Institute and Faculty of Actuaries

Climate Change: Managing Risk and Uncertainty

Policy Briefing

Summary

The risks associated with climate change are wide-ranging and could have major economic, political, social and financial impacts. The Institute and Faculty of Actuaries (IFoA) is deeply concerned by these issues and supports efforts to address climate risks. Based on the work of climate scientists and climate policy experts, and our own expertise in managing risk and uncertainty, we conclude that:

1. Climate change is a risk management problem – current climate policy is based on an understanding of what is expected to occur, when in fact there is substantial risk that future temperatures could be more extreme. If society is to understand and avoid a worst case scenario, the scale and likelihood of extreme scenarios should be a prominent element in climate policy.

2. The cost of delay is high and early action on emissions will improve future options – failure to take timely action on emissions is likely to lead to more costly and disruptive remedial action at a later date, as well as earlier and more severe climate impacts. Early reductions in global emissions also allows more time for more effective adaptation to future adverse climate impacts.

3. Continuous assessment and dynamic management should be central aspects of climate policy – there is considerable uncertainty about the precise nature and timing of climate change impacts. The IPCC's 2°C consistent carbon budget is not guaranteed to achieve its goal; it only has a 2/3 probability of limiting temperature rises to 2°C. Governments should ensure that climate risk is continually assessed to reduce uncertainty and new information and insights are used to inform policy responses.

4. Action is needed to address market failures - governments also need to recognise their role in correcting market failures, for example, by pricing the negative externalities of greenhouse gas emissions. Effective policies for pricing carbon, and compulsory and standardised disclosure of climate risks, will allow markets to respond rationally and systematically to climate change.

5. Policymakers and financial institutions need to balance multiple timeframes – current approaches to policy and investment decisions tend to place a higher value on the short-term, potentially at the expense of future generations. Both policymakers and financial institutions need to consider the time horizons on which they are basing decisions and how their decisions may affect future generations.

The IFoA recognises the serious risk that climate change poses to society. Actuaries are ideally placed to work with governments, business and other stakeholders to help better understand the long-term consequences of climate change, and help develop policy options to respond to these risks. The IFoA will continue to work with stakeholders to help address climate change risk through further research and will continue to contribute to the public debate on climate change in the coming years.

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About the Institute and Faculty of Actuaries

The Institute and Faculty of Actuaries (IFoA) is the chartered professional body for actuaries in the United Kingdom. We represent and regulate over 25,000 members worldwide and oversee their education at all stages of qualification and development throughout their careers. Under our Royal Charter we have a duty to put the public interest first. This includes speaking out on issues where the Institute and Faculty can contribute, raising public awareness of the work of actuaries and the value we add to society whilst working with government and others who shape policy.

Actuaries provide commercial, financial and prudential advice on the management of a business' assets and liabilities, especially where long-term management and planning are critical to the success of any business venture. A majority of actuaries work for insurance companies or pension funds – either as their direct employees or in firms which undertake work on a consultancy basis – but they also advise individuals and offer comment on social and public interest issues. Members of the profession have statutory roles in the supervision of pension funds and of life insurance companies and in providing actuarial opinions for managing agents at Lloyd's.

Introduction

Climate change is one of the biggest threats that society faces. The effects of climate change are already emerging with increased volatility in weather patterns and a higher frequency of extreme weather events. Without action, climate change is likely to be disruptive in the first half of this century and to become destructive and potentially catastrophic in the second half.

The direct risks of climate change are well known and include more frequent heat waves, more extreme and frequent precipitation in many regions and less precipitation in other regions, desertification, increased severity of storms, an increase in crop failures, and a rise in global sea temperatures, levels and acidity. Climate change poses systemic risks that could fundamentally change economic, political and social systems and the global financial system.[i]

The precise impacts of these changes are far from predictable. Climate change will occur over a long time horizon and with a high level of uncertainty about the exact nature and timing of its impacts. Nevertheless, if we wait until the risks crystallise, our options to deal with climate change will be fewer and more costly.

The 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) in Paris in 2015 could be a critical step towards mitigating the risk that climate change poses. Efforts are focused on securing a global framework aimed at limiting the average global temperature increase to 2°C.

However, even if such an agreement is achieved, there is a high level of uncertainty as to whether we will remain within the 2°C target. This is partly because of uncertainty associated with the climate's response to increasing atmospheric CO_2 and feedback loops relating to the carbon cycle. There is also uncertainty in assumptions about the take-up and success of future technologies such as large-scale carbon capture. Moreover, there is much uncertainty as to how any agreement from COP21 will be implemented in practice, i.e. the nature, extent and effectiveness of our actions to meet the 2°C target.

The IFoA recognises that climate change will have major consequences throughout society and that the actuarial profession has a significant role in helping society address climate change. It believes there is sufficient scientific evidence for climate change to be treated as a major risk to society.

This paper comments on the risks and uncertainty associated with climate change from an actuarial perspective, how a risk management perspective could help inform policy development, and areas of policy identified by policy institutions, commentators and think tanks that are of concern to the actuarial profession. By raising public awareness of the risks and uncertainty, actuaries can work with governments, business and other stakeholders to help better understand the long-term consequences of climate change, and help develop policy options to respond to these risks.

Climate change should be approached as a risk management problem. An important goal of climate policy is therefore to limit the probability of a very bad outcome to an acceptably small value.

Climate change is a risk management problem

Each of the last three decades has been successively warmer than any preceding decade since 1850 and according to the latest work from the Intergovernmental Panel on Climate Change (IPCC), the earth's average surface temperature is forecast to continue rising in the remainder of the 21st century.

The global mean surface temperature increase by 2100, relative to the pre-industrial era, could be in the range of 1.5-4.8°C. However, the extent of the global mean temperature increase is highly uncertain (as illustrated by the range of the projection) and will be depend on the level of anthropogenic emissions of greenhouse gases.[ii]

Climate science has been critical in identifying and drawing attention to the effects that climate change will have on our environment. We know that past greenhouse gas emissions will continue to contribute to global warming until 2050; in other words, warming will occur even if further emissions are halted immediately.[iii]

Approaches to climate change typically focus on the outcomes that are most likely to occur and the associated impacts they might have. The result is that decision-making is based on scenarios of "what is likely", when in fact there is a substantial risk that future temperature increases, and other changes in weather, could be more extreme than the "most likely" outcome. A risk-based approach to climate change that takes uncertainty into account is more appropriate.

Exploring possible extreme scenarios and then using the resulting information to mitigate the risks will promote good decision-making. Central to the actuarial approach is looking at both "what is likely to be" and "what if" (i.e. extremely bad or "tail risk") scenarios. Most importantly, we start with the question of what it is that we want to achieve or avoid.

The IFoA believes that discussion of both the scale of impact of the tail risk scenarios, and the uncertainty in modelling the potential outcome, should be prominent elements in the policy discussion around climate change. Until now neither the tail risks of climate change, nor discussion of uncertainty, have been as prominent as they should be.

The actuarial approach

For centuries, actuaries have been quantifying investment, mortality and other risks in order to calculate life assurance premiums and reserving requirements for insurance companies.

Actuaries apply their approach to risk, not only in life and general insurance, but also across financial services such as in pensions, banking and investment.

Actuaries have developed techniques for a range of risks, from low frequency/high impact catastrophic risks to those covered by mass market products such as motor and household insurance. These techniques include modelling systems failure, modelling both natural catastrophes (e.g. hurricanes, flooding) and man-made catastrophes (e.g. terrorism), and undertaking holistic risk assessments for banks. A range of sectors rely on the profession for its expertise in risk assessment and management.

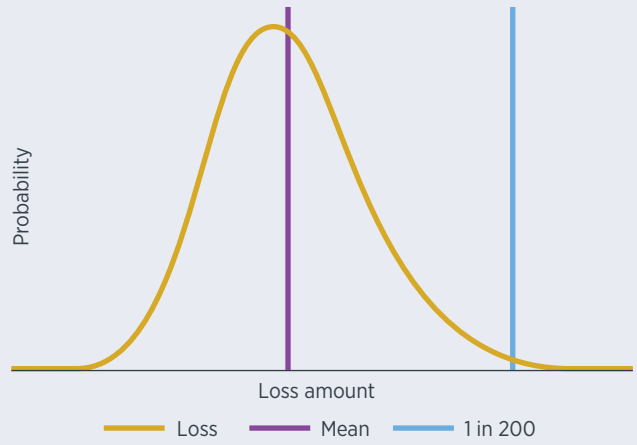
In the general insurance sector, risk assessment by actuaries is based in part on understanding scenarios that could have the greatest impact, even if their probability is low. Capital modelling for insurance companies (estimating the reserves needed to be held to ensure insolvency is avoided) typically looks at extreme events or bad case outcomes that might occur. Under the new European solvency regime (Solvency II) insurers are required to hold capital only exhausted in an extreme loss scenario, equivalent to happening once in every 200 years. The graph below sets out a stylised example of an insurance company's claims and the kind of shape you would expect – somewhat skewed towards the right tail.

An extremely bad or "ruin" scenario in the insurance context is simply where liabilities (losses) exceed assets (reserves) and insolvency occurs. As shown in Figure 1, the capital required to cover a ruin scenario sits far out to the right in the tail of the distribution, well above the level of claims the insurance company might expect on average. The approach is conservative and designed to protect shareholders and policyholders alike.

There is a direct parallel between insurance and climate change. Where the regulatory regime for insurance protects consumers of insurance from the ruin of their insurer, the regulatory regime for greenhouse gas emissions should protect citizens from the ruin of their environment. We believe that this approach to capital modelling offers a logical framework to look at climate change.

If we approach climate change from this perspective, the goal would be to limit the probability of a very bad outcome to an acceptably small value. In other words, the tail of the probability distribution would drive climate change policy and the first question would be "how bad could it get"? This is the question that is asked when an insurance company models its capital requirements. An insurance company needs to be able to withstand the uncertainty of severe events. Society as a whole may expect a similar standard for climate change.

Figure 1: Hypothetical Probability Distribution for Insurance Company Loss Amount



The "mean" outcome indicated by the left vertical line shows the weighted average of the losses of all scenarios modelled. This may be a sensible estimate to use as the basis of setting insurance premiums, but not as a basis for protection against insolvency.

At the "1 in 200" level, 99.5% of outcomes result in a smaller damage level and only 0.5% (i.e. 1/200) are greater. Insurance companies hold capital to protect against loss arising from all causes, at this level of probability, under Solvency II. This is intended to ensure their solvency except in the event of extreme losses on their insured portfolio.

Risk-based policy and regulation in Europe – Solvency II

Insurers are exposed to risks over both the short and long-term, for example, natural disasters, investment risk and operational risks such as fraud. Insurers' risk modelling assesses the ability to cover liabilities, and what happens if the business model "breaks" and it cannot continue on its present course. The claims being valued might be paid many years in the future.

To assess and manage the risk of ruin in the insurance industry, actuaries rely on three important pillars set out under Solvency II – the Europe-wide regulatory framework for risk management in insurance companies effective from 1 January 2016:

1. Models to determine sufficient capital to cover liabilities that could arise from a "1 in 200" event happening in the next year
2. Scenario and stress-testing to manage risks and assess future risks
3. Disclosure and transparency to assist market forces in imposing disciplines on firms.

Why is it important for insurance companies to hold capital? It is to protect policyholders and ensure claims are paid out even in extremely bad case scenarios. For example, Hurricane Sandy caused insurance losses of $20 to $25 billion and Hurricane Katrina, the biggest ever hurricane loss, was $41 billion.[iv]

Insurers do occasionally become insolvent, but generally they are well-regulated and secure. While there is debate over the strict interpretation of the 1 in 200 probability, setting a low assessed likelihood of insolvency is a practical step to give policyholders high confidence in the continued solvency of their insurers.

Applying an actuarial approach to climate change

Worst case scenario

What constitutes a ruin scenario for climate change is a value judgement and requires discussion for a consensus to form. At high levels of global average temperature increases the science suggests adverse impacts would escalate. Scenarios that might be termed ruinous are relatively easy to envisage, particularly viewing the world as a highly complex network of interlinked and cascading systems. Problems in the energy, water, food availability and transportation systems all have the ability to create wider crises if they were to be disrupted.

We argue that a consensus definition of ruin, as a scenario to be avoided if at all possible, would be helpful in framing future climate policy. Various definitions of ruin could be constructed. The World Bank's 'Turn Down the Heat' report from 2012 examines the effect of a 4°C global average temperature rise where crop yields decline, water availability changes, diseases move into new ranges, and sea levels rise. Crucially, it states that given the uncertainty in the scale of impacts, there is no certainty that adaptation to a 4°C world is possible.[v] This would imply some kind of collapse of part or all of our global civilization and could be considered an extreme ruin scenario.

Likelihood of temperature rises

The climate responds to atmospheric greenhouse gas concentrations, which are strongly linked to cumulative emissions of these gases. As such future emissions pathways are critical in reducing the risk of extreme climate change. The IPCC has developed a set of Representative Concentration Pathway (RCP) scenarios that explore the emission pathways from the top end of the range where no action is taken, through to "climate stabilisation scenarios" designed to be consistent with the 2°C target. Emission pathways are a key risk driver of climate change and these scenarios are an important first step in understanding the likelihood of different temperature rise scenarios over a long time horizon.

Importantly, the RCPs model a range of different scenarios:[vi]

- A very high emissions scenario based on our present emissions path and with no future technological or regulatory abatement; the best estimate is that global temperatures will rise between 2.6 and 4.8°C by 2100.
- Where emissions are reduced by 25% to 55% compared to 2010 by the middle of the century, and return to near zero by 2100, the IPCC estimates that the global temperature rise is more likely than not (50% or more) to be limited to less than 2°C and likely (66% or more) that it will remain below 4°C.
- Climate stabilisation scenarios assume that emissions peak between 2010-2020, with emissions declining substantially thereafter and estimate that global temperature rise is likely (66% or more) to remain below 2°C.

The probabilities attached to the pathways labelled "likely" indicate that there is a relatively high chance that the 2°C rise will be exceeded, even if we take significant action to reduce emissions. The indications prior to COP21 are that the Intended Nationally Determined Contributions (INDC) will fall short of the target and are capable of limiting temperature rises by 2100 to around 2.7°C, although our earlier comments on uncertainty apply.[vii]

Given the potentially ruinous impacts of higher levels of climate change, it would seem prudent to further limit the chance of global temperature rises. We would recommend that alongside a definition of ruin, agreement is reached on an acceptable probability to be associated with it. Nuclear facilities are designed to cope with external hazards on a "1 in 10,000" basis.[viii] What is the corresponding level of risk we are willing to tolerate for a ruinous level of temperature rise?

A slow and uncertain process

Climate change is a slow process and there is uncertainty about how the climate will react to feedback loops. Science is developing rapidly and much is understood about the climate system, but there are still areas of incomplete knowledge. For example, scientific understanding of the Earth's climate sensitivity and "feedbacks" relating to changes in the carbon cycle is still developing.

Conventional thinking about climate change policy is based on "fast feedbacks" – these are rapidly acting factors such as snow melt, ice melt and the behaviour of clouds and water vapour. But examination of past climate change indicates that, in the long-term, "slow feedbacks", such as the decay of large ice sheets and the operation of the full carbon cycle, could lead to around double the temperature increase from fast feedbacks alone.[ix]

There is also a high degree of uncertainty associated with how climate change will interact with social, economic and financial systems. These systems are complex and made up of a large number of interacting, interdependent components. The risks

that could arise are much less straightforward to assess than direct risks to the natural environment, but are potentially severe. For example, the impacts of climate change on food production and urban coastal populations could potentially lead to widespread change in behaviours, such as migration and hoarding, and resulting feedback loops in the economy.

We argue that policy needs to take account of the main areas of uncertainty and consider the scenarios of most concern and potential impact. Importantly, as new data and insights become available over time, these need to be incorporated into climate policy.

Underestimating risk

Models are inevitably simplifications and approximations, so there is no one single model of climate change. On the whole, most models are likely to be systematically biased towards underestimating risk, as they tend to omit a wide range of impacts that are difficult to quantify.[x] As a result models tend to underestimate uncertainty, so the probability of 4°C or 6°C warming could be higher than the models estimate.

Climate policy development over the last 30 years has relied heavily on Integrated Assessment Models which attempt to combine physical climate effects with societal and economic models. The weaknesses of such modelling are well known and stem from the near impossibility of modelling systems of vast complexity, as well as from imperfect knowledge.

Ultimately, no amount of analysis will result in a "perfect" model or a "perfect" answer. The IFoA believes that climate policy should be guided by a central target together with an agreed level of risk of ruin, analogous to the insurance industry's "1 in 200" probability.

It is important that policymakers understand the consequences of ignoring the low probability, high impact risks. While it is a matter of judgment how low a probability is worth considering, decision-makers can only assess the degree of risk by understanding the full range of scenarios – particularly worst case scenarios - in order to fully understand the implications of a given action or inaction.

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Paris could mark a shift toward an accelerated long-term programme

There is some optimism that COP21 will take significant steps in reaching a global agreement on reducing emissions in order to limit temperature rises. Even if warming is successfully limited to the 2°C target, this level of climate change entails significant societal and economic risks and costs.

The IFoA hopes that COP21 achieves a marked shift toward an accelerated programme of change that effectively addresses climate change risks over the long-term. Governmental action will be crucial, but business and civil society also need to embrace change. The financial sector has important responsibilities in terms of mobilising investment and providing insurance, and the actuarial profession recognises it has a major role to play in managing risks.

Future-proofing climate change policy

Delivering a binding agreement on emission targets that has a reasonable chance of limiting temperature increases to 2°C is the priority for leaders at COP21. But a process also needs to be put in place for continually reviewing these emission targets, in light of updated assessments of their effectiveness in limiting temperature rises to 2°C, and amending them accordingly.

Understanding the implications of cumulative CO_2, irreversibility and options theory

The IFoA believes there are a number of points stemming from climate science that could be emphasised within policy to help better manage climate risks and uncertainty. These are the cumulative nature of emissions, especially for CO_2, the irreversibility of the processes involved, and the very long time lags between cause (atmospheric concentration levels) and their full effect on climate.

Early action on global emissions reductions will increase future options for policymakers and business and provides several "option benefits". It postpones "climate milestones", the dates at which any particular concentration of CO_2 is attained. It also allows more time for more effective adaptation to the future adverse impacts of rising atmospheric concentrations of greenhouse gases.

Failure to implement early remedial action toward a given target or acceptable limit for CO_2 concentration could lead to larger, more costly and more disruptive remedies at a later date, as well as earlier and more severe climate impacts. For example, capital stock may need to be replaced over a compressed timescale, perhaps before the end of its useful life. By taking action earlier, governments could avoid building additional carbon-intensive capital stock and increasing further the replacement costs.

Action is needed to address market failures

Some asset owners around the world, such as pension funds, are beginning to react to the long-term risks of climate change. It is a financial risk for them, not just an ethical issue, because of the potential impact on their investments, such as those linked to fossil fuels. Investors are lobbying policymakers, such as with the Global Investor Statement on Climate Change, to accelerate the development of a realistic carbon price. They see this as a key step on the road to a low carbon global economy.

Carbon pricing is crucial for businesses and investors to properly incorporate climate-related risk into their decision-making. It would harness market mechanisms to rationally and systematically allocate capital away from climate risk. Conversely, if negative externalities are not internalised in prices, there is no reason to assume that free markets will provide outcomes that are optimal for society. Without addressing this market failure, markets cannot and will not produce effective or efficient solutions. However, existing carbon pricing mechanisms such as carbon taxes and cap-and-trade systems may need to further develop as part of a suite of policy measures.

Evidence suggests that the level of carbon price necessary to induce early investment in low carbon technology may be quite high. For example, the UK Committee on Climate Change indicated back in 2010 in its Fourth Carbon Budget that prices of £30 per tonne of CO_2 in 2020 and £70 in 2030 (in terms of the 2009 overall price level) in the EU Emissions Trading System would be consistent with the UK's own emission reduction goals.[xi] Early estimates of the social cost of emissions, such as those in UK Treasury official guidance for carbon valuation in public policy and investment decisions, are similar.[xii] By contrast, and after a decade of operation, the carbon price in the EU Emissions Trading System is around €8 per tonne, far below the levels required to bring about low carbon investment or even the relatively easy gas-for-coal substitution that should be happening. Current evidence suggests that it is difficult for governments to implement carbon prices, either through taxation or cap-and-trade, at a level that would allow a simple market-based system to be effective.

Even with effective levels of carbon price, other policies may need to be considered:

1. There are areas where relatively simple regulatory measures may be very important and are of proven effectiveness. These include measures in relation to the motor industry (notwithstanding the recent VW issues), the labelling of domestic appliances, and building regulations.
2. Governments can play an important role in encouraging innovation, which is a vital component of any low carbon strategy. This includes support for early stage technologies, such as carbon capture and storage (CCS). Internationally this kind of support has been one factor driving down the cost of renewables such as solar power.
3. Government policy is also important in supporting and encouraging the massive investments in energy infrastructure that are required. Infrastructure investors, such as pension and sovereign wealth funds, typically seek returns at the low risk, modest yield end of the spectrum. These returns depend on a market and regulatory framework that minimises uncertainty, or feed-in tariffs, or long-term contracts with secure counterparties.

Need for disclosure

The market will also be able to operate much more effectively if disclosure requirements relating to carbon footprints and capital expenditures are enhanced, in at least the main capital markets. Disclosure requirements are an important mechanism – if left unreported, risks can manifest into market shocks, disorder and large scale financial losses. However, current disclosure initiatives are limited in scope or voluntary in nature.

Policymakers are starting to recognise the importance of climate risk disclosure and are looking at making this compulsory for all large companies and institutional investors, with information disclosed in a standardised way. For example, the IFoA welcomes that the Bank of England will recommend to the G20 summit that more be done to develop consistent, comparable, reliable and clear disclosure around the carbon intensity of different assets.[xiii]

Long-term investment

There is widespread recognition that substantial investment will be required, including in infrastructure, to transition to a low carbon economy and to assist with adaptation and resilience to climate change. This is not only to meet greenhouse gas emission targets, but also to address many of the more severe effects of climate change we might experience in the coming decades.

One of the most difficult aspects to address with climate change risk is the choice of time horizon. Mark Carney in his September 2015 speech on climate change and financial stability noted that the most severe impacts of climate change will be felt beyond the traditional time horizons of the business cycle, political cycle and that of regulators – imposing a cost on future generations.

Investment choices made now will have a substantial impact on whether, and, if so when, a transition to a low carbon, sustainable development path is achieved. For example, the International Energy Agency estimates that to limit global temperature increases to 2°C, investment of approximately $1 trillion a year in clean energy is needed between now and the middle of the century.[xiv] Financial institutions could provide a significant part of this and, as noted above, governments have an important role in facilitating this type of investment. In this connection, there is an important distinction to be made between:

- the return on capital or discount rate which a private sector investor will require in order for a proposed investment, such as building a flood barrier or a solar farm, to be attractive; and
- the discount rate governments use to assess how much should be spent on climate change mitigation and adaptation.

The former rate is driven by commercial considerations including market forces. The latter reflects political priorities and wider social considerations and is usually lower. In other words, governments usually apply a smaller discount to future cashflows than private sector investors do. However, in both cases, existing discount rates place a higher value on the short-term than the long-term, potentially at the expense of future generations.

The IFoA believes that both policymakers and financial institutions need to do more to consider the time horizons on which they are basing decisions on climate change, the implications of their choice of discount rate, and how their decisions might affect future generations.

Next steps

There is much uncertainty as to how any agreement from COP21 will be implemented in practice, i.e. the nature, extent and effectiveness of our actions to meet the 2°C target. But, there will be disruption and economic and social costs with even this level of temperature rise. Governments, business and the public will need to manage these risks.

Governments, business and the public also need to be aware that there is a high degree of uncertainty about the measures needed to achieve this target and that worse outcomes are possible. For this reason, it is critical that we act now to reduce greenhouse gas emissions. Continuous assessment and dynamic management of risks should be central aspects of climate policy.

Climate change will impact insurers, pension funds and other financial institutions, and hence the work of actuaries. As a profession, actuaries will need to help their clients understand and manage climate risk. There will also be new opportunities - such as new insurance products and investments in infrastructure, technology and research, renewable energy sources and transport - and actuaries can help identify these. The profession will also be well placed to advise on different mitigation adaptation strategies for insurers and public sector bodies.

Under our Royal Charter, the IFoA has a duty to put the public interest first. We are committed to undertaking research and working alongside stakeholders to further inform potential policy responses to climate change.

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