor Guides @ **http://www.igcc.org.au/assessing_risks**

Table 4: Agriculture Sector

Climate Change Phenomena	Forecast Change	Direct Risks and Interdependencies	Adaptation Strategies with Mitigation Co-benefits
HIGHER AVERAGE TEMPERATURE	0.6 – 1.5°C (2030) 2.2 – 5.0°C (2070)	Heat can negatively affect crops, including viability, production and taste and lead to higher levels of evapotranspiration of water. Droughts can reduce the viability of agribusiness, and can have substantial effects on the mental health of rural communities. Based on the latest IPCC assessment, without mitigation and adaptation this could lead to; • *Reduction in the value of agricultural production in the Murray Darling Basin by 12 to 44% in 2030 and 49 to 72% in 2050.* • *3 degree C increase is expected to cause a 4% reduction in gross value of the beef, sheep, and wool sector by 2070.* • *Dairy productivity is projected to decline in all regions of Australia other than Tasmania by 2050.* • *Wine grapes -earlier budburst, ripening, and harvest with reduced quality in all Australian regions, without adaptation by 2070*	Agroforestry - Shading can substantially reduce effects of climate change Water efficient pressurized irrigation systems powered by renewable energy Enhanced water storage Agronomy that increases soil water retention. Holistic time controlled grazing systems Matching stocking rates with pasture production Practices for soil carbon sequestration increase the ability of soils to hold moisture
MORE DAYS OVER 35°C (tropics)	7 to 11 days per annum in 2000 69 days per annum by 2030 308 days per annum by 2070		
MORE DAYS OVER 35°C (temperate climate)	Hot days in Melbourne (>35°C max.) increase by 20 – 40% (2030), 30 – 90% (2070 B1), 70 – 190% (2070 A1FI).		
DROUGHT	Up to 3 times more frequent in northern Australia and 0 – 5 times more frequent in southern Australia. By 2070		
EXTREME RAINFALL EVENTS	Despite overall decreases in rainfall (see below), rainfall and stormwater events will become more intense creating a greater risk of flooding	Floods can remove top soils, can impact on crops and livestock and can cause runoff of sediment and fertilisers into downstream environments. Floods can influence supply chains reducing access to markets	Water catchment flood prevention strategies Regional managed aquifer storage, recharge and recovery. Water storage systems eg on farm dams.
HIGHER RISK OF BUSHFIRES	Increase in days with very high and extreme fire danger index by • 2 – 30% (2020), • 5 – 100% (2050)	Damage to property, stock, crops, water supplies, soils or pastures	Develop a bushfire management plan Implement fire access tracks and fire break Work with local fire services to manage fuel loads Design farm homestead to be as fire resistant as possible including sprinklers on the roof.
STORM SURGES COMBINED WITH SEA LEVEL RISES	Sea level rises: 26 to 98cm by 2100 [xi]	Changes to water tables in low lying areas, encroachment of salt water upstream from the ocean at higher levels can impact coastal farmers.	Managed retreat

(Source, Smith, M, 2015 based on analysis of Carbon Disclosure Reports, Corporate Annual Reports, and the IPCC Assessments as well as the IGCC/NCCARF Adaptation workshop))

Footnotes

[i] US DOE – Energy Efficient Window Treatments - **http://energy.gov/energysaver/articles/energy-efficient-window-treatments**

[ii] US DOE – Energy Efficient Window Treatments - **http://energy.gov/energysaver/articles/energy-efficient-window-treatments**

[iii] Leslie, L.M., Leplastrier, M. & Buckley, B.W. (2008) 'Estimating future trends in severe hailstorms over the Sydney Basin: a climate modelling study', Atmospheric Research, no. 87, vol. 1, pp. 37-51

[iv] IPCC, 2013: Summary for policy makers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1-36 (in press).

[v] See Telstra (2014) Low Carbon Connectivity @ **http://www.telstra.com.au/abouttelstra/download/document/telstra-lcf-report.pdf**.

[vi] Leslie, L.M., Leplastrier, M. & Buckley, B.W. (2008) 'Estimating future trends in severe hailstorms over the Sydney Basin: a climate modelling study', Atmospheric Research, no. 87, vol. 1, pp. 37-51

[vii] See Telstra (2014) Low Carbon Connectivity @ **http://www.telstra.com.au/abouttelstra/download/document/telstra-lcf-report.pdf**.

[viii] IPCC, 2013: Summary for policy makers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1-36 (in press).

[ix] **http://www.commerce.wa.gov.au/worksafe/content/safety_topics/Diseases_and_health/More_information/Heat_stress.html#**Are some people more prone accessed March 5 2013

[x] Mason, L, Unger, C, Lederwasch, A, Razian, H, Wynne, L & Giurco, D 2013, Adapting to climaterisks and extreme weather: A guide for mining and minerals industry professionals, National Climate Change Adaptation Research Facility, Gold Coast, 76 pp.

Acknowledgement

[xi] IPCC, 2013: Summary for policy makers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1-36 (in press).