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Importance of Climate-Related Risks for Actuaries

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Importance of Climate-Related Risks for Actuaries

This paper on the importance of climate-related risks for actuaries was prepared by the Climate Risk Task Force (CRTF) of the International Actuarial Association (IAA).

The IAA is the worldwide association of professional actuarial associations, with a number of special-interest sections for individual actuaries. It exists to encourage the development of a global profession, acknowledged as technically competent and professionally reliable, which will ensure that the public interest is served.

The role of the CRTF is to deliver on the Statement of Intent for IAA Activities on Climate-Related Risks as adopted by the IAA Council on 7 May 2020.

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This paper has been approved for publication by the IAA Executive Committee and its CRTF in accordance with the IAA's Publications Policy. While the paper summarizes many roles actuaries can play with regard to climate-related risks, it is not prescriptive, and the CRTF recognizes that there is a diversity of views regarding practice in this area.

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Table of Contents

Executive Summary	1
1 Introduction.....	2
1.1 Importance and Key Evidence	2
1.2 Why Actuaries Should Care	2
1.3 Current Initiatives within the Actuarial Community	3
1.4 Organization of this Paper	3
2 Climate-Related Risks	4
2.1 Physical Risks.....	4
2.2 Transition Risks	5
2.3 Legal and Reputation Risks	5
3 Actuarial Modelling	6
3.1 Investment Assumptions.....	6
3.2 Mortality and Morbidity Assumptions.....	7
3.3 General Insurance Claims Assumptions	7
4 Product Management	8
5 Risk and Capital Management.....	9
5.1 Enterprise Risk Management (ERM) Frameworks	9
5.2 Capital Adequacy.....	11
5.3 Relationship with the Pension Fund Sponsor.....	11
6 Investment Management.....	12
7 Disclosure	13
8 Implications for Actuaries.....	13
9 Next Steps.....	15
Appendix: Global Capital Market Initiatives Linked to Climate-Related Risks.....	17
Notes.....	18

Executive Summary

As key architects of insurance and pension systems, both public and private, actuaries have long played vital roles in managing the uncertainties of financial risk. With the growing global recognition of the importance of climate-related risks, it is natural that actuaries are involved in balancing the rapidly evolving requirements and expectations of all stakeholders, including those benefiting from or reliant on the work of actuaries, clients, communities, governments, employees, regulators, boards and shareholders/investors. The messages in this paper are intended not only for actuaries but for relevant stakeholders as well.

Climate-related risks arise when various climate-related impacts (both direct and indirect) affect the physical resources or assets of individuals or entities. When they also interact with various socio-economic systems, they may disrupt the mechanisms traditionally used to maintain financial stability.

While the primary focus of this paper is on climate-related risks, actuaries also need to consider the opportunities that may result for their stakeholders.

Actuaries are increasingly involved in considering how climate-related risks are applicable to their work and to the wider business interests of their employer or client. This paper examines the categories of climate-related risks and their importance for actuaries in identifying, measuring, managing and reporting this type of risk. In so doing, this paper reviews the impact of climate-related risks on actuarial work summarized under five broad categories: actuarial modelling, product management, risk and capital management, investment management, and disclosure.

Actuaries increasingly collaborate with business, regulators, governments and relevant stakeholders in order to understand the economic consequences of climate-related risks, to advise on solutions to serious gaps in insurance coverage, to develop potential mitigation and adaptation strategies and to contribute to a well-informed public debate about effective policy responses.

At the time of writing, the COVID-19 pandemic was continuing around the globe, affecting not only mortality and morbidity but many aspects of everyday life and economic activity. Even in the presence of COVID-19, climate-related risks continue to have major implications for actuarial work. While this paper does not address the issues of COVID-19, some of its implications, such as the high degree of global connectivity and volatility in business and financial markets, are also of importance in considering climate-related risks.

This paper concludes with implications and next steps for actuaries. The Climate Risk Task Force (CRTF) of the International Actuarial Association (IAA) hopes this paper will be of assistance to actuaries in considering how climate-related risks affect their work and the wider work of their employer or client, and the communities they serve.

1 Introduction

1.1 Importance and Key Evidence

We live in an age where a failure to collectively recognize and address certain types of risk can lift regional crises to a global scale. These crises are slowly creating a tipping point for the global economy, requiring a review of business-as-usual models and compelling us to rethink our future.¹ Even in the presence of COVID-19, climate-related risks continue to have major implications for actuaries. Climate-related risks are rising to a global level with impacts on many areas of our society.² For example, extreme weather events are ranked as the No. 1 risk based on the likelihood of occurrence and the No. 2 risk based on the evolving risk landscape, as reported by the 2020 Global Risk Report.³ Business, governments and society are seeking the best means of managing and mitigating climate-related risks, both financial and non-financial, as well as exploring climate-related opportunities.

1.2 Why Actuaries Should Care

As key architects of insurance and pension systems, both public and private, actuaries have long played vital roles in managing the uncertainties of financial risk. It is recognized that actuaries also play important roles in other businesses, such as banks, and, while all aspects may not have been considered regarding how actuaries' clients/employers are impacted by climate-related risks, many of the issues outlined in this paper remain relevant. With the growing global recognition of the importance of climate-related risks and opportunities, it is natural that actuaries are involved in responding to these uncertainties as well as meeting and balancing the rapidly evolving requirements and expectations of all stakeholders, including customers, communities, governments, employees, regulators, boards and shareholders/investors. Indeed, the importance of actuarial involvement in climate-related risks has been noted in a survey of insurance supervisors.⁴

Climate-related risks can arise from local conditions, but increasingly the world is becoming aware of the importance of understanding their wider regional and global impact and implications. Recent climate-related events have included hurricanes and other types of windstorms, floods, droughts and forest and bush fires. These events have affected human activity locally and globally through their impact on, for example, vulnerable populations, agricultural production and commercial activity.

Climate-related events impact people's belongings, dwellings, physical structures, crops, infrastructure, businesses, etc., and may result in damage and financial loss. These events and longer-term variations in the climate may also affect human health, morbidity, mortality and longevity, and the value placed on assets by the financial markets. Changes in consumer and investor preferences resulting from climate-related risks will create risks and opportunities, both short-term and in the longer term.

Actuaries can play several important roles in helping to address the challenges of climate-related risks, including:

- Reviewing the underlying models used in their work for their continued suitability in light of climate-related risks in the short and long terms – such a review may need to consider a system-wide approach to modelling climate-related risks;
- Creating insurance products and pricing structures that align policyholders' financial interests with behaviour that promotes innovative solutions or climate-adaptive outcomes;

- Aligning insurance product design (e.g., features, exclusions, pricing) with the needs of consumers, corporates, vulnerable groups, regulators, governments, etc.;
- Encouraging pension funds, insurers and other clients to be active investors who support the management of climate-related risks in the companies in which they invest;
- Sharing their expertise in modelling the financial impact of extreme climate-related events (e.g., catastrophe modelling);
- Developing investment strategies and products that will help to solve or address problems associated with climate-related risks;⁵
- Advising various types of organizations, including governments and other policymakers, on climate-related risk initiatives that encourage improved governance and risk management of this risk;
- Contributing to the public debate and review of relevant government programs, public policy issues (e.g., insurance supervision) and climate-related disaster planning, and informing building codes and land-use policies; and,
- Disclosing in their work, in clear and unambiguous terms, the impact that climate change has regarding the physical, transition and legal/reputation risks, according to frameworks such as that of the Task Force on Climate-Related Financial Disclosure (TCFD) of the Financial Stability Board (FSB).⁶

An increased focus on and understanding of climate-related risks benefits all stakeholders by increasing the transparency with which these risks are addressed by all market participants. Improved outcomes will result from better governance and risk management, disclosure, coverage of vulnerable populations, product management, investment returns and sustainable approaches to this risk.

1.3 Current Initiatives within the Actuarial Community

At the time of writing, several actuarial organizations are responding to the challenges raised by climate-related risks. In North America, four such organizations – the American Academy of Actuaries (AAA), the Canadian Institute of Actuaries (CIA), the Casualty Actuarial Society (CAS) and the Society of Actuaries (SOA) have joined forces to create and maintain the Actuaries Climate Index.⁷ The Actuaries Institute Australia publishes the Australian Actuaries Climate Index,⁸ and the Actuarial Association of Europe is investigating a European Climate Index. The Institute and Faculty of Actuaries has published a series of practical guides on climate change for actuaries, which inspired some of the content of this paper.⁹ The IAA Resource and Environment Working Group continues to develop papers that have relevance to and/or affect the work of actuaries. Major actuarial journals are publishing articles on the topic of climate-related risks relevant not only to general (i.e., property and casualty) insurance but also to life insurance and pensions^{10,11,12} and thus to the individuals who are the ultimate beneficiaries of their products.

1.4 Organization of this Paper

This paper was written by the CRTF on behalf of the IAA in support of its initiative to address climate-related risks. The paper is organized as follows. In Section 2, we summarize the main components of the climate-related risks relevant to actuaries. Sections 3 to 7 provide an introduction to the broad categories of actuarial work and the importance of climate-related risk to each category. The categories considered are actuarial modelling, product management, risk and capital management, investment

management, and disclosure. In Section 8, the broader implications for actuaries are discussed. The paper concludes in Section 9 with several steps to consider moving forward.

2 Climate-Related Risks

There are various definitions of climate-related risks. This paper is based on the definition used by the TCFD¹³ due to its applicability to a large range of sectors, and because it is international in nature. The definition has nevertheless been modified to recognize that legal and reputation risks are enduring risks for some of the major businesses advised by actuaries. Physical risks, transition risks and legal/reputation risks have significant relevance to actuaries.

2.1 Physical Risks

Physical risks resulting from climate change can be event-driven (acute) or longer-term (chronic) shifts in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply-chain disruption. Organizations' financial performance may also be affected by changes in water availability, sourcing and quality; food security; and extreme temperature changes affecting their premises, operations, supply chains, transport needs and employees' safety.¹⁴

Consequently, insurers and pensions funds (as well as institutions such as banks) may be exposed to risks both through their asset portfolios and their liabilities, and insurers may be particularly exposed to physical risks through insurable events. For example:

- Asset values or investment returns might be adversely affected due to increased costs of climate change adaptation, the impact on the economic value of businesses or losses from physical damage to assets.
- An increase in the frequency and severity of heatwaves could lead to an increase in mortality and morbidity, damage to infrastructure and business interruption. It could also lead to extensive use of air conditioning, which in turn can increase greenhouse gas emissions.
- There could be an increase in the frequency of extreme rainfall and associated flooding, causing damage to property and crops, as well as an increase in infestation of insects, such as mosquitoes. Windstorms and flooding events can also give rise to significant pollution and consequential liabilities, especially where industrial sites (e.g., oil rigs, power stations) are affected.
- Some parts of the world may see an increase in the duration and intensity of periods of low precipitation, such as droughts. This will lead to famine, food insecurity, increased crop damage, water scarcity and wildfires.
- Worsening living and medical conditions could arise from disruption to health and social care services, involuntary forced migration, and damage to infrastructure due to extreme weather.

The impacts of these risks vary by geographic region and the sensitivity to loss and damage. Furthermore, many of these risks may be interconnected, as discussed by the World Economic Forum's Global Risk Report.¹⁵

2.2 Transition Risks

Transitioning to a lower-carbon economy may entail extensive policy, technology and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed and focus of these changes, transition risks may pose varying levels of financial risk to organizations.

- **Policy risk:** Policy actions around climate change continue to evolve. Their objectives generally fall into two categories – policy actions that attempt to constrain actions that contribute to the adverse effects of climate change, or policy actions that seek to promote adaptation to climate change. The risk associated with and financial impact of policy changes depend on the nature and timing of each policy change.
- **Technology risk:** Technological improvements or innovations that support the transition to a lower-carbon, energy-efficient economic system can have a significant impact on organizations. To the extent that new technology displaces old systems and disrupts some parts of the existing economic system, winners and losers will emerge from this “creative destruction” process. The timing of technology development and deployment, however, is a key uncertainty in assessing technology risk.
- **Market risk:** While the ways in which markets could be affected by climate change are varied and complex, one of the major ways is through shifts in supply and demand for certain commodities, products and services as climate-related risks and opportunities are increasingly taken into account.¹⁶

2.3 Legal and Reputation Risks

- **Legal risk:** Recent years have seen an increase in climate-related claims being brought before the courts by property owners, municipalities, states, insurers, shareholders and public-interest organizations. Reasons for such litigation include:
 - The failure of organizations to mitigate the impacts of climate change;
 - Failure to adapt to climate change; and
 - The insufficiency of disclosure around material financial risks.

As the value of loss and damage arising from climate change grows, litigation risk is also likely to increase.¹⁷

Attempts to recover such losses could impact many types of organizations and may frequently involve litigation between the involved parties. In some cases, the party being sued may have at least partial financial protection against such costs through the purchase of general insurance contracts such as professional indemnity or directors’ and officers’ insurance, with a consequent impact on the insurers. Insurers identify the insurance coverage of legal risk as *liability risk* on their own balance sheets. Some organizations, such as insurers and pension funds, may be advised by actuaries who would be subject to professional liability risk individually.

- **Reputation risk:** Climate change has been identified as a potential source of reputation risk tied to changing customer or community perceptions of an organization’s contribution to or detraction from the transition to a lower-carbon economy.¹⁸ Also, the reputation of the profession as a whole could suffer damage if actuaries collectively fail to advise appropriately.

3 Actuarial Modelling

Most forms of actuarial work involve some form of modelling. For example, the design and pricing of insurance products, setting pension fund contribution rates, selecting investment strategies, and setting the relevant technical provisions, reserves or capital requirements, all depend on assumptions regarding future experience.

The development and selection of assumptions frequently begins with consideration of past data and underlying trends. Consideration is also given to changes in conditions that could affect the frequency and severity of losses associated with certain types of events, investment experience, inflation, changes in underlying exposures and the environment, and anticipated changes in the frequency and severity of events that give rise to claim payments. However, identifying, searching for and assessing relevant data is a problem, especially for less developed and developing countries where such data is scarce. A key challenge in actuarial modelling is the limited technical knowledge that currently exists regarding the translation of future climate possibilities into financial variables that can be modelled. A survey of insurance supervisors found that data deficiency is the main challenge that insurers face in assessing their climate risk exposures.¹⁹

Changes in climate-related risks increase uncertainty about trends in the data on which assumptions are based. The impacts of climate change are interrelated, and changes in one area potentially have compounding effects in other areas. Actuaries need to consider the appropriate way to allow for that uncertainty. They also need to consider whether the underlying models used in their work appropriately allow for climate-related risks in the short term as well as in the longer term. Such a model review may need to consider whether a wider system-wide approach to modelling climate-related risks is necessary.

Differences in experience may arise between losses and damages that affect overall society and those experienced in the population segments that are under analysis. Actuaries need to be able to distinguish between these effects in their models, including how the models are structured and how to allow for the potential correlations between risks.

Overall, the breadth and severity of the impacts of climate-related risks have the potential to cause widespread adverse damage to society and the economy, much of which may be difficult to capture in a model in a credible manner. Possible future scenarios will need to be considered. Actuaries need to make sure that relevant data is identified to enhance the assessment of the future impact of climate change across locations and demographic and socio-economic profiles, while taking into account the increasing uncertainty due to the lengthened time period of the modelling.

Subsequent papers in this series will cover the development of scenarios and their usage, so are not considered in detail here.

3.1 Investment Assumptions

Due to the long-term nature of some of the products and programs for which actuaries advise, assumptions need to be made of future investment returns for various purposes such as insurance pricing, reserving and assessing the funding of pension schemes. Actuaries need to consider the implications of climate-related risks (both financial and non-financial) for investment portfolios, principally in terms of the physical, transition and legal/reputation risks outlined in Section 2.

Environmental, social and governance (ESG) investment strategies will inevitably become more widespread and important in soundly run businesses. Investors in these businesses may divest from securities issued by carbon-intensive companies, leading to a fall in their price and a reduction in future investment returns for the investors who have not changed their strategy.

While the climate-related risks are not known with precision, their potential effects can be modelled (this will be discussed further in a subsequent paper in this series on scenario testing). The nature and timing of these effects will vary by such factors as the nature of each investment, its location/geography, its industry segment and the quality of management. It may well be that some businesses would benefit as a result of climate change – for example, companies involved in building solar panels or flood defenses – but it is unclear whether such benefit would be permanent or short-term in nature.

3.2 Mortality and Morbidity Assumptions

Actuaries are increasingly considering the impacts of climate-related risks when modelling mortality or morbidity-related liabilities. They consider the impacts on demographic assumptions arising from climate change, and the resulting changes that might emerge in longevity, mortality and morbidity. These can result in short-term sudden spikes as well as affecting long-term trends, ranging from malnutrition and respiratory disease to storm accidents.

Climate-related risks could affect assumptions in many ways. Some examples are outlined below:

- **Food and water insecurity:** Changes in average and extreme temperatures, rainfall, and weather generally, may affect crop production and many other aspects of agriculture. Water supply (for drinking and for other uses) may be heavily reduced by drought. Large locust storms, caused by huge rainfall in areas in which they breed, may result in significant crop damage. These events would likely result in increases in the probability of disease and a negative impact on life expectancy.
- **Temperature change and volatility:** The impact of changes in mean temperatures may be beneficial for mortality from conditions relating to cold weather, but conditions relating to high temperatures could be exacerbated by the increased likelihood and severity of heatwaves. In addition, the impact is not the same for all ages, with younger and older people likely to be the most affected. It is also possible that changing weather conditions could have other indirect impacts on mortality/morbidity which could become significant over a number of years.
- **Pandemics and vector-borne infectious diseases:** It is possible that climate-related risks could increase the prevalence of pandemics or outbreaks of disease such as malaria, due to a wider spread of disease-carrying insects. There is also the potential for increased exposure to existing diseases, as rising global temperatures can lengthen the season and increase the geographic range of disease-carrying insects.
- **Social impacts:** Climate change could lead to social unrest, migration and the need for severe measures to try to reverse the causes of climate change. Increased rates of mortality and morbidity, combined with climatic changes that render parts of the planet less habitable (or even uninhabitable), would represent material changes to economies and societal behaviours.

3.3 General Insurance Claims Assumptions

Given that many general insurance products are annually renewable, it may be thought that it will be possible to adjust premium rates each year to reflect the gradually emerging impacts of climate change. However, it can be difficult to identify trends in changes in the frequency and/or severity of large catastrophe events and hence to determine the appropriate premiums for physical risks or determining reinsurance requirements. In addition, actuarial models, and the assumptions underlying them, may need to be adapted and developed to recognize that past experience may not be a guide to the future. There will also need to be a consideration of how transition and legal risks may have an impact through step changes in the regulatory and legal environments.

Examples of additional climate-related risk considerations might include:

- Agriculture is a major economic sector and a critical source of livelihood in many developing countries which could be particularly affected by climate change. Agricultural insurance products provide tools to agricultural producers to adapt and even mitigate the risks associated with adverse natural events. They are designed to provide insurance coverage for financial losses incurred due to reduction in agricultural outputs. Actuaries play an important role in developing and pricing these products.
- Decarbonization of the global economy may create new risks and opportunities for insurers. Shifts in economic activity, supply chains, business practices and consumer behaviour might impact the underlying exposures. For example, this could lead to existing carbon-based industries receiving lower investment and adopting higher-risk strategies. Conversely, the growth of renewable energy producers could result in increased needs for insurance protection.
- Insurers offering coverage for climate-related liability risks will need to carefully consider their strategy (e.g., including risk management, contract design, limits, exclusion, pricing and reinsurance) for providing such coverage. Already there is an increasing trend in litigation associated with climate-related liability to both businesses and governments, which has been observed in at least 28 countries and has not been limited to cases of physical damage. Increasingly, cases have been brought by investors, activists and government bodies.²⁰
- Catastrophe models are being used to understand the incidence, expected value and potential variability of losses from catastrophe events. However, current catastrophe models may not adequately capture climate-related risks, and there may be risks emerging outside the scope of the catastrophe models currently being used. Models may have been developed using historical events, implicitly allowing for climate change trends in the past. Further, models may not have been designed to quantify changes in climate-related risks; hence careful interpretation of the results is necessary – for example, by understanding the key assumptions made and testing the impact of alternative assumptions.

Actuaries face the challenge of quantifying the uncertainties of modelling future climate-related risks over long periods. All the elements of future climate-related risks need to be captured in the catastrophe models. Additional sensitivity testing of possible outcomes or correlations, such as more intense hurricanes or more severe floods, may help to inform market participants to take risk-mitigating actions. To quantify climate sensitivity, the frequency and/or severity of simulated events could be modified based on scientific studies (e.g., increasing the frequency of extreme floods or rainfall severity and speed of tropical cyclones). One means of assessing the variability in natural catastrophe estimates is to consider a blending of several different model results. Naturally, in reviewing the results of such blending, actuaries need to carefully consider fundamental differences in the design of the different models.

4 Product Management

Product management, including important areas such as product development, pricing and compliance, is a key aspect of actuarial work that reflects both the risks and opportunities associated with climate change. Such products may provide insurance protection, annuity or pension income, investment strategies or other forms of advice regarding risk/reward trade-offs both to customers and other relevant stakeholders.

Actuarial work in this area must balance the needs of those purchasing or making use of the product itself (e.g., a homeowner purchasing insurance protection for their home against designated perils, or a

farmer protecting their income against adverse weather events) with the needs of the stakeholders responsible for managing the business venture (e.g., return on capital for an insurer or an acceptable funding cost for a pension scheme). A fundamental tenet of such work is that consumers are treated fairly and that business (e.g., by the insurer or pension scheme) is conducted according to sound and sustainable principles.

The immediate challenge is to properly design and price products in light of climate-related risks and the needs of relevant stakeholders, including customers, shareholders, supervisors and investors. In insurance that may mean increasing premiums or excluding coverage in areas more susceptible to climate-related risks such as flooding or bush fires. With pension and investment management products it may mean ensuring that products adopt a sustainable investing approach according to ESG criteria to minimize unacceptable short- and long-term climate risk exposures.

However, these approaches look at risk in a one-sided view. Increased granularity in pricing of insurance risks may increase accuracy, but at the same time it can reduce the pooling of risks and impede the possibility of covering those who are in greatest need, which underpins insurance. Limitations in insurance coverage for certain types of climate-related risks may control claims costs for insurers but may fail to meet the needs of consumers and lead to gaps in protection that are important not only individually but collectively for jurisdictions. This will inevitably lead to reduced trust in and coverage by the private-sector insurance approach.

Investment managers also struggle with the trade-off between engaging with companies versus divesting, and the impact on benchmark-relative risk that taking positions on climate-related risks can generate. Seeking to address climate-related risks in products can result in unintended consequences (e.g., unanticipated customer behaviour) or risks that require additional risk management and/or product management.

The opportunities for successful product management include creating insurance products that align policyholders' financial interests with behaviour that promotes improved climate outcomes. This could be achieved by introducing incentives that eliminate or control risk and investment and pension products that are low-carbon or provide capital for initiatives that seek to directly address climate-related risks. The Global Sustainable Investment Alliance's 2018 review reported that overall sustainable investments had grown by over a third from USD 22.9 trillion to USD 30.7 trillion between 2016 and 2018. However, mandates requiring the sub-categories of sustainable-themed investments and impact/community investing had grown by 175% over the same period (noting of course the smaller base).²¹

5 Risk and Capital Management

5.1 Enterprise Risk Management (ERM) Frameworks

Climate-related risks are likely to impact different risk categories in different ways, as shown in Table 1. The examples here are purely illustrative. The actual rating for a given firm or set of circumstances needs to be considered case by case.

Table 1: ERM risk classes impacted by climate-related risks

Risk Class	Physical Risks	Transition Risks	Legal / Reputation Risks
Market	Medium	High	High
General Insurance	High	Medium	High
Longevity	Medium	Low	Low
Mortality/Morbidity	Medium	Low	Low
Lapse	Low	Medium	Low
Counterparty	Medium	High	Medium
Operational	Low	Medium	Low
Strategic	Medium	High	High
Reputational	Low	Medium	High

Table 2 shows how climate-related risk considerations might influence the key components of an ERM framework.

Table 2: ERM key features with potential climate-related risk considerations.

ERM Key Feature	Potential Climate-Related Risk Considerations
Governance and an ERM Framework	Those responsible for governance should ensure that climate-related risks are properly considered and assessed in its ERM framework.
Risk Management Policy	Risk management policies need to be sufficiently flexible to incorporate climate-related risks both as they are considered now and also as they develop.
Risk Tolerance Statement	The Risk Tolerance Statement should explicitly consider climate-related risks. This may be with regard to the fund's or firm's investment strategy, or to its tolerance of demographic or other insurance exposures.

<p>Risk Responsiveness and Feedback Loop</p>	<p>The firm or fund should have analysis of previous experience, both internally and through external events, as well as forward-looking emerging risk assessments, to be responsive to emerging trends and to help develop appropriate mitigating actions.</p>
<p>Scenario Analysis</p>	<p>Forward-looking views of companies' risk exposures and how they link to their future business strategy need to be considered, for example in the Own Risk and Solvency Assessment (ORSA) report prepared by insurers.</p>

Insurers are increasingly required to consider the effect of climate-related risks in their ORSA. Similarly, insurers' boards should consider the effect of climate-related risks on the insurers' underwriting, pricing, marketing, investment, risk management and actuarial functions. Pension funds, banks and other institutions all have their own versions of risk management frameworks which will have similar considerations.

5.2 Capital Adequacy

Actuaries may use models to identify and explore potential vulnerabilities to a firm's business model, the adequacy of its capital resources and the feasibility of its existing and alternative business strategies. This type of modelling may also be relevant for government bodies, non-governmental organizations (NGOs) and supranational organizations. Given the uncertainties involved, this work may need to explore an appropriate range of scenarios into the varying nature, extent and timing of impacts that could arise, including climate-related risks.

A stable capital position may be desirable to ensure a consistent level of protection for stakeholders or policyholders/customers over time, as well as a predictable return on capital for shareholders. However, given the potential disruptions involved, firms will need to be prepared to explore a challenging range of stress tests and loss scenarios, to determine the potential impact on their capital and identify the different risk mitigation (and avoidance) actions that they might take. For insurers, these could include more extensive reinsurance cover, better monitoring of portfolios, stricter limits on policies, or withdrawal from individual lines of business, which for consumers may lead to unaffordable premium increases.

Rating agencies may introduce new climate-related risk measures when evaluating companies' financial ratings. This may affect the ratings of those companies. For example, major rating agencies have said that companies' ratings could incorporate environmental and climate factors. Advisors may wish to consider their firms' environmental and climate-related risk profiles to anticipate and, potentially, avoid sudden downgrades in their credit ratings.²²

5.3 Relationship with the Pension Fund Sponsor

An important aspect of a defined benefit pension plan is the employer covenant. If the sponsoring employer is engaged in activities that are likely to become less popular/less valuable over time (e.g., building non-environmentally friendly automobiles), its future profitability, and hence its ability to fund pension obligations, may be brought into question. Actuaries may be involved in the assessment of the employer covenant.

Climate-related risks which may impact the future prospects for the sponsoring employer may also have an impact on the size and structure of the expected workforce. In addition, they may even impact on the morbidity or longevity of the employees, which actuaries will need to consider when valuing the liabilities of a defined benefit plan or the expected benefits from capital accumulation or defined contribution arrangements.

6 Investment Management

The investment portfolios of pension funds, insurers, banks and other financial institutions are invested to meet the obligations of those entities as they become due. The most significant climate-related risk in a pension plan is a decline in the value of investments purchased/held for retirement. This will lead to either lower retirement income for the members (in a defined contribution arrangement) or a funding requirement to be met by the employer in a defined benefits arrangement (and if such additional funding is not provided, potentially lower benefits for members).

Similarly, for an insurer, there is the risk that the investment portfolio has a lower-than-anticipated value due to the direct impact of or correlation with climate-related risks. The insurer may wish to mitigate or eliminate that risk.

Actuaries may be engaged to advise the fiduciary or management body of the pension plan, or the board or management of the insurer, on the investment strategy to be adopted. To provide this advice, actuaries should be familiar with sound methods of measuring and managing climate-related risks in an investment portfolio.

In addition to boards of insurers or fiduciary bodies of pension funds, some beneficiaries, particularly of defined contribution plans and non-pension retail investments, want to know how climate-related risks are being allowed for in investment strategies, and actively demand change. There is a growing call for allowance for climate-related risks both in default options and through the choice of more specialized investment choices.

Furthermore, pension funds and other investment institutions may be faced with questions about whether their investments are in line with the growing public demand for environmentally responsible behaviour and adequately carry out the fiduciary obligation to consider these risks. Therefore, it is not only a question of financial risks and return but also a matter of reputational and legal risk.

Climate-related risks can be managed in an investment portfolio with an ESG or socially responsible approach, more actively reducing the carbon footprint of the portfolio or seeking out investments that may benefit from climate-related risks, such as renewable energy or water-related projects. Part of the actuary's advice may be to help determine the approach that the actuary's client would like to incorporate in its investment policy.

Actuaries may also be involved in implementing the investment strategy. In practice, actuaries and other professionals are involved throughout the investment management value chain where climate-related risks are incorporated. Examples of actuarial involvement include:

- Analysis of individual securities to determine their exposure to climate-related risks;
- Calculation of quantitative measures for individual securities such as carbon footprint and carbon reserves;
- Investment management that incorporates allowance for climate-related risks or quantitatively seeks to reduce climate-related risk scores across a portfolio;
- Engagement with companies on their approach to climate-related risks;
- Reporting on the climate-related risk exposure in the investment portfolio; and
- Development of products that allow for climate-related risks, seek a particular climate-related outcome (like a reduced carbon footprint) or pursue a climate-related theme (like renewable energy or adaptation technologies).

The interactions between investment risk and return, and climate-related risks and solutions, are complex. Decision makers need to be risk-aware and balance different timescales when investing, as they may affect beneficiaries in various age groups differently.

7 Disclosure

There is increasing awareness and focus on climate-related risks in financial markets. Given the varied impacts they may have on companies in different countries and sectors, it is not surprising that there has been an increasing demand by stakeholders for more extensive disclosure of companies' own assessment of the risks they face, together with the actions they are taking to identify, manage and mitigate those risks.

There are two ways these disclosures may be relevant to actuaries:

- Actuaries are likely to be asked to support the development and production of the disclosure for the insurers, pension funds or other institutions they work for or advise; and
- The disclosures of firms in which those institutions invest will be of interest to actuaries as they will help them understand the sustainability of those investments.

In June 2017, the TCFD released its final recommendations,²³ which provide a framework for companies and other organizations to develop more effective climate-related financial disclosures through their existing financial reporting processes. Many companies have developed this framework for the purposes of disclosing exposure and governance of climate-related risks.

The TCFD structured its recommendations around four key elements – governance, strategy, risk management, and metrics and targets:

Table 3: The TCFD's recommended four-pillar approach to company disclosure on climate-related risks

Governance	Strategy	Risk Management	Metrics and Targets
Disclose the organization's governance around climate-related risks and opportunities	Disclose the actual and potential impacts of climate-related risks and opportunities on the strategy and financial planning of the business	Disclose how the organization identifies, assesses and manages climate-related risks	Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities

Actuaries can play a constructive role in enhancing the quality and accelerating the development of the disclosures by supporting the preparation of a disclosure report. A company may use such a report for its own benefit even if it does not wish to submit it in accordance with the TCFD.

8 Implications for Actuaries

There is growing global recognition of the importance of climate-related risks for businesses, governments and society. It is natural that actuaries are involved in helping businesses to adapt as well as meeting and balancing the rapidly evolving requirements and expectations of all stakeholders, including customers, communities, governments, employees, regulators and shareholders/investors. Table 4, adapted from Figure 1 in *The Impact of Climate Change on Mortality and Retirement Incomes in Australia*,²⁴ illustrates how actuarial work is exposed to climate-related risks.

Actuaries are increasingly involved in considering how the impacts and effects of climate-related risks are applicable to their own work, and to the wider work of their employer or client, in areas such as governance, strategic decision making, risk management, investments, scenario analysis and actuarial function. Increasingly, the management of climate-related risks is considered a core business issue.

The insurance and pension industries are important in building and maintaining socio-economic resilience. As key architects of insurance and pension systems, actuaries have long played vital roles in managing the uncertainties of financial risk. It is natural that actuaries in these industries also advise on climate-related risks.

Table 4: How actuarial work is exposed to climate-related change

Climatic Impacts		Socio-Economic Impacts		Impacts on Actuarial Work
Direct	Indirect	Social	Economic	
<ul style="list-style-type: none"> • Heatwaves • Storms • Floods • Sea level rise • Bush fires • Droughts 	<ul style="list-style-type: none"> • Air pollution • Water and food supply • Diseases 	<ul style="list-style-type: none"> • Migration • Health infrastructure • Emergency and social services • Consumer behavior 	<ul style="list-style-type: none"> • GDP growth • Investor preferences • Infrastructure investment • Employment • Housing • Energy • Taxation 	<ul style="list-style-type: none"> • Changes to modelling and assumptions • Development of products including re-design, pricing, exclusions, etc. • Changes to risk management practices • Changes to capital management practices • Revised/new investment management practices • Changes to financial stability management • Disclosure that allows for climate risk • Broader application of actuarial work

Actuaries increasingly collaborate with business, regulators, government and relevant stakeholders in order to understand the economic consequences of climate-related risks, to advise on solutions to serious gaps in insurance coverage, to develop potential mitigation and adaptation strategies and to contribute to a well-informed public debate about effective policy responses.

When considering climate-related risks, it is important to consider all the risks, such as those discussed in Section 2. Transition and legal/reputation risks may also include step changes in many of the social, economic, regulatory and/or legal environments and result in more highly correlated and non-linear impacts than previously observed (e.g., as evidenced by the COVID-19 pandemic). Therefore, actuaries need to consider the ways in which climate-related risks may have impacted their past data, models, trends, and outlook for the future. In addition, there is a need to increase efforts to collect high-quality data and develop sophisticated models reflective of system-wide thinking regarding climate-related risks.

Increasingly, actuaries are participating as members of multi-disciplinary teams with a range of experts, such as meteorologists, economists or doctors, to make much greater use of broader scientific information.

9 Next Steps

Climate-related risks have wide-reaching implications for the work performed by actuaries through their potential to impact human health and mortality; the economy and financial stability; the risks people and businesses face from natural disasters; and the value of assets held by insurers and pension schemes or by individuals as retirement savings.

There is no area of actuarial practice that is isolated from these implications. Stakeholders demand accountability from financial institutions. An inability to appraise relevant risks may be considered a failure of management, directors and/or officers to fulfill their responsibilities. As a result, it is incumbent on the actuarial profession to be able to recognize and consider climate-related risks.

What could an actuarial association do?

National and international actuarial organizations can potentially contribute to the topic of climate-related risks in several areas, including, for example:

- i. **Research and development efforts:** Actuarial journals may promote research on climate-related risks, via individual articles or special journal issues on this topic. Actuarial conferences may create a conference session or track dedicated to climate-related research. A partnership between the academic community and the actuarial profession is vital in advancing actuarial research and positioning the profession.
- ii. **Training and continuing professional development:** As noted earlier, there is a need for actuaries to familiarize themselves with climate-related risks and have at least a basic level of training.²⁵ There is a role for actuarial professional bodies, possibly in conjunction with other professional bodies or academic institutions, to deliver that education and training.
- iii. **Regulatory environment:** Proactive actuarial involvement in support of regulators and supervisors in addressing issues related to climate-related risks is important, particularly for the financial services sector, where regulators at both the international and local jurisdictional level are tackling these issues themselves.

What can actuaries as individuals do?

There are several ways actuaries can enhance their ability to recognize and consider climate-related risks, including:

- i. **Be informed:** Climate-related risks affect all practice areas in different ways. Actuaries have professional obligations to stay up to date with current developments within their professional remit and to be familiar with climate-related risks and their applicability to the actuarial practice areas.
- ii. **Learn about climate-related risks and the value of adaptation:** For most actuaries, it will be appropriate to have some broad training on techniques for measuring and responding to climate-related risks and adaptation responses relevant to their practice areas.
- iii. **Build deeper expertise:** Some specific areas affected by climate-related risks require specialized skills such as catastrophe modelling in general insurance, measurement of carbon footprints in pensions and investing and development of climate-related metrics for actuarial work. Practising in a specialized area requires further training and skills development in that area.

- iv. **Collect and share data and techniques:** Data sharing and collection are important to support climate-related research. The climate science community faces the significant challenge of dealing with continuously changing observation methodologies and systems impacted by many natural processes.
- v. **Start a dialogue:** It is important that this learning is not done in isolation. A discussion with stakeholders would develop an understanding of their perspectives on climate-related risks and the demands that they are faced with. The climate-related risks discussed in this paper, and the ways that actuaries can respond, are part of a broader context.
- vi. **Validate the sources of information used:** The actuary should be aware that not all information has been developed using solid scientific knowledge and peer review. It is proper practice to divulge external sources of information when relying on external expertise, and explain the rationale for their selection. This is especially pertinent when dealing with climate-related risks in view of the existing debates on the topic.
- vii. **Develop a plan to make this an integrated part of day-to-day work:** Climate-related risks can be integrated into the standard risk considerations, like many other risks, that are part of the standard day-to-day process for providing actuarial advice. While there is some specialized climate-related work, most areas of actuarial practice are impacted in one way or another.
- viii. **Continuously learn:** Actuaries are committed to lifelong learning as part of their own personal and professional development to meet the needs of the new world of work. Science and the understanding of climate-related risks are continuing to develop and evolve, so it is important to keep learning and adapting.

What can the IAA Climate Risk Task Force do?

This paper is the first of a series of papers that the CRTF has committed to develop over the coming years. In order to address the needs of actuaries, additional papers are anticipated in 2020. The intent of the CRTF is to:

- Provide education and advice useful to actuaries applying global climate-related scenarios; and
- Develop a paper on effective and globally applicable links between climate-related risk scenarios and insurance and pension risks and costs.

To that end, the CRTF plans to review existing IAA publications to identify and address climate-risk-related gaps as well as produce additional educational materials such as:

- A paper on the application of climate-related risk scenarios to asset portfolios with an important subsidiary goal of encouraging consistency between assets and liability modelling;
- Advice on climate-related financial risk management and addressing emerging third-party regulatory/reporting/disclosure requirements;
- A paper on the potential effects of transition and adaptation steps;
- A review of existing IAA publications to identify and address any climate-risk-related gaps; and
- A paper on the link between climate-related risk scenarios and social security.

The CRTF welcomes and encourages input and involvement in these activities.

Appendix: Global Capital Market Initiatives Linked to Climate-Related Risks

The list below of global capital market initiatives is by no means exhaustive.

- The TCFD aims to improve the information available to investors on climate-related risks. It has made recommendations for a voluntary, consistent climate-related financial risk disclosure framework for use by companies in providing information to investors, lenders, insurers and other stakeholders. The task force will consider the physical, liability and transition risks associated with climate change and what constitutes effective financial disclosures across industries.
- United Nations Principles for Responsible Investment works to understand the investment implications of ESG factors and to support its international network of investor signatories in incorporating these factors into their investment and ownership decisions.
- The Transition Pathway Initiative aims to evaluate what the transition to a low-carbon economy looks like for companies in high-impact sectors, starting with oil and gas, mining, electricity generation, cement, iron and steel, and automobiles. This enables asset owners and other stakeholders to make informed judgments about how companies with the biggest impact on climate change are adapting their business models to prepare for the transition to a low-carbon economy.
- Carbon Tracker is an independent financial think tank which provides in-depth analysis on the impact of climate change on capital markets and investment in fossil fuels, mapping risk and opportunity for investors on the route to a low-carbon future.
- The Institutional Investors Group on Climate Change provides investors with a collaborative platform to encourage public policies, investment practices and corporate behaviour that address long-term risks and opportunities associated with climate change.
- The High-Level Expert Group on Sustainable Finance reported in 2018 with recommendations for the European Union to reform rules and financial policies to facilitate green and sustainable investment.²⁶
- ShareAction is an organization with a mission to transform capital markets into a greater force for public good. Its vision is of a responsible investment system that truly serves savers and communities, and protects the environment for the long term.²⁷
- The Asset Owners Disclosure Project (now operated by ShareAction) is an independent not-for-profit global organization whose objective is to protect asset owners from the risks posed by climate change. It does this by working with pension funds, insurers, sovereign wealth funds, foundations and universities to improve the level of disclosure and industry best practice.
- The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), established at the Paris One Planet Summit in December 2017, aims to help strengthen the global response required to meet the goals of the Paris climate agreement and to enhance the role of the financial system to manage risks and mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development. To this end, the Network defines and promotes best practices to be implemented within and outside of the membership of the NGFS and conducts or commissions analytical work on green finance.²⁸

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