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CASE STUDY REPORT

Understanding the climate change information needs of the financial services sector

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Report summary

The Australian economy is influenced by changes to the average climate (e.g., increases in the mean temperature and mean sea level) as well as by long-term climatological changes to extreme weather conditions which have the potential to cause more rapid economic impacts (e.g., as can be associated with phenomena such as bushfires, cyclones and floods). In addition, the exposure to some climate hazards has increased over time and could continue in future. For example, continued coastal development mean there are more assets exposed to sea level rise. Managing these changes within the economy involves a range of financial risks and opportunities, including questions of liability and indemnity for the financial services sector as well as presenting opportunities to optimise investment and facilitate ongoing prosperity for stakeholders more broadly. To achieve this goal, there is a large and growing need for climate information for the financial services sector that is scientifically credible (based on peer-reviewed knowledge with institutional authority), salient and relevant and tailored for financial applications.

Through various engagements with the financial services sector over 2017 and 2018, this case study has found that the current generation of available climate information (based on observations and projections, including associated training, information and data products) can be useful in some cases but doesn't do all that is needed for many specific applications. Different components of the sector need different information, but there are some common threads. The delivery of climate information can be readily enhanced, including through provision of:

- Targeted guidance, training and background learning
- Information specifically relevant to financial risk and exposure
- Protocols for using future climate projections so analyses are defensible
- More information about extremes, compound extremes and 'worst case' scenarios to stress-test systems
- Greater accessibility and utility of relevant data and information including enhanced visualisation tools and integration with financial management models

The Earth Systems and Climate Change (ESCC) Hub of the Australian Government's National Environmental Science Program (NESP) is developing improved projections of future risk in relation to the influence of climate change on weather and ocean conditions. Complementary to other research efforts in Australia around climate, a focus of this research is to provide practical guidance and tools for direct use by end-users in different sectors of Australian society. This includes helping to address the physical hazards aspect of climate risk of relevance to the finance sector. This report details the case study work from ESCC Hub Projects 2.6 and 2.8, as an initial effort to provide improved information for managing climate risk in the Australia finance sector.

This report provides details on some initial engagement activities that occurred between the climate researchers from the ESCC Hub and the finance sector in Australia (including insurance, actuaries, banking, regulators, as well as government and private organisations). Concise summaries of key climate risks are then provided, intended for practical applications in the finance sector in relation to the influence of climate change on weather and ocean conditions. Significant changes have already occurred to a number of physical risks relevant to the finance sector, and that further changes will continue to occur in the future due to ongoing climate change. Recommendations for next steps following on from this case study are also provided.

1. Introduction

There is a growing need in Australia and globally for improved information on climate and climate change to make evidence-based risk-management decisions by organisations and regulators in the financial services sector (including banking, insurance, funds management and ratings agencies, amongst others). This includes a need for salient and credible future climate change projections and/or globally consistent scenarios to assess future risk, underpinned by high quality observations and understanding of physical processes.

The financial services sector (FSS) has seen rapid developments in relation to climate risk in recent years. The Financial Stability Board's Taskforce on Climate-related Financial Disclosures (TCFD) recommendations in 2017 for the development of consistent climate-related financial risk disclosures by companies (supported by more than 100 private firms responsible for assets worth more than $24 trillion) has significantly raised the awareness of corporate Australia in relation to climate change risk and the need for new and novel risk management approaches. The Australian Prudential Regulatory Authority (APRA) has established a Climate Change Financial Risk Working Group to develop their response to the TCFD recommendations for the industries they regulate in Australia, and published Australia's New Horizon: Climate Change Challenges and Prudential Risk (APRA 2017).

Climate-related risks to the FSS in terms of loss of income, reputation, market share, market resilience or even market integrity exist within three main categories:

1. Physical risks – impacts, financial exposure and liability that could be reasonably foreseen given our current knowledge of future climate change (e.g. by using plausible future climate change scenarios).
2. Liability and indemnity risks – risks from the changing insurance environment, and legal liability challenged in courts.
3. Transition risks – risks from transition to a low-carbon economy, including financial exposure from investments in carbon-intensive industries, or new technology aimed at reducing carbon emissions, and the effects of carbon taxes or emissions trading schemes.

There is also a need to demonstrate that the risk management process is adequately documented and undertaken using defensible 'best practice' methods based on scientifically robust, peer-reviewed data and information. The provision of data and information to use as input, and recommendations on principles of how to use it, can be done in the form of tailored and targeted climate change information services. Each of the component bodies of the Australian finance sector have different functions and therefore different data and information requirements, in several dimensions:

- Spatial scales – a household or small business is at one location and so primarily wants local information, through to bodies such as APRA that may have a broader scope over Australia and the globe.
- Timescales – all bodies typically have an interest in the current and near-future climate (e.g. 2030), whereas they vary more in their capacity and need to look strategically at the far future (e.g., 2050-2100).
- Risk profile – different bodies can have different vulnerabilities and tolerance for risk.
- Budgets and scope for assessing and managing risk – ranging from severely constrained to the ability to dedicate huge resources.

The need for high-quality tailored climate information for the FSS is clear. However, existing climate change projections data and information from sources such as Climate Change in Australia are not specifically targeted to meet identified needs of the various FSS components.

The ESCC Hub is developing improved projections of future risk in relation to the influence of climate change on weather and ocean conditions. In particular, NESP Project 2.6 is focused on improving the accessibility of regional climate projections, and Project 2.8 is developing projections for weather extremes including many of the more costly natural hazards such as tropical cyclones, bushfires, Australian east coast lows and thunderstorms (which can cause extreme winds, rainfall, lightning, tornadoes and hail). This work is useful for assessing risks in categories 1 and 2 above and is complementary to other climate and impact research efforts in Australia. One focus of this ESCC Hub research is to provide practical guidance and tools for direct use by end-users in different sectors of Australian society, including helping address the physical hazards aspect of climate risk of relevance to the FSS. The intention is that the new scientific data and information produced by these and other ESCC Hub projects will be used by user groups including the FSS to inform physical climate risk assessment and associated management and planning.

This report details activities and key findings from a 2018 ESCC Hub Research Plan V4 case study undertaken through Project 2.6 and 2.8 as part of wider and ongoing engagement and cooperation with the FSS by the ESCC Hub. This report outlines four main items:

1. A summary of some key climate risks and phenomena of interest (Section 2).
2. An initial scan of the resources that are currently available and useful to the finance sector (Section 3).

3. An overview of some remaining gaps and needs for managing climate risk in the Australian FSS, including potential structures and styles of information products that may be useful as climate change services. This includes recommended next steps (Section 4).
4. Details of the initial engagement activities between the climate researchers from the ESCC Hub and the FSS in Australia (including insurance, actuaries, banking, regulators, as well as government and private organisations) that were used to help inform this report.

It is intended that this report will inform the development and testing of prototype products, as well as further user engagement. A focus of this case study was on the potential to adapt current projections data and information and how they might be presented in innovative ways as climate change services tailored to the needs of target users. This is intended to provide a starting point for a process of partnering and delivering information for this growing need going forward.

2. Practical guidance on physical climate risks for the financial services sector

Based on user engagements and feedback (listed in Section 5), this section presents a synthesis of the physical climate impacts that are relevant to the FSS and what is known about the current and future climate risks, noting that many of these changes have already started to occur (as observed in recent decades). This information is intended for general use in some FSS applications, such as to help provide practical guidance in relation to planning risk assessment and management activities.

Variability and change in the average climate (including air, land and ocean) drives incremental impacts, sometimes known as 'slow burner' impacts that are relevant to the economy and finance. Changes to the average climate impacts bioclimatic zones, agricultural production, natural resource management, ranges of pests and diseases, energy demand, labour demand and supply, health and mortality, and more. However, the influence of climate change on extreme weather events was consistently identified by stakeholders as more acutely relevant to financial risks than changes to the averages.

Direct and indirect impacts from extreme events can have both immediate and longer-term material influence on the economy, and so have large implications for the FSS specifically in terms of managing risk. Extreme phenomena of greatest interest include heatwaves, bushfires, hail, extreme rainfall, floods, droughts and coastal inundation. Storms, particularly tropical cyclones, east coast lows and thunderstorms, are responsible for many of the most costly and destructive natural hazards and disasters influencing Australia. Furthermore, compound events – consisting of multiple interacting factors that can exacerbate the resultant impacts, including coincident extreme climate events – were also identified as important. It was identified that physically plausible 'worst case' scenarios based on multiple extreme events are therefore needed to 'stress test' systems and management models.

Significant changes have already occurred to several natural hazards relevant to the FSS, and further changes will occur in the future due to ongoing climate change.

Table 1 summarises a range of key climate-related natural hazards relevant to Australia and by association the FSS, and what we know about the effect of climate change on these extremes. Table 2 presents projected changes to mean weather and ocean conditions in Australia that are relevant to the economy and by association the FSS.

Table 1: Summary of the influence of climate change on relevant weather and ocean hazards relevant to Australia

Hazards type	General influence of climate change
Extreme heat	More frequent and intense extreme heat events, including record-breaking temperatures in summer, and warmer than average temperatures in cool seasons.
Drought	Rising temperatures mean droughts are hotter and impacts can be exacerbated. There may be more time in drought in areas where rainfall is projected to decrease.
Bushfires	More frequent and dangerous bushfire conditions in some regions, particularly due to weather conditions in southern and eastern Australia, including an earlier start to the fire season.
Extreme rainfall	More intense extreme rain events are likely throughout Australia, with potentially large increases for short duration events.
Flooding	Increased risk of flash floods, particularly in urban areas but also in rural areas, and larger uncertainties for other types of flooding.
Sea level rise and storm surge	Sea levels will continue to rise around Australia, increasing storm surge, coastal inundation and erosion risk.
Marine heatwaves	Increase in the intensity, frequency and duration of marine heatwaves, with increased associated impacts.
Thunderstorms	Potentially large increases for short-duration rainfall extremes, with larger uncertainties for extreme winds, tornadoes, hail and lightning associated with thunderstorms.
Cyclones and low-pressure systems	Fewer tropical cyclones but with a greater proportion of high intensity storms, as well as fewer Australian East Coast Lows, particularly during winter.
Compound events	Larger uncertainties, but growing importance, for the impacts of compound and coincident events.

Table 2: Summary of the influence of climate change on average (mean) weather and ocean conditions in Australia

Average (mean) weather and ocean conditions	General influence of climate change
Mean temperature	Increased temperatures between around 2 °C (under a low emissions scenario) up to 4 °C or more (under a high emissions scenario). This will affect fundamental aspects of the economy including bioclimatic zones, agricultural production, ranges of pests and diseases, water and energy demand, labour demand and supply, community health and mortality, tourism, infrastructure design etc.
Mean rainfall	General drying over southern Australia in the cool season, significant changes possible in northern Australia in the wet season, but the direction of change is unclear with seasonal differences in many cases. This affects water supply, agriculture, bioclimatic zones, bushfire and disaster management and much more.
Water availability	Projected drying in southern Australia is accompanied by decreasing humidity and warmer temperatures, meaning more evaporation, drier soils, with hotter and more frequent droughts (including more heatwaves during droughts).
Mean winds	Relatively small changes in mean wind climate (less than 10% change), e.g. small decrease in southern mainland Australia but an increase in Tasmania in winter. This may affect wind power generation, coastal sedimentation processes etc.
Solar radiation	Generally small changes (<10%), such as an increase in sunshine in areas projected to become drier (e.g. southern Australia in winter).
Sea level	Ongoing sea level rise – the rate of rise later in the century depends on the emissions scenario we follow. The expected change due to incremental processes is clear, but the rate could be much higher if non-linear processes kick in (such as collapse of the Antarctic ice sheet).
Combined stresses	Compound, consecutive and coincident events (see Table 1) can have more acute impacts than any one stress alone, and when combined with other socio-economic vulnerabilities can have cascading impacts.

3. Existing material and its utility

Table 3 lists the existing resources that are useful for the finance sector, both in terms of information and guidance. This focuses on the information and data provided on Australia's national climate change projections (Climate Change in Australia), but also lists material from international sources and state-based climate projections. Table 4 lists some examples of the information and guidance available from NGOs, commercial groups and others, as important context.

Table 3: Existing resources providing climate data and information, including tools to explore and use projections

Resource	Components
Climate Change in Australia	• Reports and brochures – assessment of various lines of evidence, assessment of climate models, projections of various climate variables, details for cluster regions and example locations. • Climate Campus - background information on climate change processes, modelling, emissions scenarios etc. • Webtools – explore projected changes in climate variables along various dimensions (emissions, range of change, time frame), visualise changes in climate using geographic analogues, etc. • Climate futures tool – explore and select representative models and scenarios • Dataset delivery – time series for stations, gridded data layers of climate variables made of observed data scaled by projected change factors.
Other Australian projections	Tailored, high-resolution projections for State Government and other applications: • NSW and ACT Regional Climate Modelling project (NARCliM) • Queensland projections • Upcoming Victorian State government projections • Climate Futures for Tasmania
Observations and indices	• Bureau of Meteorology climate service and datasets

Table 4: Examples of further resources, including those produced for the FSS by national and international bodies

Resource types	Examples
Online tools to link to or learn from	• Copernicus Climate Change Service (C3S) EU • Digital Agriculture Services • CoastAdapt • GeoScience Australia portal • Australian Urban Research Infrastructure Network (AURIN) • OASIS loss modelling framework • Climate Risk Information Services Platform (CRISP)
International resources	• The TCFD report itself • AECOM 'Becoming climate resilient' • UNISDR Sendai framework for disaster risk reduction
National reports and resources	• Garnaut climate change review and update • Australian National Outlook – upcoming version • 427.org: 'Responding to Economic Climate Risk in Australia' and other resources • Investor group on climate change - various reports • Actuaries Institute - climate index and other resources
Sector-specific guidelines	• Climate Change Adaptation Guidelines, Water Services Association of Australia • Climate change and the emergency management sector in Australasia

4. Identified gaps and needs

Table 5 presents known gaps and needs in the resources available for the FSS in Australia. These gaps and needs represent barriers to including climate knowledge into financial risk assessments in a robust and defensible way using the existing resources. Substantial improvements in addressing some of these gaps and needs could be made with relatively little effort, and future work is intended to further explore methods for including climate projections information into the assessment of finance-relevant risk on a more substantive basis over the longer-term.

Table 5: Identified gaps and needs in data and information for the FSS in Australia

Gaps and needs	Use
Scenarios that are consistent between Australia and the globe – with storylines and non-climate aspects (e.g. 2030, 2050, Paris Agreement or no Agreement etc.)	• TCFD recommendations on the use of globally consistent scenarios for financial risk disclosure. • Updated and improved (next generation) climate change projections for Australia. • Many wish to assess financial impacts for local and Australian regions within the global context, and to assess climate impacts along with non-climate changes. This means providing projections with detailed information for Australia but linked to consistent equivalent global projection, as well as provide a clear link to the non-climate aspects involved in these futures.
Enhanced guidance specific to financial analyses and risk assessment	• Guidance on various choices when using projections and observations and what they mean in terms of financial risk e.g. how to frame emissions scenarios and justify using one over another. • Guidance on using projections information and data to analyse financial indices e.g. how to select future scenarios, export the data and calculate financial costs.
Protocols to assess risk to ensure the process is defensible	• From the scientific side (not the regulator or policy side), a set of minimum requirements for any analysis that meet our standards and so would be defensible.
Climate change sensitive natural catastrophe (Nat-Cat) models	• Integrated climate/Nat-Cat models or Nat-Cat models otherwise re-configured to incorporate the climate change signal.
Capacity development	• Targeted training (climate science 101, use of decision support tools etc.) for risk managers and associated decision-

	makers in relation to understanding and application of climate change science.
More information about extremes	• More data and information on extreme events and the risks they bring. • More data and information on compound extremes, including consecutive and coincident extremes and cascading impacts. • Worst case scenarios of multiple coincident or concurrent extremes to 'stress test' systems. • Availability and use of standardised indices of extreme events. • More information on detection and attribution of extreme events, including development of near real-time analysis.
More information about climate variability and change in the near term (e.g. to 2030)	• Conceptual framework and supporting data to help with framing risk for the near-term climate where climate variability is crucial, but the climate change 'signal' is exerting an influence. • Next generation climate change projections, including update of CMIP5 projections against updated baseline data.
Simple datasets summarising climate risks specific to finance (e.g. map layers)	• Simple indices or measures that summarise risk in a meaningful way in a few layers rather than many layers and model outputs of climate data. E.g. rather than the forest fire danger index from 40 models for four emissions scenarios for four future time periods, create three layers of minimum, maximum and median plausible change in overall fire danger.
Enhanced visualisation and geo-spatial referencing of climate data including inter-operability with other common analysis tools (e.g. map layers that can be overlaid with maps of assets)	• The ability to use data and information from projections portals directly in the tools and data from other platforms - both the ability to work across online platforms and the ability to export data to use with offline tools. • A very common desire is to overlay projections information as maps or GIS layers with other GIS information such as maps of infrastructure or other assets. • Enhanced digital content for greater accessibility and utility.
Case studies	• Practical real-time/real world FSS case studies to facilitate outreach, develop capability and capacity and demonstrate applications. • Documented success stories.
Quality control/quality assurance	• Guidance to enhance compliance with consistent and robust, scientifically valid/peer-reviewed QA/QC standards for developing and applying climate data and information for risk assessments and general decision-making.

5. Next steps and recommendations

The information presented here is intended as an initial effort towards developing data and information products, and guidelines for their use, for effectively using climate projections in the FSS, and potential for broader sectoral application across Australian industry.

There are several potential ways forward in terms of addressing the priority gaps and needs around climate risk for the FSS. In the short term (next two years), information and engagements can be provided by the ESCC Hub and partner agencies based on requests from various FSS groups. In the medium term, some new climate change data and information products and services including tailored guidance, training, protocols and content on areas of interest (near-term climate, global context etc.) can be added to the national climate projections through Hub projects. Likewise, more detailed data products and guidance information is available on physical risks from extreme events from Hub projects, covering hazards associated with thunderstorms, bushfires, tropical cyclones and Australian east coast lows.

Further needs assessments are required to inform new work on an on-going basis, particularly more assessments of the specific tools, analysis methods and data that are most commonly used by financial analysts.

As highlighted in Table 1 for various extreme weather and ocean phenomena, there remain considerable knowledge gaps around the influence of climate change on some natural hazards, in association with phenomena such as severe storms. This is largely due to the fine-resolution needed to model the physical processes that cause severe storms, including costly impacts associated with thunderstorms (such as extreme winds, rainfall, lightning, tornadoes and hail). Improved fine-resolution (i.e. downscaling) modelling capabilities is one way to help address this need in the future.

Building on the outputs from this case study, it is intended that in subsequent years of the ESCC Hub, further work will contribute to developing methods for effectively using climate projections in the finance sector and potentially for broader application across industries. As appropriate products and services are developed, they will be communicated to stakeholders with interest in making climate sensitive, high-value financial and associated risk management decisions.

6. Engagements

Table 6 presents a list of some of the key stakeholder engagements that have occurred during 2017-2018 with the FSS in relation to ESCC Hub activities. Discussions at these events typically centred on the information needs for assessing climate risk in the FSS with an emphasis on retail banks, insurance and fund managers. Some of these engagements were relatively informal and preliminary in nature, including face-to-face and/or video-conference meetings, whereas others were more formal and detailed as part of a structured event such as workshops, seminars, committee meetings etc. Topics covered ranged from the identification of data and information gaps and needs, to consideration of topics such as scientific standards and risk assessment methodologies, the role of open-source, public good science and strategic priorities for the FSS going forward.

Table 6: Stakeholder engagements that have occurred with the FSS in relation to ESCC Hub activities during 2017-2018

Event, date and group	Summary of main insights
Investor Group on Climate Change, June/September 2018 – Geoff Gooley, Michael Grose, Andrew Dowdy, Nick Wood, David Karoly	Initial Hub presentation at IGCC Workshop followed by more detailed engagement. Huge need for tools for combining projections with other resources to do analysis – primarily GIS style analysis such as overlaying spatial climate layers with other data (such as maps of assets).
UNEP-FI Australian stakeholder (banks, fund managers and insurance) meeting, July 2018, Sydney – Jason Evans, Geoff Gooley, Nick Wood and Kate McKenzie	Banks are looking at information from various sources and groups, including consultancies. It would be useful for them to have a clear line-of-sight from the research to the things they use, and for the research community to have a path to impact that is clear about the role for consultancies.
Australian National Outlook meeting (various banks, industry bodies represented), May 2018 Sydney and follow ups – Michael Grose	Need for basic information and assistance with framing future climate – conflicting information out there, a lot of other considerations to manage (demographics, technology etc.).
Information and data provided to various insurance, reinsurance and insurance broker companies on how climate change is influencing extreme weather hazards in Australia; various interactions during 2017 and 2018 – Andrew Dowdy	The provision of this information has been noted to be very useful for their applications, including for their modelling of physical hazards in Australia as well as for being able to help demonstrate understanding of their climate change risk.
Deloitte Risk Advisory Pty Ltd – initial meeting with manager for sustainable services within Strategic and Reputation Risk area in late 2018 – Aurel Moise.	Discussion on various weather and climate science topics with a focus on extremes, but also discussing information to explore the climate impacts on streamflow (or water availability in general) for the Latrobe valley.

Actuaries Institute and Finity Consulting - various meetings and other interactions during 2017 and 2018 – Andrew Dowdy and Karl Braganza	Discussions and guidance on various weather and climate science topics, including for assistance during their development of a climate index, an objective measure of extreme weather conditions and changes to sea levels, to help policymakers and Australia's businesses assess how the frequency of weather extremes is changing over time.
Commonwealth Bank (CBA) and the Reserve Bank of Australia (RBA), Aug 2018 – Kate McKenzie and David Karoly	Various meetings to brief CBA and RBA stakeholders on status of climate change science informing corporate risk in Australia.
Carbon Market Institute (CMI) Corporate Climate Change Working Group workshop/seminar presentation Oct 2018 – David Karoly	Workshop convened by CMI to facilitate engagement between CMI corporate members and the climate change science community in Australia, as represented by the NESP ESCC Hub. An overview of the Hub's research was presented as part of a broader discussion around industry data and information gaps and needs.
Actuaries Institute – Hub Stakeholder Advisory Group Young Professional's event, March 2018 – 'New Derby' Developing Northern Australia: an insurance challenge' - Nick Wood, Geoff Gooley, Karen Pearce, Savin Chand, Tony Rafter, Julian O'Grady, Acacia Pepler	Part of the ESCC Hub's Stakeholder Advisory Group (HSAG) series of 'Young Professionals' events, co-convened with the Actuaries Institute. The hypothetical theme of 'New Derby', Developing Norther Australia: an insurance challenge was utilised in an open workshop setting to explore the use of climate science to develop better resilience and risk management, and specifically to identify climate change data and information needs for the insurance sector to make more climate sensitive, risk-based decisions.
Various FSS stakeholders/other corporate entities at University of Sydney/Climate KIC convened roundtable on climate risk, Nov 2018 – Nick Wood	Roundtable entitled 'Climate Science, Industry and Governance' convened jointly by Climate KIC and Future Earth Australia at University of Sydney to discuss data and information needs of FSS to assess/inform climate risk. Hub represented by HSAG and key outcomes included need for science-based standards to inform climate-related financial disclosure in the FSS.
ANZ and NSW Treasury Corp, May & Dec 2018 – Nick Wood	Discussions around the role of science-based climate change data and information informing development of green finance products, including Green/Climate Bonds.

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