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Importance of Climate-Related Risks for Actuaries

IAA Climate Risk Task Force

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IAA Paper

Importance of Climate-Related Risk for Actuaries

This paper on the Importance of Climate-Related Risk for Actuaries was prepared by the Climate Risk Task Force of the International Actuarial Association (IAA).

The IAA is the worldwide association of professional actuarial associations, with several special interest sections and working groups for individual actuaries. The IAA 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 Climate Risk Task Force 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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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 risk, it is natural that actuaries are involved in helping clients to respond 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. The messages in t his paper are intended not only for actuaries but for relevant stakeholders as well.

Climate-related risk arises 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 risk, actuaries need also to consider the opportunities that may result for their clients, employers and stakeholders.

Actuaries are increasingly involved in considering how the impacts and effects of 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 risk 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 risk 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, government and relevant stakeholders in order to understand the economic consequences of climate-related risk, 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 publication of this paper, the COVID-19 pandemic continued 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 risk continues to have major implications for actuaries. 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 risk.

This paper concludes with future implications and next steps for actuaries. The Climate Risk Task Force of the International Actuarial Association hopes this paper will be of assistance to actuaries in considering how climate-related risk affects their work and the wider work of their employer or client, and the communities they may 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 requiring us to rethink our future [1]. Even in the presence of COVID-19, climate-related risk continues to have major implications for actuaries. Climate-related risk is 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 No. 2 risk based on the evolving risk landscape, reported by the 2020 Global Risk Landscape 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 have not been considered of how climate-related risk impacts them, many of the issues outlined in this paper remain relevant. With the growing global recognition of the importance of climate-related risk and opportunities, it is natural that actuaries are involved in helping clients to respond 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.

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

Climate-related events impact our belongings, dwellings, physical structures, crops, infrastructure businesses etc., and may result in damages and financial loss. These events and longer-term variations in the climate may also impact on 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 risk will create both 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 risk, including the following,

- Reviewing the underlying models used in their work due to climate-related risk in the short-term as well as longer-term. Such a review may need to consider a system-wide approach to modelling climate-related risk.
- Creating insurance products and pricing structures that align policyholders' financial incentives, with behavior that promotes innovative solutions or climate-adaptive outcomes.
- Aligning insurance product design (e.g., features, exclusions, pricing etc.) with the needs of consumers, corporates, vulnerable groups, regulators, governments etc.
- Encouraging pension funds, insurers and other clients to be active investors who encourage 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 [4].
- 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), climate-related disaster planning and in informing building code and land use policies.
- Disclosing in the actuary's work, in clear and unambiguous terms, the impact that climate change has regarding the physical risks and transition risks, according to frameworks such as that of the Financial Stability Board's Task-Force on Climate-related Financial Disclosure (TCFD)

The importance of actuarial involvement in climate-related risks has been noted in a survey of insurance supervisors [5].

An increased focus on and understanding of climate-related risk benefits all stakeholders by increasing the transparency with which these risks are addressing 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 this paper, several actuarial organizations are responding to the challenges raised by climate-related risk. In North America, four actuarial 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 [6]. The Actuaries Institute Australia publishes the Australian Actuaries Climate Index [7] 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 [8]. 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 risk relevant not only to general (i.e., property and casualty) insurance but also to life insurance and pensions [9,10,11] and thus to the individuals who are the ultimate beneficiaries of their products.

1.4 Organization of this Paper

This paper is written by the Climate Risk Task Force on behalf of the International Actuarial Association in support of its initiative to address climate-related risk. The paper is organized as follows. In Section 2, we summarize the main components of the climate-related risk relevant to actuaries. Sections 3 to 7 introduce the reader to 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 next steps to consider moving forward.

2 Climate-Related Risk

There are various definitions of climate-related risk. This paper is based on the definition used by the TCFD [12] due to its applicability to a large range of sectors and it is international in nature. The definition has nevertheless been modified to recognize that legal and reputation risks are an enduring risks for some of the major businesses advised by actuaries. Each of these risk areas, Physical Risk, Transition Risk and Legal/Reputation Risk has significant relevance to actuaries.

2.1 Physical Risk

Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) 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 organizations' premises, operations, supply chain, transport needs, and employee safety [12].

Consequently, insurers and pensions funds (and banks for example) 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, 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 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 Risks Report [13].

2.2 Transition Risk

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 the 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.

2.3 Legal/Reputation Risks

- **Legal Risk -** Recent years have seen an increase in climate-related litigation 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 [12].

  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 – and the profession as a whole if actuaries collectively fail to advise appropriately.
- **Reputational 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 [12].

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 and assessing relevant data is a problem, especially for less developed and developing countries where such data is sparce. A key

challenge in actuarial modelling is the limited technical knowledge that currently exists regarding the translation of possible 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 [5].

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

Differences in experience may arise between losses and damages that affect overall society from those experienced in the population segments are under analysis, whether it be private sector insurance, pension plans' coverage or for any other purpose. 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.

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 (both financial and non-financial) risks 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.

While the impact of climate-related risks is not known with precision, its 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, industry segment, and quality of management. It may well be that some businesses may 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. In particular, 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, will affect crop production and many other aspects or 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, has resulted 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, for example, due to a wider spread of disease-carrying insects, which can be especially damaging when these diseases have become resistant to the chemicals that have been used to treat them. There is also the potential for increased exposure to existing diseases as well, 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, such as restrictions on travel. 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.

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, demographic, and socio-economic profiles, whilst taking into account the increasing uncertainty due to the lengthened time-period of the modelling.

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 recognise that past experience may not be a guide to the future. There will also need to be a consideration of how transition and liability 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. It is designed to provide covers for financial losses incurred due to reduction in expected outputs from agricultural products. 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, will existing carbon-based industries receive lower investment and move to higher risk practices or conversely will the growth of renewable energy producers 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 [14].

- 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 risk and there may be risks emerging outside the scope of the catastrophe models currently being used. Models may have been developed using historical events, therefore, implicitly allowing for climate change trends in the past. Further, models may not have been designed to quantify changes in climate-related risk and 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 risk over long periods. All the elements of future climate-related risk 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, compliance etc., is an important area 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 the 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 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 the business (e.g., 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, investors etc. In insurance that may mean increasing premiums or excluding coverage in areas more susceptible to climate-related risks such as flooding or bushfires. 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 impedes the possibility of covering those who are in greatest need, that 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 may 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 risk in products and 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 incentives with behaviour that promotes reduced climate outcomes by way of 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) [15].

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	Transition	Legal/ Reputation
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 Enterprise Risk Management Framework	The governance framework should ensure that climate-related risk is properly considered and assessed in its enterprise risk management framework.
Risk Management Policy	Risk management policies need to be sufficiently flexible to incorporate climate-related risk both as it is considered now but also as it develops in the future.
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 for its tolerance of demographic or other insurance exposures.
Risk Responsiveness and Feedback Loop	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.
Scenario Analysis	Forward-looking views of companies' risk exposures and how this links to their future business strategy need to be considered, for example in the Own Risk and Solvency Assessment report prepared by insurers.

Insurers are increasingly required to consider the effect of climate-related risks in their ORSA and for insurers' Boards to have considered the effect of climate-related risks on the insurers' underwriting, pricing, marketing, investments, 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 advisory work could also be undertaken 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 risk.

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 [16].

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, their future profitability, and hence their ability to fund the pension promise, 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, and perhaps even 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 fall due. The most significant climate-related risk in a pension plan is that the investments being bought/held to provide for retirement turn out to have a lower value than expected when there is a need to draw on those assets, typically at or in retirement, due to unanticipated climate-related risks. That will lead to either lower retirement income for the pension plan member (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 cannot be/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 impact of climate-related risks. Additionally, some insurers may find that their investment portfolios and insurance policies are subject to similar climate-related risks; they may wish to reduce that correlation.

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 methods that climate-related risk of an investment portfolio can be measured and soundly managed.

Climate-related risks can be incorporated in an investment portfolio in an ESG or socially responsible investment 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 investments. Part of the actuary's advice may be to help determine the approach that the actuary's client would like to incorporate in their 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, for example:

- Analysis of individual securities to determine their exposure to climate-related risks;
- Calculating 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
- Developing products that allow for climate related risk, 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 risk and solutions, are not straightforward, and there is no zero-risk answer. Decision makers need to be risk aware and balance different timescales when investing, as they may affect beneficiaries in various age groups differently.

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 demand 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 an environmentally responsible behavior and adequately carry out the fiduciary obligation to allow for these risks. Therefore, it is not only a question of financial risks and return but also a matter of reputational and legal risk.

7 Disclosure

There is increasing awareness and focus on climate-related risk in financial markets. Given the different and varied impacts it may have on different companies in different countries and sectors, it is not surprising that there has been an increasing demand 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 understand the sustainability of those investments.

In June 2017, The Task Force on Climate-related Financial Disclosures (TCFD) released its final recommendations [12], which provide a framework for companies and other organizations to develop more effective climate-related financial disclosures through their existing reporting processes. Since then more companies are adopting these as a standard for reporting on their exposures and what they are doing to manage them.

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

Table 3: *TCFD recommended a 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 clearly can play a constructive role in enhancing the quality and accelerating the development of the disclosures in preparing in preparing 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 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 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 [17], illustrates how actuarial work is exposed to climate-related related risks.

Actuaries are increasingly involved in considering how the impacts and effects of climate-related risk 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 risk 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 risk.

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

Climatic impacts		Socio-economic impacts		Impacts on actuarial work
Direct	**Indirect**	**Social**	**Economic**	• Changes to modelling & assumptions • Development of products including re-design, pricing, exclusions etc. • Changes to risk management practices • Changes to capital management practices • Prevised/new investment management practices • Changes to financial stability management • Disclosure that allows for climate risk • Broader application of actuarial work
• Heatwaves • Storms • Floods • Sea level rise • Bushfires • Droughts	• Air pollution • Water and food supply • Diseases	• Migration • Health infrastructure • Emergency & social services • Consumer behavior	• GDP growth • Investor preferences • Infrastructure investment • Employment • Housing • Energy • Taxation	

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 liability risks may also include step-changes in many of our 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 risk may have influenced 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 risk.

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 done 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. In particular, they contribute to the uncertainty regarding the future, that actuaries are heavily involved with in many areas and for a variety of clients.

There is no area of actuarial practice that is isolated from these implications. Stakeholders may demand accountability from financial institutions, who may be seen as failing in their duty if they are not able to appraise relevant risks. As a result, it is incumbent on the profession, and on individual actuaries, to be able to recognize and consider climate-related risk.

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 risk, by 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 in this paper, there is a need for actuaries to familiarize themselves with climate-related risks and have at least a basic level of training [18]. 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 involvement in support of regulators and supervisors in addressing issues related to climate-related risks is important particularly for the financial services sector whose regulators at both the international and local jurisdictional level are tackling these issues themselves.

What can actuaries as individuals do?

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 the professional remit and to be familiar with climate-related risk and its 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 the climate-related risks and adaptation responses relevant to our practice areas.

iii. **Decide to 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. Practicing 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:** Be aware that not all information has been developed using solid scientific knowledge and peer review.

vii. **Develop a plan to make this an integrated part of the day-to-day work:** Climate-related risks should 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. **Continuous learning:** Actuaries are committed to their lifelong learning as part of their responsibility and their own personal development to meet the needs of the new world of work. Science and our 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 IAA Climate Risk Task Force has committed to develop over the coming years. In order to address the needs of the actuaries, some additional papers are anticipated in 2020. It is intended that they will:

- Provide education and advice useful to actuaries applying global climate-related scenarios.
- Develop papers designed to further stimulate development of effective and globally applicable links between climate-related risk scenarios and insurance and pension risks and costs.

Over the following years, the Climate Task Force plans to continue to tackle additional topics on climate-related risks and expects to produce 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 modeling.
- 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.
- Review of existing IAA publications to identify and address any climate risk related gaps.
- A paper on the link between climate-related risk scenarios and social security.

The IAA Climate Risk Task Force welcomes and encourages input and involvement in these activities.

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

The list below is by no means exhaustive.

- FSB Task Force on TCFD aims to improve the information available to investors on climate-related risk. 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.
- 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 autos. 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.
- Institutional Investors Group on Climate Change provides investors with a collaborative platform to encourage public policies, investment practices, and corporate behavior that address long-term risks and opportunities associated with climate change.
- The High-Level Expert Group on Sustainable Finance reported in 2018 [19] with recommendations for the European Union to reform rules and financial policies to facilitate green and sustainable investment.
- ShareAction [20] is an organization with a mission to transform capital markets into a greater force for public good. Their vision is of a responsible investment system that truly serves savers, communities, and protects our environment for the long term.
- Asset Owners Disclosure Project (now operated by ShareAction) was 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.
- Network of Central Banks and Supervisors for Greening the Financial System (NGFS), established at the Paris “One Planet Summit” in December 2017 [21]. The Network’s purpose is to help strengthening the global response required to meet the goals of the Paris agreement and to enhance the role of the financial system to manage risks and to 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.

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