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Between the Orderly and Hot House World: A Practical Guide to Effective Climate Risk Management for Banks

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Presented to the Actuaries Institute
2024 All-Actuaries Summit
1-3 May 2024

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Abstract

As the effects of climate change become better understood and the need to address this issue becomes more pressing, the expectations on financial services firms, and banks in particular, will continue to increase. Prudential regulators, central banks, customers, investors, and funders each have unique perspectives and requirements on the banks they deal with. This paper is a practical guide for banks on how they should integrate climate risk management into their broader risk management frameworks, with a focus on residential lending.

Keywords

Banking, Climate Risk, Enterprise Risk Management, ERM, Scenario Analysis, Residential Lending, Credit Risk, ICAAP, Stress Testing

Contents

1 Introduction

1.1 Background

Over the last decade, there has been significant development in understanding and disclosing the impact of climate on the banking sector, primarily lead by regulators including the Network for Greening the Financial System (NGFS) at a global level. In Australia, the Australian Prudential Regulation Authority (APRA) has issued its CPG 229 on Climate Change Financial Risks (APRA, 2021), as well as conducting a Climate Vulnerability Assessment (CVA) on banks (APRA, 2022). Together with the development of sustainability disclosure requirements, beginning with the Task force on Climate-related Financial Disclosure (TCFD) in 2017 (Paddam & Wong, 2017) and most recently culminating in disclosure standards published by the International Sustainability Standards Board (ISSB, 2023), this has driven disclosure by banks both globally and in Australia, including (CBA, 2023) and (Bank Australia, 2023).

In this paper we focus on residential lending, an area where climate related risk analysis at banks has been relatively less developed. The institutional and business banking sectors, with a focus on financing the transition to net zero (see, for example the Glasgow Financial Alliance for Net Zero (GFANZ, 2023)), have been a priority, and there have been significant developments both in levels of finance and in disclosure for those sectors. In this paper we will extend to consider residential lending, which in Australia in February 2024 makes up 62% of bank lending according to APRA statistics but has received less attention.

Secondly, this paper looks beyond disclosure and considers what climate risk management looks like at a practical level. We discuss key aspects of Enterprise Risk Management (ERM) for banks, and how this is applied to credit risk management, including credit risk assessment, underwriting and loan origination, provisioning, capital adequacy and stress testing processes. We focus on credit risk as the major risk type arising from the core lending activity of banks; whilst recognising that operational, liability/reputational, and market/investment risks are also impacted by climate-related risks, these are not directly considered in this paper.

We consider climate risk both from a physical and transition risk perspective, where physical risk broadly considers the impact of physical changes in the weather and climate, while transition risk considers the impact of economies moving to reduce greenhouse gas emissions to net zero.

1.2 Context of a changing climate

Scientific evidence coordinated through the Intergovernmental Panel on Climate Change (IPCC) unequivocally demonstrates that climate change has been caused by human generated emission since the industrial revolution. Earth's eco-systems are approaching a tipping point, where further increases in emissions and therefore temperatures could cause irreversible shifts in the climate. Increasing temperatures will give rise to climate physical risks, resulting in adverse consequences including increased extreme weather events.

A number of governments have agreed to limit global temperature increases to no more than 1.5C above pre-industrial levels (the global benchmark set by the 2015 Paris Agreement). This will require drastic reductions to greenhouse gas (GHG) emissions, which in turn will require economy-wide structural changes to substantially reduce reliance on fossil fuels and transition to renewable energy. These actions give rise to climate transition risk, and the resulting economic structural shift impacts all banking segments: retail, commercial and institutional.

Banks will need to operate with the increasing uncertainty of nature and timing of the change, balancing their strategic ambitions and to prudently manage risk. This means making climate-risk

informed assessments of new loan applications, understanding climate-related risks embedded into the existing lending portfolio, and managing financial resources such as capital resources in the context of climate related risks.

Action by banks to date has been sporadic and slow (TCFD, 2023), relative to other sectors such as general insurance. One of the key drivers of this is the inherently different nature of climate-related risks compared to the risk-types traditionally managed by banks such as credit, market and operational (see Section 3.3). This requires new capabilities, skills, methods and data to be brought into bank processes, and this takes time and resources.

1.3 Climate-related risks

Climate change and climate risk means different things to different people. In order to ensure that a comprehensive approach is taken to addressing both changes to the climate itself and the global actions being instigated in response to mitigate and adapt to climate change, consideration needs to be given to the two primary types of climate-related risk.

Physical Risk

The Australian Accounting Standards Board (AASB) in its Exposure Draft on Australian Sustainability Reporting Standards (ASRS) (AASB, 2023) defines physical risks as:

"risks resulting from climate change that can be event-driven (acute physical risk) or from longer-term shifts in climatic patterns (chronic physical risk). Acute physical risks arise from weather-related events such as storms, floods, drought or heatwaves, which are increasing in severity and frequency. Chronic physical risks arise from longer-term shifts in climatic patterns including changes in precipitation and temperature which could lead to sea level rise, reduced water availability, biodiversity loss and changes in soil productivity.

These risks could carry financial implications for an entity, such as costs resulting from direct damage to assets or indirect effects of supply-chain disruption. A for-profit entity's financial performance and a not-for-profit entity's ability to further its objectives could also be affected by changes in water availability, sourcing and quality; and extreme temperature changes affecting the entity's premises, operations, supply chains, transportation needs and employee health and safety".

Widely adopted physical risk scenarios include the IPCC's Representative Concentration Pathways (RCPs) (IPCC, 2014) and the NGFS scenarios (NGFS, 2023). The RCPs represent different plausible future concentrations of greenhouse gas emissions, used in climate science models. Whilst not specifically created for financial risk assessment, they are often used as the foundation of a financial climate risk assessment which may apply models to evaluate the financial implications of these scenarios. The NGFS scenarios on the other hand were designed specifically to assess climate-related impacts, both physical and transition, to the financial system. In Australia bodies such as the Climate Measurement Standards Initiative (CMSI, n.d.) have carried out work to provide the level of granularity needed in running scenario analyses for Australian banks.

Physical risk affects banks as it can impact the ability of borrowers to service loans, as borrowers face lower income and or higher expenses in responding to adverse climatic changes or events. It can also reduce asset values of physical collateral held against secured loans. Borrowers may also have trouble sourcing the required insurance over assets pledged collateral. These are discussed in more detail in Section 3.1.

Transition Risk

ASRS (AASB, 2023) defines transition risks as:

"risks that arise from efforts to transition to a lower-carbon economy. Transition risks include policy, legal, technological, market and reputational risks. These risks could carry financial implications for an entity, such as increased operating costs or asset impairment due to new or amended climate-related regulations. A for-profit entity's financial performance and a not-for-profit entity's ability to further its objectives could also be affected by shifting demands from recipients of its goods and services (e.g. consumers) and the development and deployment of new technology".

Modelling transition risk requires making assumptions on likely policies as well as industry and consumer responses. It is further complicated as changes in international markets will also affect outcomes, which is particularly relevant for Australia with its high dependence on international trade.

Transition risk scenarios can be classified as orderly, where climate policies are assumed to be introduced early and have a gradual impact over time, or disorderly, where impacts of the transition are more sudden due to policies or actions being delayed and subsequently introduced without notice. Transition scenarios help model different pathways to reach the goals outlined in the Paris Agreement, illustrating the contribution of policy design, technological innovation or market changes to climate action. Australia's recently formed Net Zero Economy Authority (NZEA, n.d.) aims to support workers in emissions intensive sectors reskill and access new employment, coordinate programs and policies across government to support regions and communities as well as help investors and companies engage with net zero transformation opportunities.

The NGFS's scenarios are commonly used around the world by financial institutions to model transition risk, as seen in APRA's CVA as well as other similar initiatives conducted by the European Central Bank and the Bank of England. Additionally, the International Energy Agency (IEA) have developed widely adopted transition scenarios, specifically exploring transition risks associated with shifts in energy technologies, policies and market dynamics.

Transitional risk impacts for residential lending are transmitted through both regional and industrial exposure. Transition risk contains regional qualities, whereby sudden and acute changes to emission emitting industries are transmitted across other sectors reliant on these industries in these regions. This regional impact was apparent in the results from APRA's CVA (APRA, 2022), which concluded that particular regions and sectors could be acutely impacted under climate risk scenarios.

Most transition risk modelling to date tends to be conducted at the industry sector level, with models producing impacts on broad macroeconomic variables. This includes APRA's CVA, which used a top-down modelling approach with limited sectorial detail, assuming no region or sector-specific responses based on differences in production and consumption patterns. Industry sector impacts are readily translated to into impacts for corporate borrowers whose exposure arises from changes to demand for their services, as well as the cost of their inputs.

For climate risks within a bank's residential lending portfolio, it is necessary to consider the geographical exposure to climate physical risk, which varies across Australia (CMSI, n.d.). Further, since different sectors are concentrated within different geographic regions in Australia, transition risk is also driven by geographic exposure – i.e. the health of the local economy under transition. Thus, to have meaningful results of a bank's exposure to climate risk, bank's need to perform such assessments at a fine geographic resolution.

1.4 Climate risk assessments for banks

Banks have started to incorporate climate risk assessment using a combination of regulatory expectations, emerging disclosure reporting standards, and needs of customers, funders, and investors to guide their approach.

Regulators globally have commenced running various exploratory exercises across major financial institutions on climate-related risk. In Australia APRA ran the CVA for banks in 2021 to 2022, which required the selected prescribed scenarios to be applied by the four major banks plus Macquarie Bank to their portfolios and the results reported back to APRA.

The economy-wide scenarios used in such assessments may not test, or not test at a sufficient level of granularity, the idiosyncratic climate-risk profile for a specific bank. Therefore, banks have developed their own scenarios (often based on the global scenarios included within the NGFS scenarios) to test the climate-resilience of their largest and/or most vulnerable portfolios. The Commonwealth Bank of Australia was the first to do and disclose this in their landmark 2018 work assessing the vulnerability of their home loans portfolio to physical climate risk (CBA, 2018), followed a year later by a similar exercise for the agriculture portfolio. Other Australian banks have since followed suit.

Disclosure expectations have been a major driver of the work undertaken by banks to date in the climate space. The content of disclosures to date has been driven by the recommendations of the TCFD, a body established by the Financial Stability Board and chaired by Michael Bloomberg, which developed principles-based recommendations on disclosure designed to solicit “decision-useful, forward-looking information” for use by investors (TCFD, 2017). Various jurisdictions, regulators and companies have adopted these as a framework for disclosure standards.

However, their role in disclosure is about to be superseded by new sustainability disclosure standards from the ISSB (ISSB, 2023), part of the International Financial Reporting Standards (IFRS) and implemented through local jurisdictions. In Australia, the AASB has released its draft ASRS (AASB, 2023), which are proposed to come into force for the largest corporations from 1 July 2025 (Chalmers, 2024).

For disclosing companies this will mean reporting on their governance, strategy, risk management and metrics and targets relating to climate-related risks and opportunities. The legislation includes a timeline for assurance over such disclosures. Compared to existing accounting standards, much of the ASRS disclosure is qualitative in nature. Quantitative disclosure metrics are not fully specified within the ASRS, which do not include sector specific guidance developed by the ISSB. And many metrics will relate to greenhouse gas emissions, which are currently not routinely captured within financial systems and ledgers. New metrics, methods and processes will need to be rapidly established in order to enable companies to meet these disclosure requirements within the required timelines, and to enable effective assurance by auditors.

The introduction of sustainability reporting standards will increase pressure on banks to understand the implications of climate change on their portfolios and operations and articulate their how they have adapted their strategies, business plans and risk management frameworks in response.

1.5 Objectives of this paper

Banks play a central role in the functioning of economies. The global response to mitigating and adapting to climate-related risks will result in in significant changes to the operating and economic environment for all banking customers. This paper aims to provide a practical guide for banks to incorporate climate risk into their broader risk management processes.

In this paper we have focused on residential lending (i.e. home loans), as they are the largest part of Australian banks' balance sheets, and property ownership plays a significant role of in the wealth of many Australians. The general principles and approaches demonstrated will also be required for other banking products and markets, though the methodologies may differ.

We begin with a general description of typical enterprise risk management frameworks for banks, then discuss the potential impacts of climate-related risk, and finally discuss how these can be integrated within the bank's key credit risk management processes.

2 Enterprise Risk Management for banks

2.1 Risk management frameworks

In its Risk Management Prudential Standard CPS220 APRA defines the Risk Management Framework (RMF) for financial institutions as

"the totality of systems, structures, policies, processes and people within an institution that identify, measure, evaluate, monitor, report and control or mitigate all internal and external sources of material risk."

It is important to note that this definition is not limited to a document or set of documents, but rather the totality of the way that banks bring risk into their decision-making processes.

The foundation of any RMF is the Board's Risk Appetite. This is usually documented in the Risk Appetite Statement (RAS), and it defines the boundary on the level of risk which the Board is willing to accept. It can be thought of defining the playing field within which management must operate. It should be noted here that the RAS does not define the level of risk the Board wants to take, so is not a target; it just defines where the Board is unwilling for management to operate.

The Risk Appetite is then translated by the Risk Management function, under the leadership of the Chief Risk Officer, into minimum standards and limits to which the business management must operate. This is usually articulated via various risk policies and standards, the most significant of which are approved by the Board as being in alignment with their Risk Appetite.

However, all of this documentation will mean very little if the content is not operationalised by business owners. Therefore, the business needs to incorporate all of the RMF documentation into their Standard Operating Procedures (SOPs) and processes, which are the procedure documents followed by staff in undertaking their everyday activities. These SOPs need to allow for all of the risk requirements as well as those of other functions, such as Customer Service, Financial Crime, Finance etc. Post the Banking Royal Commission in Australia the mantra became "Risk is everyone's accountability", and it is by incorporating risk requirements into operating procedures that the business puts this accountability into practice.

What all of this means is that when new risks emerge, such as climate-related risks, updating the RMF is no small task, as it impinges on every relevant process that supports decision-making across the organisation.

2.2 Credit risk management

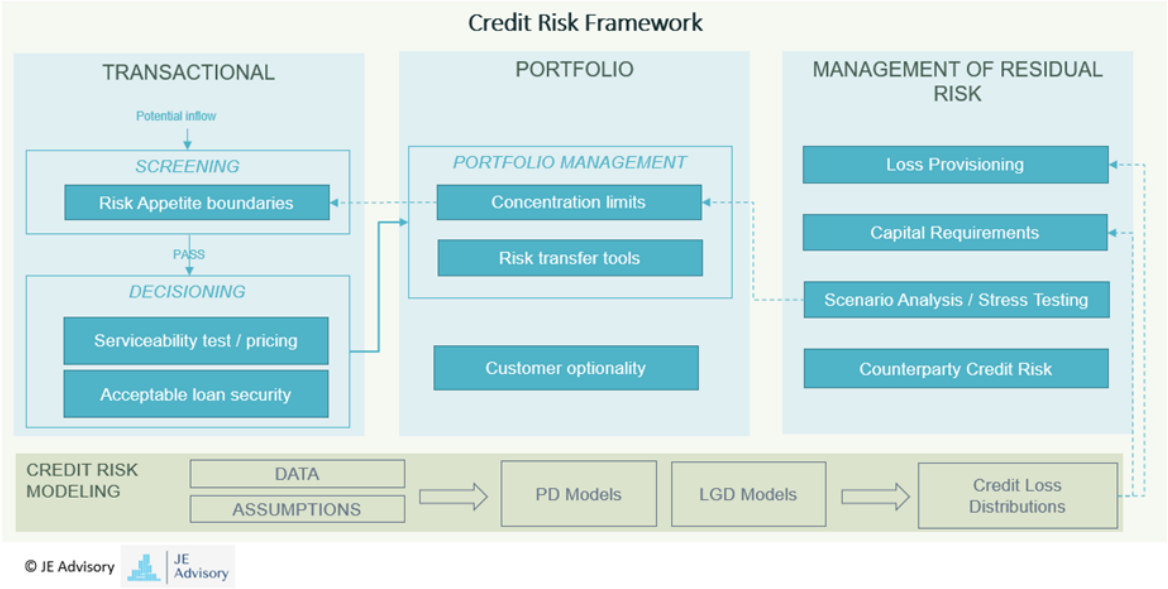
A bank's primary activity is to intermediate between lenders and borrowers of money, and to make a return on this activity by borrowing funds at one rate and lending it out at a higher rate.

If every lending customer was certain to repay their loan per the terms of the contract, then there would be little to worry about. However, as we know, life is full of uncertainties and so bank loans are subject to credit risk, i.e. that customers will be unable or unwilling to repay their loans per their contract.

This credit risk needs to be assessed at origination of new loans, and then managed over the lifetime of the loan once it is on the bank's books and until it is fully repaid. Consequently, banks will operate a Credit Risk Framework (as a material sub-component of the overall RMF). The framework will be divided into a number of key components, and although there is no standard design of these frameworks, it would need to address several key aspects:

- *Transactional* – covering loan origination and loan conditions/pricing
- *Portfolio* – covering the management of the bank's loan portfolio
- *Financial management of residual risk* – covering financial protections put in place against potential future credit losses
- *Credit risk modelling* – covering the tools and methods to quantify and understand the level of credit risk exposure

These elements and their high-level interactions are illustrated in the diagram below.



A bank's credit risk policy will describe how banks will manage credit risk over the lifetime of loans it originates.

Transactional

The first hurdle any prospective bank customer will have to clear is falling within the bank's risk appetite boundary. If the Board has articulated that it does not wish to be exposed to certain types of risks, then these applications will be screened out without further consideration.

Even for those who pass screening, banks will be selective about who they lend to and the terms on which they lend. This is to align with their target market, to minimise customers that might default on their loans, and to ensure appropriate security over the loan, so that should the customer default the bank will have recourse to an asset/guarantee that will reduce the amount of any loss they might suffer.

Thus, at a transactional level, banks will set certain lending criteria that must be met by prospective customers, including:

- a serviceability test to seek to ensure that customers will be able to meet their contractual repayments of loan principal and interest, and
- minimum standards for acceptable loan security.

Banks may also place certain conditions on the loan (e.g. customer commitments during the term of the loan) and of course can also price the loan based on the estimated level of risk (albeit much of

retail and business lending is done on a binary basis where accepted applications receive the same price or interest rate).

Portfolio management

Portfolio management is all about managing the risk profile of the lending book. The management of the portfolio composition is important as too much exposure to a certain counterparty group, industry, type of exposure or geography can leave the banks susceptible to concentration risk, i.e., that a factor impacting a certain segment of the portfolio leads to systemic losses across the segment which in aggregate lead to unacceptable material losses or other financial impacts for the bank.

Therefore, part of the credit policy settings will be credit concentration policies which set aggregate exposure limits for different dimensions of the credit portfolio. So, part of the screening of loan applications will be to decline applications that would result in a breach of the concentration limits. Once loans are on the book, it is very hard to independently manage concentration risk. Banks can use risk transfer mechanisms such as credit default swaps, where two banks swap losses from complementary high-exposure and low-exposure segments. However, this depends on finding a willing partner for the swap. Securitisation is also an option for transferring loans to investors and can be applied to residential loan portfolios.

One further aspect of portfolio management that often gets less consideration is changes in the risk profile of the portfolio due to customer optionality. This arises because of the actions taken by existing customers, so is something that the bank cannot directly control. Many of these relate to typical customer behaviours, such as their propensity to pay down loans early or re-finance loans away to another institution, as well as the “stickiness” of deposits (i.e. customers leaving their cash on deposit for longer than the contractual date of the product). These patterns of behaviour are often formed over long period of relative stability, and then become baked into bank assumptions of expected future behaviour.

Management of residual risk

The bank needs to establish appropriate financial protections against potential future credit losses arising from lending portfolio. The regulatory prudential standards define minimum requirements for establishing appropriate amounts for two key financial protections:

- *Provisions* – which cover the expected losses from the lending portfolio, and follow methodologies set out in international accounting standards.
- *Capital* – which covers the additional potential unexpected losses that could be experienced by the lending portfolio, and follow methodologies covered in the prudential standards which in turn are generally based on the thought leadership issued by the Basel Committee of the Bank of International Settlements. Banks also use stress testing and internal capital models (economic capital) to inform capital adequacy.

These financial protections are put in place by the regulators to ensure that bank shareholders have provided sufficient financial resources, so that in the event of unexpected losses occurring the safety of customer deposits is not compromised.

Both provisions and capital level are quantified using credit risk models, as well as by considering *scenario analyses* (which examine credit losses under various future potential economic pathways) and *stress testing* (which examine the potential spread of “extreme” potential losses around a central scenario). The results of these “what if” scenarios and stress tests should also be used to inform the

Risk Appetite Statement and policy settings (e.g. concentration limits), so as to avoid creating a future lending portfolio whose risk profile would fall outside the Board's Risk Appetite.

Counterparty Credit Risk arises from risk that the other party in an investment, credit, or trading transaction (rather than a lending decision) may not fulfil its part of the deal and may default on the contractual obligations. So, counterparties to credit swaps, hedging instruments or insurers are examples of these, which might include other banks and financial institutions.

Credit risk modelling

Credit risk modelling is used to provide the quantification and understanding of credit risk. Ultimately it is about establishing loss distributions for different types of loans. Key input models are those used to measure:

- *Probability of Default (PD)* – the probability of a particular loan defaulting on its repayment obligations; and
- *Loss Given Defaults (LGD)* – the size of the potential loss should the loan default.

Each of these models will have a number of drivers i.e. factors that have been established as having a causation impact on the measure. Data and/or assumptions will be required to establish the appropriate level/quantification of each driver for a given loan. Models should also consider potential PD – LGD correlation, where factors that drive higher PD may also drive higher LGD.

The resulting loss distributions are used to quantify the appropriate level for provisions and capital, that are designed to ensure the financial stability of the bank. Therefore, a lot of detailed analysis and regulatory scrutiny is applied to the models and the data and assumptions that feed into them.

3 Risks arising from climate change on residential lending

3.1 Climate physical risk impacts on residential lending

There are at least four mechanisms by which climate physical risk impacts on credit risk for a bank's residential lending portfolios.

- Impact of increased damage and repair costs from climate physical risk on household finances and the ability to service home loans
- Impact of increased insurance costs on insurance purchase decisions
- Reduced availability of insurance
- Impact of increased disasters and climate-related events on house prices

Extreme weather events, such as floods, storms, cyclones, coastal inundation and erosion, and bushfires in Australia, can damage properties leading to costs associated with repair and replacement of buildings and contents. At significant extremes, this can require a complete rebuild of the property. These costs will primarily fall to householders, putting stress on household budgets and in potentially default on home loan repayments.

Insurance and risk pooling

While home (buildings and contents) insurance can provide some protection against the costs of extreme weather events, it is important to understand that the cost of insurance reflects the expected annual average cost for each individual home. In Australia, competitive forces and increased technological capability, means that insurers aim to accurately price the risk at an individual address level. While this expected cost is simply transferred in the insurance price, the unexpected cost is what is effectively pooled by insurers, and then transferred to capital markets either directly through listings in share markets, or indirectly through reinsurers. Through this mechanism, insurers diversify the expected cost across time (i.e. smooth year to year volatility) and diversify unexpected cost across time and geography by pooling risk. The expected cost is not pooled across geography under address-based risk pricing (Actuaries Institute, 2020).

Home insurance acts as a risk control and serves to transfer risk for the lender to an insurer. However, it can fail in three ways.

- Firstly, home insurance may not cover all the risk. For example, in Australia typical insurance policies do not cover actions of the sea, except in limited circumstances such as from storm surge caused by cyclones. In addition, typical home insurance does not cover the value of the land.

- Secondly, insurance may not be purchased by borrowers, even though this is a standard condition of lending for many lenders. For example, the ACCC noted in 2020 that 11% of homes did not have insurance coverage, though this almost doubles to 20% in Northern Australia, where extreme weather events are more frequent compared with the rest of Australia (ACCC, 2020). This protection gap is exacerbated where borrowers do not purchase sufficient insurance to cover the costs of rebuilding or replacing contents – also known as underinsurance. Recent research by the Melbourne Institute suggests borrowers may deliberately underinsure when budgets are strained (Settle & Ananyev, 2023). Where borrowers do not purchase insurance, or enough insurance, lenders are potentially directly exposed to climate physical risk events.

- Thirdly, climate change, by increasing the frequency or severity of extreme weather events, will drive-up insurance costs, and potential levels of non-insurance or under-insurance as insurance becomes less affordable.

Climate physical risk could also impact on property prices. For example, following the 2022 Northern NSW and South East Queensland floods, Mullumbimby recorded the largest 12-month decline in property prices nationally, down 30.1%, roughly equivalent to a $432,000 decline in the median value, followed by South Lismore which decreased by 27.0% (CoreLogic, 2023). Historically, however, longer-term house prices in Australia have been by other factors such as constrained supply and market incentives, and such trends in prices have not persisted. However, there is strong evidence in other markets that increased exposure to natural disasters can impact on house prices, where areas at risk of flooding have a 3% to 6% price discount in comparison to properties that are not at risk (Nguyen, et al., 2019) . Such reduced property prices can increase loss given default for banks, leading to higher credit risk.

Assessment and measurement of climate physical risk for residential lending

To measure a bank's exposure to the physical risks from climate change, both the uninsured and insured risks need to be considered.

Uninsured physical risks for a property include perils that are not covered by insurers, for example coastal erosion and heat stress in Australia. To convert this uninsured risk impact into credit risk impact, a bank must look at the loan exposure at risk from these uninsured perils. First, future climate scenarios must be defined including impact of extreme weather-related events. Next, the risk of properties exposed to the uninsured perils can be estimated under current and future scenarios. Finally, exposure of the portfolio exceeding different risk thresholds can be measured.

Insured risks for a property include perils that are covered by insurers, for example, bushfires, floods, storms, hail, cyclones and earthquakes. If a property has full insurance coverage, there is minimal risk to the bank, except potentially through loss in the value of the land itself. However, where a property is not covered, the physical risk can be converted into credit risk for the bank. Many properties do not have insurance because it is unaffordable today and this is expected to rise as changing climate conditions over time drives up the cost of insurance making it unaffordable in the future.

Measuring climate physical risk using insurance to price climate risk

By looking at the impact of perils on home insurance premiums, a climate adjusted property value can be calculated which will inform a climate adjusted loan to value ratio. Additionally, looking at the impact of perils on home insurance premiums provides information on home insurance affordability and loan serviceability impacts. Both the home insurance affordability and loan serviceability metrics combined with the climate adjusted loan to value ratio gives information of the loan exposure at risk from insured perils caused by climate change. Specifically, the current climate physical risk can be measured by setting thresholds on the home insurance affordability metric and the adjusted loan to value ratio and assessing the proportion of the portfolio that exceeds the different thresholds. For future climate physical risk, an additional threshold on the loan serviceability metric can be set and assessed against.

To measure this, banks can use the following general approach:

- Define climate scenarios including impact of extreme weather-related events
- Estimate average annual losses from the perils under the current and future climate scenarios. The average annual loss is an estimate for premium for home insurance to cover

the insured perils, which can be calculated at an individual property level. The average annual losses can be loaded up to consider taxes, profit margins and non-weather-related costs to calculate property level home insurance premiums.

- Estimate the implied increase in these premiums under different climate scenarios.
- Using borrower income information, a home insurance affordability metric can be calculated as the ratio of home insurance premium to income under each scenario. Where climate change increases the cost of weather-related events, the home insurance premium is likely to increase. This increased home insurance premium, when taken as a ratio of the loan exposure equates to an equivalent interest rate shock or a serviceability impact.
- The property price can be adjusted by the capitalized value of future home insurance premiums. A rational informed consumer would discount the property price for this future increase in insurance costs. Then, an adjusted loan to value ratio can be calculated under the different climate scenarios.

Looking at the home insurance affordability metric, the adjusted loan to value ratios and the serviceability impact metric against thresholds, a bank can assess their exposure to physical climate risk under different climate scenarios.

3.2 Climate transition risk impacts on residential lending

The transition has a potential impact on credit risk through impacts on household income (including through employment), expenditure and house prices.

For example:

- Household income depends on local employment opportunities for specific occupations and sectors. For example, workers in high emissions industries, such as coal mines, may become unemployed, underemployed, or otherwise suffer a reduction in income if the coal mining industry is curtailed in an effort to reduce emissions.
- Household spending may also be impacted by the transition as the costs of goods and services may change – for example, increases in the cost of high emissions goods and services such as energy, construction or agricultural produce.
- House prices may also change as local employment opportunities change. For example, the closure of a coal mine could lead to reduced demand for houses, causing prices to fall. An American study tracking how the retirement of fossil fuel power plants influence local migration trends and community dynamics during the transition found that house prices fall 3% after the closure of a coal-fired power station (Liu, 2023).

Changes to household income and spending caused by the transition may impact the ability of a household to meet their mortgage repayments, increasing their probability of default. Reductions to the value of housing stock as communities migrate away because of the transition will contribute to increasing a bank's loss given default.

APRA's CVA discussed the potential variable impact of transition on regional areas of Australia (APRA, 2022). In Australia, the end of the mining boom in 2016 gave rise to similar regional impacts on household income, employment and house prices. Newman, a Pilbara town originally established to support BHP's Mount Whaleback iron ore mine, the largest single-pit open-cut iron ore mine in the world, saw median house prices fall 82% from $850,000 in 2012 to $153,000 in 2016 (Wahlquist, 2017).

3.3 Nature of climate risks

Climate-related risks can differ substantially from typical risks considered for residential lending. For example:

- Climate physical risks can emerge over longer time horizons (CMSI, n.d.) than a banks' usual strategic or business/financial planning horizon. Climate transition risks can emerge faster – for example, Australia's targets for reducing emissions by 43% by 2030, means substantial climate transition risks can be expected to emerge over the next six years. As stated, climate risks typically materialise over a far longer period compared to non-climate induced macroeconomic shocks and include climate variables that are beyond the socio-economic realm that banks use in traditional stress tests (Pui & Werner, 2023).
- Fundamentally, climate change means that the future will not be the same as the past, and this limits the use of historical data as a basis for risk assessment. Even outcomes modelled under scenarios are highly uncertain.
- Climate change is expected to not only impact on the average or expected future outcomes, but also on the volatility of future risk. This unprecedented nature represents the non-stationarity of climate risks, where we arrive at new baselines as we continue to pass tipping points (Energetics, Swiss Re, ARC Centre of Excellence for Climate Extremes, 2022).

Climate risks have compounding effects, interacting with each other, including interactions between physical and transition risk, and interacting with non-climate risks. For example, the impact of the 2019-20 Australian Black Summer Bushfires was followed by impacts of the COVID-19 epidemic, leading to compounding climate, health and economic effects. A study seeking to explore this impact proposed a metric called the compound risk multiplier (CRM), which found that the CRM can peak over 150%, meaning, the GDP impacts of the compound shock can be 50% larger than the sum of the individual shocks (Ranger, Mahul, & Monasterolo, 2021).

These characteristics make climate scenarios vastly different in nature to traditional stress tests and banks need to change their thinking when incorporating climate related risks into their risk management framework.

For example, traditional stress tests often feature a financial shock defined by changes in key macroeconomic variables relative to a baseline. For example, the Basel framework, which underpins international banking regulation, only focuses on short-term capital requirements based on a one-year probability of failure. On the other hand, climate scenarios generally model smoothed macroeconomic pathways over a longer period. In traditional stress tests, these crisis or shocks recover, and the economic variables revert to pre-crisis levels. Climate scenarios on the other hand continue to arrive at new baselines, as we continue to pass irreversible tipping points. More recently regulators have been considering the interactions between the climate change induced shocks and broader business cycle impacts. Both physical and transition risk can precipitate or heighten a business cycle shock. Finally, the focus of climate risk assessments should centre around the tail risk and potential variability. Focusing on the most likely outcomes under climate change can lull us into a false sense of security (Trust, Bettis, Saye, & Bedenham, 2024). This is because a central estimate approach fails to recognise the margin of risk tolerance deteriorating over time and overlooks the outliers and extremes. Instead, it is the lower probability, high impact tail risk events that banks should seek to mitigate.

4 Implementing climate related risk management for residential lending

4.1 Climate-risk impacts on the credit risk framework

Having established the key elements of the credit risk framework in Section 2.2, we consider which of the elements are impacted by climate-related risks, how are they impacted and how these impacts should be addressed.

Credit risk has traditionally considered the financial risks that:

- loans will not be repaid per their contractual terms, or
- the security for the loan will not provide adequate recourse in the event of default.

Lending decisions may also have historically considered Corporate Social Responsibility (CSR) aspects, such as the ethical aspects of lending to industries such as gambling or munitions manufacturing, which impact the reputation of the organization with some stakeholders.

Climate-risk (and sustainability more widely) takes this reputational consideration to a whole new higher level. Large sections of society and bank's other stakeholder groups have strong concerns on climate-change and the emissions-intensive activities that science has shown fuel this. In making lending decisions, bank's therefore now need to consider not only the traditional financial credit risks as they have in the past but also the wider reputational aspects of extending credit to certain industries and counterparties. These reputational impacts are not just contained to the deal in questions; they are much wider as ultimately, they will influence who wants to do business with you as an organisation, with implications for ongoing support of investors, shareholders and customers. The dual consideration of financial and reputational risks, means that it is vital that credit risk management takes a *double materiality* approach when considering climate-related risk. Double materiality means assessing both:

- the impact of the external operating environment on the company ("Outside-In" factors); and
- the impact of the company on the external environment ("Inside-out' factors)

In the context of climate-related risk:

- Outside-in factors would include the changes in the physical environment and the economic environment driven by the shift towards a net-zero economy.
- Inside-out factors would include reputational damage from supporting companies or industries that are not net-zero aligned and contribute to physical climate change via their high-emissions generating activities. (when extended to wider sustainability consideration this lens brings many more factors into play, such as pollution, waste management, biodiversity damage, unethical labour practices, etc)

Applying this double materiality lens to the elements of the Credit Risk Framework described earlier identifies the following examples of where climate-related risk has impacts:

Credit Risk Framework element	Example impacts on CRF element		
	Physical Risk	Transition Risk	Reputation
Risk appetite boundary	Limited appetite for locations at very high-risk from physical perils	Limited appetite for industries at very high-	Reputation damage from supporting climate-damaging companies

Credit Risk Framework element	Example impacts on CRF element		
	Physical Risk	Transition Risk	Reputation
		risk from transition to net-zero economy	
Serviceability test / pricing	Increased insurance costs for climate-vulnerable properties	Decreased profitability of transition-impacted companies (either directly or indirectly).	
Serviceability test / pricing	• Incorporating climate-related risk into credit assessments and scorecards. • Introducing greater granularity in risk-based pricing to differentiate between customers with materially different levels of climate-related risk exposure.		Reputation damage from charging the most vulnerable customers higher prices for loans, or not offering terms at all.
Acceptable loan security	Impact of physical climate vulnerability on the value of property and land	Impact of potential obsolescence of secured assets in net-zero economy on resale value	Reputation damage from not supporting the most climate impacted customers
Concentration limits	Limit exposure to locations at very high-risk from physical perils	Limit exposure to industries at very high-risk from transition to net-zero economy	Reputation damage from disproportionate support of high emitters.
Risk transfer tools	Increased risk of losses in our own or potential counterparties' portfolios make mutually acceptable credit swaps harder to achieve.		
Customer optionality	Higher-risk customers less likely to overpay on mortgage repayments due to increased insurance costs	Higher-risk locations less able to re-finance and loans remain on bank books for longer	
Loss Provisioning and Capital Requirements	Expected and unexpected losses increase due to elevated physical perils incidence and impact.	Expected and unexpected losses increase in areas whose primary industry is high emitting.	Reputation damage from lack of appropriate increases in provisions or capital as a result of recognised increase in risk.
Scenario Analysis/Stress Testing	• Scenario Analyses need to consider different potential physical and transition pathways as alternative baselines for the bank.		Reputation damage from perceived unrealistic baseline for

Credit Risk Framework element	Example impacts on CRF element		
	Physical Risk	Transition Risk	Reputation
	• One scenario should form the expected baseline for strategic planning. • Stress Testing needs to consider more extreme "what if" scenarios. • Require a larger number of scenarios to capture uncertainty • Scenario Analyses incorporate a longer timeframe		strategy and financial planning.
Counterparty Credit Risk	Counterparties may default due to exposure to physical climate risks in their business which is currently not considered.	Counterparties may default due to non-recognised exposure to transition climate risks in their business.	Reputation damage from perceived lack of robust due diligence over counterparties.
Data	New data items needed to assess the exposure and vulnerability of loan security to physical risk, e.g. geolocation, property build characteristics.	New data items needed to assess the exposure and vulnerability of loan to transition risk, e.g. industry of employment, primary industry of local economy.	
Assumptions	Current model assumptions require revalidating or amending due to climate-risk factors e.g., extend of customer pre-payment, customer propensity to refinance loans, productivity of agricultural land.		
PD and LGD models	Need rebuilding and recalibrating to allow for climate-related drivers (leveraging above data and assumption enhancements)		
Credit Loss Distributions	Need updating to incorporate climate-related risk changes to PD and LGD models.		

These examples are by no means exhaustive, but clearly illustrate that every element of the credit risk framework is in some way impacted by climate-related risk. Thus, the task of updating the credit risk framework for banks is far from a simple task but is absolutely imperative if banks are to avoid taking on unknown or unrecognised levels of risk which are therefore not able to be managed appropriately.

4.2 Integration into risk management processes and decision making

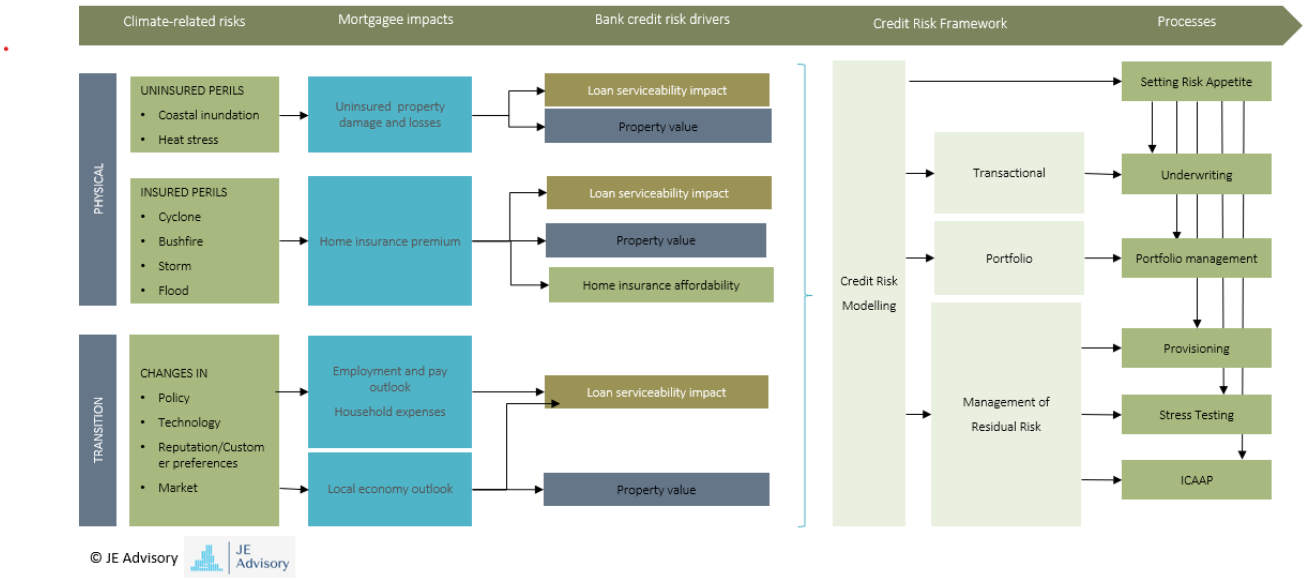
In order to manage the impact of climate-related risk on credit risk, management will need to define appropriate metrics, targets and limits. These can then be used by management to make decisions on:

- Risk appetites and thresholds – What risks is the bank willing to accept?
- Risk pricing – What price should the bank charge for accepting the risk?
- Risk mitigation – What controls and risk treatments should be sought when accepting risk?
- Risk monitoring – How should risks be monitored over time?

This section outlines some practical ways that banks can incorporate climate risk management into six key processes undertaken as part of a bank's Credit Risk Framework:

- Setting Risk Appetite
- Underwriting
- Portfolio management
- Provisioning
- Stress testing, and
- Internal Capital Adequacy Assessment Process (ICAAP).

The focus is on the way that these processes are impacted by climate-related risk for housing loans as shown in the below diagram:



Credit risk models inform all of these processes. One of the key decisions will be how the changes to banks credit risk drivers are brought into the existing models. Two broad approaches are possible:

- Translating climate-related risk impacts into financial parameters which are existing inputs to current credit risk models.
- Including climate-related risk impacts directly into credit risk models as new inputs/drivers (in addition to the current financial/economic drivers)

In practice, it is probably most likely that a combination of these two approaches will be used.

4.3 Climate risks metrics

Banks can use a mix of qualitative and quantitative measures to manage risk. Qualitative approaches include statements about the types of risk that banks may be willing to take or those risks or exposures that banks will not take on.

When implementing climate risk considerations into business decisions particularly at the transactional, portfolio or residual level, quantitative metrics will be required to operationalise risk considerations. Metrics for financial risk that banks use can generally be classified into four types:

- *Exposure at risk* - A readily understood metric that provides a measure of the scale of the problem for the bank given its current portfolio mix. The metric can also be allocated easily to sub portfolio (e.g. by industry or geographic regions). It, however, does not give an indication of how much the potential loss is. In the context of residential lending this is measured using outstanding loan balances for home loans.
- *Expected loss* - Estimate of loss for a given amount of exposure at risk over a given timeframe such as 12 months. As this is a financial impact, it can be linked to the bank's financial objectives for profitability and capital adequacy. It however requires quantifying how much loss arises from the risk.
- *Earnings at risk* - Estimates losses for a given amount of exposure at risk at a given level of confidence. This measures the potential downside or unexpected loss that arises in a period.
- *Value at risk* - Value at risk is applicable to assets which may be revalued on the bank's balance sheet. It is the potential reduction in value at a given level of confidence. Value at risk includes impacts from such as through write down of loans or bonds, or value of investments that have lower market value or must be written down/written off.

Exposure at risk

Exposure at risk can be determined by applying one or more thresholds based on climate risk impacts to individual borrowers or collateral and identifying the high-risk loans as those that breach the threshold. Alternatively, exposure is based on criteria such as exposure to identified regions or industries.

Where exposure at risk is used, any thresholds or limits can be considered on a balance or flow basis. Exposure at risk is expressed on (a percentage of total) balance basis is an indicator of risk that has been accumulated in the portfolio. Exposure at risk as a percentage of new business flows gives an indication of how much risk is added and gives better indicator of changes.

Exposure at risk is key metric particularly for measuring and managing concentration risks. Exposure at risk is also required to be reported under proposed climate risk disclosure standards. (IFRS S2, and proposed ASRS)

Expected loss

Expected loss requires estimating loss associated with exposure. Expected loss from credit risk is generally calculated as:

$$Exposure \times Exposure\ at\ Default \times \Pr o\ bability\ of\ default \times Loss\ Given\ Default$$

In general, for credit risk, historical data is available to determine the key metrics Exposure at Default (EAD), Probability of Default (PD), and Loss Given Default (LGD). Some of these models can be

leveraged to estimate the impact of climate risk. For example, the impact of reduced serviceability from increased insurance premiums can be estimated using models that link serviceability to PD, or the estimated impact on asset values translated to LGD impacts.

In addition, the individual components (i.e. PD rate, or LGD rate) or percentage loss rate can also be used as metrics and limits. Banks may not have appetite to make loans that are expected to have a high loss rate or a high PD. Similarly, security coverage or LVR may be used in metrics and limits.

Accounting and APRA prudential standards have specific requirements to set up provisions to cover expected losses from credit risk, and banks may need to consider if climate risk related credit losses should be incorporated in provisions.

Earnings at risk or Value at risk

Determining Earnings at Risk or Value at Risk requires estimating a distribution of losses. This is possible for some risk types such as credit losses or market losses by using the distribution of historic losses. Where there is insufficient historic data or the data is not representative of the full distribution of losses (as is the case for climate risk), then expert judgement and scenario analysis can be used to determine the loss distribution.

Earnings or value at risk feed into both risk appetite considerations as well as capital a bank should hold. Stress testing can be used to identify where banks have material Earnings at risk from climate change and therefore may hold additional capital buffers.

4.4 Scenario analysis in the context of residential lending

As set out in APRA CPG 229, scenario analysis is the main approach used to assess the impacts of climate risk, given the significant uncertainty on the timing, transmission and impact from climate risk. Scenario analysis provides impacts on assets from physical climate risk, or the impact on revenue, expenses and income earning potential from transition risk.

Scenarios representing a lower and upper boundary can be used to estimate the range of outcomes. For physical risk this can be a low and high emission scenario (for example set as RCP2.6 and RCP8.5). An alternative is to use specific events as scenarios to determine exposure to physical risk. For transition risk, scenarios such as state policy or net zero transition scenarios can be used.

- A mid-point or low severity scenario could be used for the purpose of estimating expected losses. Banks will need to consider if any losses assessed from climate change scenarios should be included in their provisions for either regulatory or accounting purposes.
- An adverse scenario may be used to identify high risk exposure and as an upper bound for losses related to climate risk. Hence this could be used to estimate earnings or value at risk.

4.5 Applications within a bank's RMF

Setting risk appetite

Banks can use any of the metrics above to translate risk appetite to operational limits. Use of the metric should balance practicality and reflect the types of losses that a bank is looking to protect against.

Metric	Application in Risk Appetite Setting	Examples
Exposure at Risk	Transactional	• No more than 2% of new loans written for addresses with high exposure to physical risk • No more than $5m in new loans in any one SA4 identified as having high exposure to transition risk • Maximum LVR for loans secured by high-risk properties is 70%
Exposure at Risk	Portfolio	• Risk accept where exposure to high risk at portfolio level is less than 2% • Annual evaluation of physical risk where exposure to high risk properties exceeds 2% • Implement underwriting controls on loans for high risk properties where exposure to high risk properties exceeds 3%
Expected Loss	Transactional	• Maximum probability of default for a loan is 3% • Maximum expected loss attributable to future climate risk is 1% of exposure
Expected Loss	Portfolio	• Maximum overall expected loss of 3% • Maximum overall expected loss attributable to climate risk of 0.5%
Earnings at Risk	Portfolio	• Maximum Earnings at Risk attributable to climate risk not to exceed 5% of Target Management Capital Buffer.

Once the risk appetite is set, then management will need to:

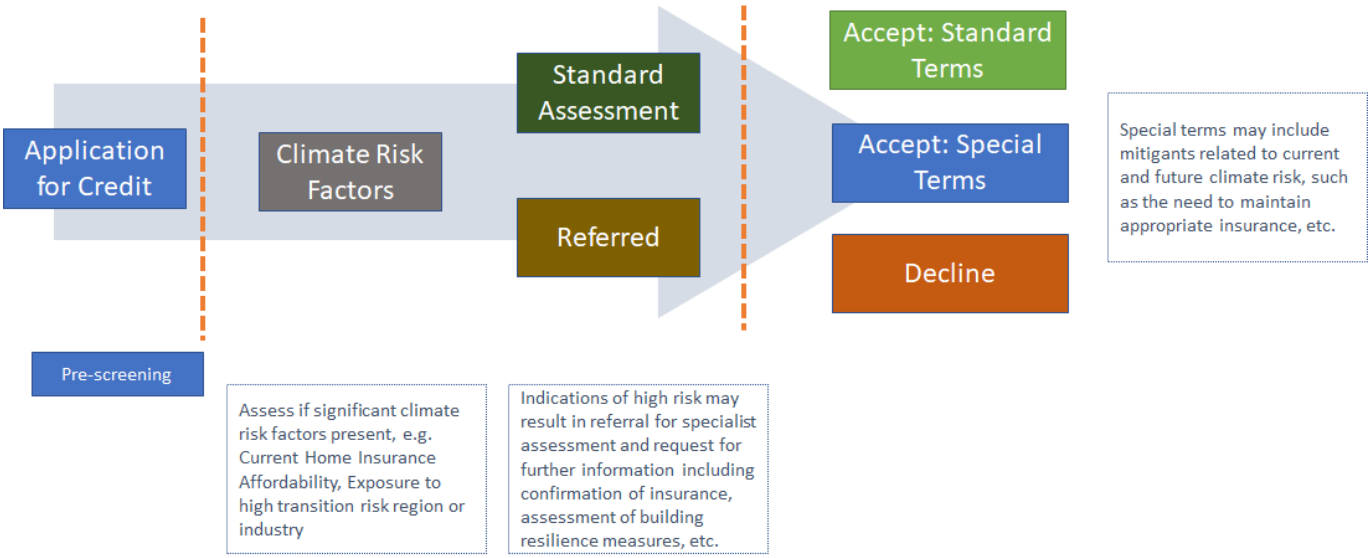
- Implement appropriate systems and reporting to monitor metrics against risk appetite limits
- Translate limits to more granular limits for individual business units
- Carry out regular reviews of the limits to reflect loss experience as it flows through, and as the science and understanding of climate risk and the impact for credit risk continues to evolve.

Underwriting

Prudent underwriting at loan origination ensures that the bank does not accumulate excessive risk and that risk is consistent with pricing and risk appetite. Once loans are originated, banks have few options to transfer the credit risk. At origination banks need to decide whether to accept the risk (and conditions or covenants required), or to decline. Underwriting processes should be balanced with ensuring that customers are not excessively impacted and that it does not result in business being turned away particularly where conservative or too broad a criterion is applied.

Scenarios analysis will be useful to identify how climate related risks will be transmitted and therefore the characteristics that need to be considered at the point of underwriting. As noted above, the impacts of climate risk will likely be concentrated in specific geographical regions and industries. Hence underwriting practices should be targeted to avoid unnecessary processes and impacts across all customers. The process and metrics should be readily implemented in the underwriting and workflow systems.

Underwriting staff will need to be appropriately trained to assess the specific risks associated with climate change and be able to communicate the underwriting decisions for clients. While outside the scope of this section, the banks will need to consider the implications of not accepting loan applications due to climate risk on customers and broader reputational and legal risks.



Underwriting and loan pricing at origination is a key lever to manage the level of credit risk in the portfolio particularly where there are limited opportunities or liquidity to hedge or transfer credit risk after origination. Often underwriting and loan pricing methodologies and policies are developed by a central credit portfolio management team.

Portfolio Management

Banks carry out ongoing monitoring of their lending portfolios to manage both risk and profitability. The main objectives of portfolio management are:

- Manage concentration risk across bank
- Manage portfolio profitability and return on capital outcomes
- Support reporting on portfolio performance

Credit portfolio management has a key role identifying changes or emerging trends in portfolio performance. Hence credit portfolio teams need to therefore have access to capabilities to collect and analyse data from both internal systems and external sources. Banks have some levers such as the ability to sell individual or portions of loans, securitise loans or buy protection for credit losses such as through credit default swaps.

Portfolio management utilise a number of tools and platforms to achieve the objectives.

Portfolio Management Capabilities	Addressing Climate Change Related Risks
Early warning indicators	• Ingest new data sources capturing physical and transition risks, data sources may include weather related information, economic activity, supplier and customer dependencies, etc.

Portfolio Management Capabilities	Addressing Climate Change Related Risks
	• EWI will need to include prospective information that statistical models trained on historic data will not capture.
Risk models	• Credit risk metrics able to integrate future climate scenarios to provide climate adjusted views • Enhance capabilities to carry out industry specific stress tests under climate scenarios
Concentration management	• Ensure sufficient degree of granularity to measure exposure to physical and transition risk. This can include geographic granularity, industry sector or by dimensions such as flood annual return intervals.

Credit portfolio management teams will need to carefully consider granularity of exposure measurement and limit setting, to monitor and manage concentrations to physical risk and transition risk. Current geographic resolution such as by postcode may not be sufficient for some perils such as flood and bushfire, similarly industry sector resolution may need to be further refined e.g. mining activity for rare earths used in battery production will be favourably affected in transition scenarios compared to broader mining activities.

Provisioning

Banks generally hold loans at face value (rather than market value) and hold provisions for losses due to credit defaults under accounting rules for financial instruments (IFRS9/AASB9) for their loan portfolios. The calculation of provisions depends on the current credit worthiness of the loan. AASB9 defines three stages:

No change in credit risk since origination	**Significant increase in credit losses from origination**	**Impaired loan or facility**
12 month expected loss	**Lifetime expected loss**	
	• Consider increase in risk of default using a combination of quantitative and qualitative information • Threshold for significant increase in credit risk is judgement based • Should incorporate forward looking information • 'Back stop' or rebuttable presumption is 30 days past due.	Defaulted loans or facilities Meets bank's definition of default which generally includes: • 90 days past due • Bank restructures the loan or facility • Placed in bankruptcy

Upon origination all loans are classified under Stage 1. Banks then monitor their portfolio to identify loans where there has been significant deterioration of credit risk relative to origination and move these loans to Stage 2. This requires judgement as banks need to define their own thresholds and the information they use.

As banks integrate climate risk into their risk management processes, the provisioning process should be reviewed to ensure it is aligned. Key areas are where the bank starts to identify loans that are affected by climate risk:

- Use of data on climate change to identify loans that may have had significant increases in credit risk
- Assessment of provisions for Stage 3 based on the recoverability of assets

AASB9 requires banks to incorporate data, which can be obtained without undue cost or effort. As banks start to systematically collect data for assessing climate risk, they should also look at whether the data will indicate changes in credit risk from a provisioning perspective. If the data is used by the bank to assess loans at underwriting, then there is a strong argument that the data should be used for provisioning as well. Examples of triggers can include:

- Significant increases in home insurance premiums result from insurers pricing in worsening natural perils risk. This reduces serviceability and may affect the property value.
- Recent weather events cause damage disrupting lives and businesses and causing financial stress due to the cost of repairs and clean up;
- Adoption of legislation to support transition to net zero affects specific businesses or counterparties, as well as retail borrowers directly or indirectly employed;

Thresholds can be applied on an individual or collective basis (e.g. borrowers located in a specific geographic region). The selection of thresholds should be balanced so that it does not delay the recognition of provisions or result in loans moving between Stage 1 and Stage 2 frequently. Banks can use stress testing and historical event analysis (e.g. closure of major coal power plant or flood event in particular communities) to evaluate different triggers and thresholds and impact on provisions.

When loans are in Stage 3 (impaired), then the bank needs to assess collective provisions. A key element of the assessment is the likely recovery from sale of assets such as a mortgaged residential property. The valuation of the property should include the impact of climate risk. Methods or models calibrated on historic data may underestimate provisions where it does not capture the impact of prospective climate change, and to the extent this is not captured in historical experience.

Stress testing

Banks use stress testing to inform a range of areas including risk limits, strategy, target capital, capital triggers and management actions. Banks have historically used macroeconomic scenarios such as an economic downturn precipitated by a slowdown in a major trading partner such as China. Banks have now started using independent climate risk stress testing. Scenarios generally follow standard scenarios such as the warming scenarios under IPCC. Banks have also used event scenarios such as a major flood event to assess the exposure of their portfolio. Stress testing is a key tool to evaluate the impact of climate risk and how it may impact banks.

In general, a stress test starts with a scenario narrative, this is then enriched and then impacts on risk factors are calculated. The outcome is the impact on future profitability, capital and capital adequacy as shown in the diagram below.

Scenario Narrative	Scenario Enrichment	Impact on Risk Factors	Forecast P&L and Balance Sheet
Articulates how a stress scenario originates including a narrative of how downturn evolves in Australia	Forecast impacts on production, unemployment, key interest rates, currency and housing and asset prices	Estimate impacts for: • Business volumes and mix • Funding costs • Product interest rates • PD • LGD	Evaluate impacts on forecast financials including capital requirements. Carried out with and with management actions

Banks use credit risk models to link changes in macroeconomic factors such as unemployment, interest rates and house prices to PD and LGD. Similar processes can be applied to climate stress tests, with the difference that the scenario narrative starts with changes stemming from either physical or transition changes. Banks can leverage the extensive research and advances in modelling the physical processes, as well as likely economic impacts from transition to estimate the impacts on their business.

Scenario Narrative	Scenario Enrichment	Impact on Risk Factors	Forecast P&L and Balance Sheet
Anticipated global warming based on a assumption of action undertaken, e.g. restrict warming to 1.5°C vs BAU	Impacts for sea levels, global temperatures, regional risk factors for specific perils, these can be translated to: • Serviceability impact due to insurance costs • Value of assets impacted by physical perils • Productive yield of agriculture • Employment opportunities	Estimate impacts for: • Business volumes and mix • Funding costs • Product interest rates • PD • LGD	Evaluate impacts on forecast financials including capital requirements. Carried out with and with management actions
Narrative on transition risk taking into account stated policies as well as assumptions to meet Net Zero commitments	Impacts on different industries and occupations at a regional level. Results in changes to: • Regional production • Unemployment • Cost of living • House and asset prices		

Reference scenarios published by the Network for Greening the Financial System (NGFS) provide a useful starting point to base scenarios on (NGFS, 2023). These are increasing used by regulators and banks across the globe, and hence will be familiar to the bank's stakeholders such as regulators and investors.

The scenarios such as those from NGFS represent plausible internally consistent pathways. NGFS outline 7 scenarios that test different level of commitment and transition to net zero, with consequent

impacts for physical climate risk. With adaptation, the NGFS scenarios can form the foundation of a bank's stress testing scenarios, Four NGFS scenarios are shown below (NGFS, 2023):

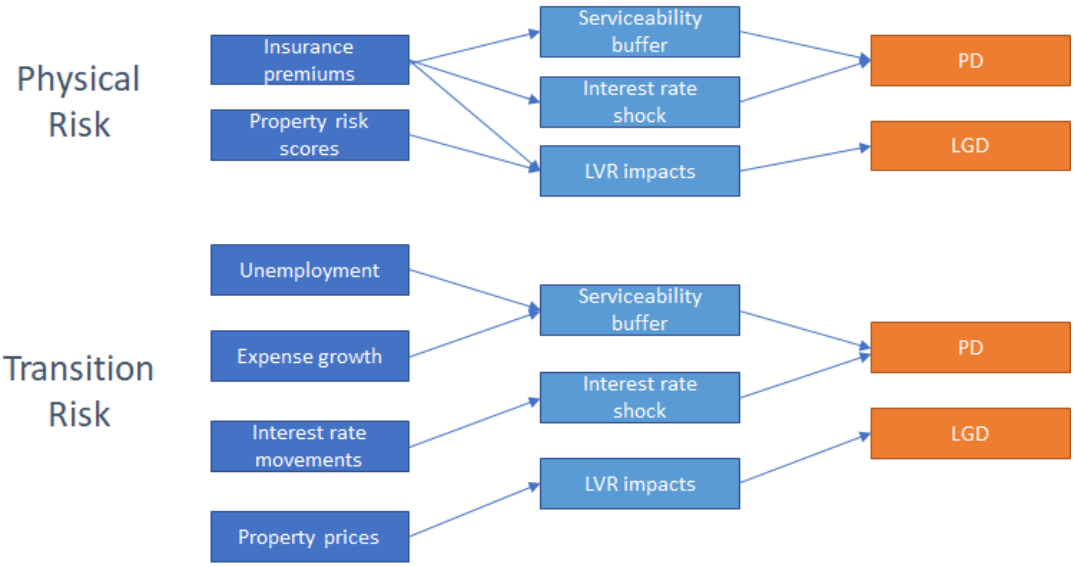
Scenarios name	Description
Delay Transition	Assumes annual emissions do not decrease until 2030. Strong policies are needed to limit warming to below °2C. Negative emissions are limited.
Net Zero 2050	Limits global warming to 1.5 °C through stringent climate policies and innovation, reaching global net zero CO2 emissions around 2050
Fragmented Work	Assumes a delayed and divergent climate policy response among countries globally, leading to high physical and transition risks. Countries with net zero targets achieve them only partially (80% of the target), while the other countries follow current policies
Current Policies	Assumes that only currently implemented policies are preserved, leading to high physical risks.

Once scenarios are defined, scenario enrichment is required to provide level of granularity that allows affected regions and customers to be assessed. Scenario enrichment should consider how risks unfold over time, particularly as time periods are longer than for macroeconomic scenarios currently used in stress testing. Banks may also need to consider the order in how risks unfold and the interactions between physical and transition risk.

Banks will need to access specialist technical skills to enrich scenario narratives such as using perils models to get likely impacts at address level or from broad economy wide Net Zero actions to specific industries and regions.

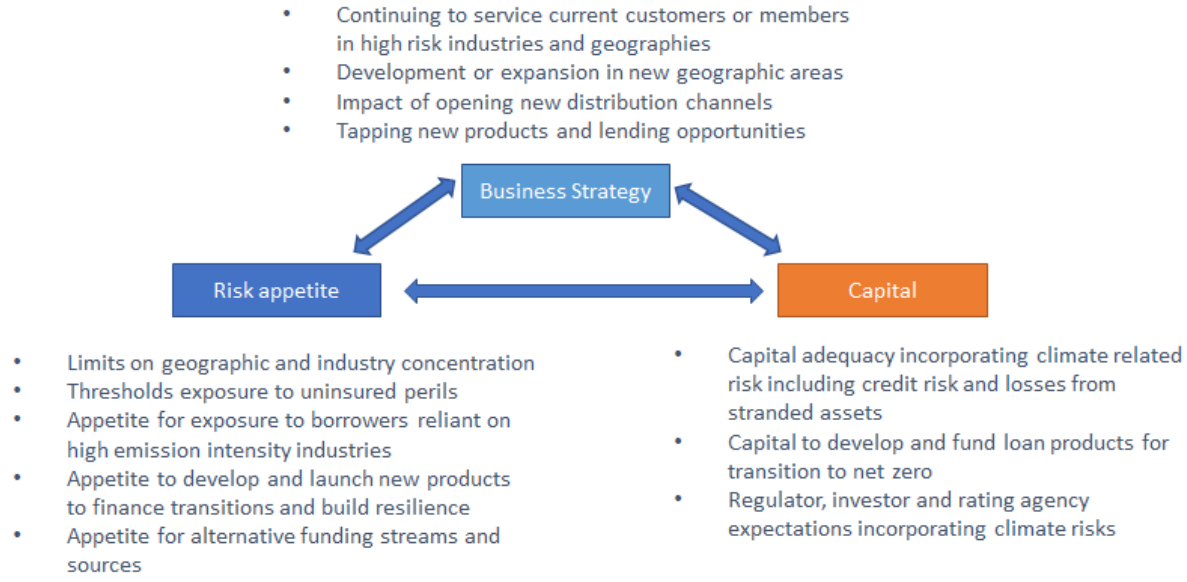
Most analysis to date has involved linking exposure to industries and regions that are most affected and reporting this as exposure at risk under the scenarios. While this is useful to understand the scale of the problem, it does not provide a direct measure of credit risk.

Translating the detailed or enriched scenarios to impacts on risk factors particularly PD and LGD requires judgement. Banks use their existing models and understanding of credit risk. The diagram illustrates how banks can convert climate related impacts to inputs used by credit models such as macroeconomic movements, interest rate, serviceability buffer shocks or LVR shocks:



ICAAP

ICAAP considers the risk appetite and broader business strategy to understand the capital needs of the bank. While regulators have not mandated specific capital requirements to mitigate climate related risks, banks should start to consider how climate risk may impact capital adequacy. The diagram below shows how climate risk feeds into the key linkages across risk appetite, business strategy and capital:



ICAAP should be informed by analysis such as stress testing and will require input from different areas within the bank such as lending, treasury and sustainability teams. This allows banks to assess:

- Business strategy especially expansion into new industries, geographical regions or changes in customer mix from new distribution channels affect exposure to climate risk.
- Strategies such as expanding resilience lending (e.g. lending to improve resilience to physical perils) can reduce risk, however this may need capital to develop and launch the product as well as supporting regulatory capital requirements.

- Potential for larger losses particularly where climate related risk interacts with and compound economic conditions

Stakeholders such as investors and rating agencies may also require banks to explicitly consider climate related risks in considerations of capital adequacy. In particular as banks disclose more on their strategy, risk management and exposure under ASRS, banks need to demonstrate that they have reflected this in how capital is allocated and managed.

5 Closing comments

As has been demonstrated in this paper, climate-related risk impacts numerous elements of ERM for banks, and particularly the credit risk framework.

In assessing potential impacts banks need to take a comprehensive forward-looking approach to changes in the external environment, covering both physical and transition risks, as well as the reputational impacts of their lending activities. This is likely to require new capabilities, including relevant skills, data and assumptions.

Most importantly, banks need to adapt their key business and risk management processes to appropriately and adequately integrate responses to these potential climate-related impacts. Without such action being taken, and continuing to operate as they have historically, banks will take on unknown and unrecognised levels of risk for which they will not be financially or operationally prepared leading to underperformance as these risks become a reality.

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