Treating climate uncertainties as knowable risks – a recipe for greenwash?

Energetics, Swiss Re and ARC Centre of Excellence for Climate Extremes

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Swiss Re Corporate Solutions

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Climate change presents unprecedented management challenges

When organisations come to understand that climate change presents a growing challenge to their strategic plans and fundamentally, to their business models, they in turn recognise that what they face are unprecedented and profound uncertainties. However, they must also realise that climate change cannot be treated as “just another risk”. It is too different in nature and too far outside the expertise of most businesses.

As experts from three different disciplines - climate science, corporate insurance and commercial advisory - it is our contention that the current approaches to the analysis of climate-related change undertaken by organisations are suboptimal to a material degree for their own decision making as well as for the economy and society. Our primary concern is that the deep uncertainty (unknowable details) presented by climate change cannot and should not be treated as a risk (knowable). Why? Because whereas risks require measuring for their management, uncertainty requires understanding from which responses are revealed through innovation. The failure to distinguish between risk and uncertainty leads to analyses, decisions and market disclosures that are potentially misinformed at best, or misleading at worst.

Instead, organisations must innovate to develop new or improved approaches such as well-designed scenario analyses that can provide an understanding of the uncertainty associated with potential novel climates. They also need to know under what circumstances their current response to these uncertain futures needs to be adapted, by establishing and monitoring appropriate indicators with associated calibrated trigger levels.

Most importantly, decision makers need to feel confident in taking short and medium-term decisions that build resilience, despite the uncertainty ahead. This will also require them being comfortable that they can recognise and act to modify those decisions as greater certainty of climate-related change evolves.

In this paper we draw on insights from our three areas of expertise and experience in the assessment of risk and uncertainty as it relates to climate change.

Risk versus uncertainty

Many candid persons, when confronted with the results of probability, feel a strong sense of the uncertainty of the logical basis upon which it seems to rest – John Maynard Keynes

There is a very significant difference between risk and uncertainty. Despite this having been recognised and debated by many prominent thought leaders for over 100 years (and certainly since the work of Frank Knight in the 1920's), the two are often spoken about interchangeably with common management techniques often being applied to both.

Recognising the difference and therefore developing and applying appropriate techniques for managing them is vital. The difference is particularly important when it comes to understanding the financial and social impacts of uncertain futures associated with climate-related change. The current practice of climate risk management observed in the market shows clear evidence of confusion between the two concepts.

In addition to this, even where uncertainty is appropriately recognised, the techniques, tools and, in particular, the data used to understand the uncertainty are in the most part unregulated, untested and unscientific. This is rarely made fully transparent to end users of the analyses that they underpin.

We can no longer make assumptions of stability in the global climate

One of the primary reasons that uncertainty requires different approaches to risk is because of changing environments (in its broadest sense rather than in a climate sense). The underlying premise of much probability theory on which the measurement and subsequent management of risk is based, is the condition of stationarity. This is the assumption of stability in the system, without which it is impossible to use past frequencies to infer probabilities of future events.

Historically, modern society has evolved in a relatively stable (or stationary) global climate, where climate variations have existed within a broadly fixed set of potential outcomes. Humans have changed that. Climate change is altering the earth's weather systems and giving rise to non-stationarity' where the probability distribution of variables such as daily maximum temperature or seasonal accumulated rainfall shift away from their historical normal with every advancing year. Furthermore, we do not know whether our collective efforts to reduce the emissions of greenhouse gases will be sufficient to stop and reverse climate change.

We are not taking the climate from Point A to Point B but from Point A to a mixture of known and unknown destinations. We do not know, with precision, or with certainty where this is going and the more greenhouse gases we allow to accumulate in the atmosphere, the more uncertain our situation becomes.

For the authors of this paper, the current practice of climate risk management, as seen across the growing numbers of published climate disclosures, and the rapid emergence of ecosystems of climate service technologies, fails to clearly differentiate between what is risk and what is uncertainty to a material degree. The approach of assigning numerical values to climate risk factors for which there may be no underlying scientific basis is highly counterproductive as it gives rise to three unintended consequences:

1. Inappropriate statement / pricing of risk that may be misleading to investors and to market regulators.
2. A hesitancy, often vocalised as "we need more information", from business leaders and company boards when it comes to making strategic decisions in response to current and potential future climate change (or conversely inappropriate strategic decisions being taken on the back of insufficient understanding).
3. Spurious assertions, arising from a cognitive vacuum that allows the creation of a counterfactual narrative, that climate change may "not be that bad an outcome " when in fact the recent emergence of very destructive novel climates would indicate the opposite.

The authors are not here to be merchants of doom (or doubt). Rather, we propose that a fundamental first step in the response of any business attempting to deal with the current or future impacts of climate change is to the accept the existence of uncertainty. When we don't know we should say "we just don't know".

Why? Because having to face uncertainty triggers innovation. Humans evolved to deal with uncertainty by innovating. Economist John Kay and the former deputy Governor of the Bank of England Mervyn King make this point in their recent publication "Radical Uncertainty"[1]. One of their key observations being that humans make sense of an uncertain worlds through the use of dynamic collective narratives, by developing "good enough strategies" and most critically, by innovation.

We observe that too often when a business really needs innovation informed by an understanding of climate change drivers and implications, what it gets are arguments for adapting current practices to make them work, not overengineering change to keep things simple, postponing action until more is known and following what competitors or industry are doing. This often leads to an extensive sustainability report signed off by the auditor or an accountant, but with little value in helping the business or its stakeholders make appropriate and robust decisions in relation to the business' future resilience and prospects in the face of climate-related change.

Across the following sections, we present our discussion in the form of three voices each with a unique expert perspective on the risk vs uncertainty issue as it pertains to climate change.

1 ***Kay, J and King, M | Radical Uncertainty***

Section 1: The emergence of novel climates

Professor Andy Pitman
ARC Centre of Excellence for Climate Extremes

In 2008, Chris Milly from the US Geological Survey and Princeton led a paper in Science titled "Stationarity is dead: Whither water management". It is a paper of significance in any derivation of future climate risk. "Stationarity" is the idea that while one sees fluctuations in climate – whether it is rainfall, temperature, or frequency of cyclones – those fluctuations occur within an unchanging envelope of variability. This is critical of course where an assessor uses historical observations to calculate the risk of an event; the assumption is that the historical risk informs you of the present and future risk.

Two different mechanisms killed physical climate stationarity, and the significance of the two mechanisms depends on the variable in question.

- Global climate change has warmed our climate, raised sea levels, changed the probability of the frequency, magnitude, and duration of heatwaves and so on.
- Humans have also modified natural landscapes by building cities, damning rivers, replacing forests with crops, or modifying catchments. These changes affect temperature, wind climatologies, peaks in river flow and flood risk.

In combination, these two mechanisms mean for many variables, and therefore for many estimates of risk, historical data are of less value in estimating current risk that it would otherwise be.

The rate of climate change is accelerating, and humans continue to modify landscapes. Clearly, using observations over the last (say) 30 years to estimate risk in 30 years' time in a landscape about to be urbanised is very wrong. However, using observations over the last 30 years from a heavily urbanised region to calculate risk for the next 5 years is quite different. Climate is changing fast, but in most circumstances the envelope of variability described by historical observations over the last 30 years is unlikely to transform into something entirely new in the next 5 years.

Let's consider two variables: temperature and rainfall. Figure 1 (left column) shows the relationship between temperature and another variable (say the risk of heatwaves). Each row shows the relationship under the historical climate, and the present climate. The top row assumes stationarity which means no change is the envelope of variability over time and so the ovals perfectly overlap. However, we know warming is occurring and so the second row shows a shift in the distribution of temperatures so that the two ovals begin to have different statistical properties. The difference in the properties diverge under higher amounts of warming (3rd row) and here "novel climates" – climates that do not exist in the historical data – emerge. Note that for temperature the shift is in the same direction for 1.5°C and 3°C (green arrows).

Warming in the global average of 1.5°C is now inevitable, most likely by around 2050. Warming of 3°C is not inevitable and is infeasible before around 2080. In other words, if one is assessing most heat related risks, for most regions, and on short timescales (next ten years) the assumption of stationarity, while wrong, is unlikely to be very wrong. Assuming stationarity becomes very wrong in longer-term decision making of course. Note also that it is not always true that climates at regional scales change slowly (more on this later).

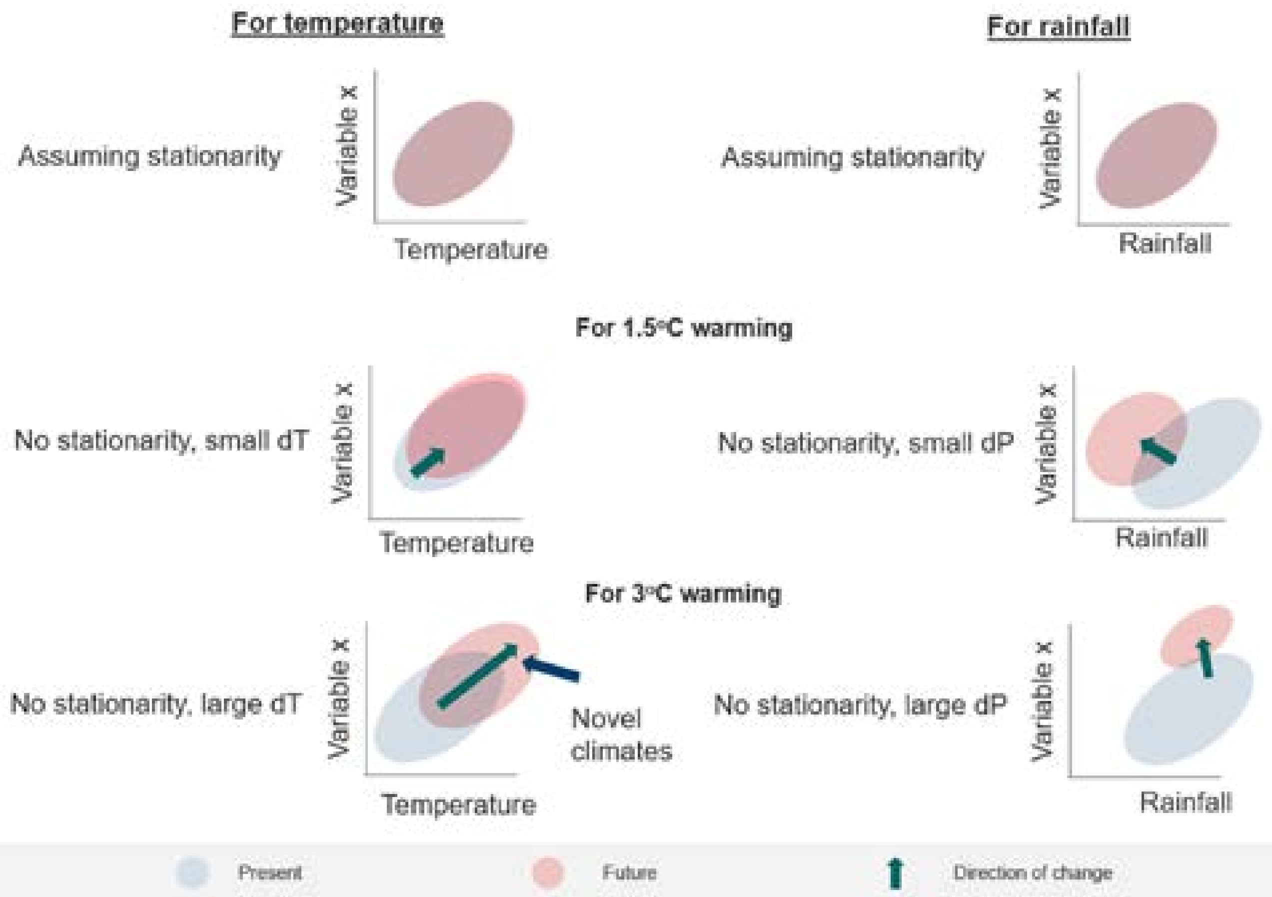

Figure 1: Illustration of how temperature (left) and rainfall (right) relationships vary with and without assumptions of stationarity for changes in global temperature with the present shown in blue and the future in red. The green arrows illustrate the direction of change. On near future timescales, assumption of stationarity for temperature is not likely generally very wrong, but it becomes very wrong further into the future. For rainfall, assumptions of stationarity are very likely highly misleading.

Temperature is a well-behaved variable; rainfall is not. Rainfall can be binary (it rains, or it does not). Small changes in synoptic scale weather patterns can change temperature many degrees but can change the rainfall over a region from at risk of drought to at risk of flood in a matter of days. Climate change affects rainfall in two ways.

1. Rainfall is intensifying due to the Clausius–Clapeyron relation which means warmer atmospheres hold more water (this is the thermodynamic response). All things being equal, this means more, and more intense rainfall in the future.
2. Unfortunately, all things are not equal, and our weather patterns change due to climate change and this "dynamic response" means that for a specific location the tendency might be for more rain, but the weather patterns divert the moisture away from that region such that rainfall dramatically decreases.

Figure 1 (right column) illustrates this; the response of rainfall to global warming is highly non-linear and small changes in temperature a long way from a region of interest can have profound impacts on rainfall over the region of interest. Thus, for rainfall, assuming the historical data are a guide to the future rainfall (that is stationarity) is far more courageous than for temperature and the sign of the change in rainfall is sensitive to the amount of warming.

These inferences about local or regional changes in climate due to 1.5°C or 3°C warming are general in nature. Summer heatwaves can increase dramatically in a region due to a small change in synoptic processes – for example imagine a three-day heatwave, broken by a cool day and then followed by a 4-day heatwave. If the weather patterns mean that break does not occur – for example the front that brings the cool air fails to move into a region, the heatwave can become a serious 8-day event. There are no "rules of thumb" here. One cannot infer what is going to happen easily and in terms of climate extremes the evidence does seem to point to rapid acceleration in the risk of some extremes.

Perhaps the critical element here is that the builders and users of Earth System Models understand their limits, some of the deep uncertainties and form a deep understanding of how to use the model simulations.
One might aggregate a large ensemble of simulations from one model for purpose X or aggregate a large number of simulations from many models for purpose Y. Very detailed models might be used to examine a process (say tropical cyclone dynamics) or a simplified model might be used to explore something like tipping points. One might exclude some models based on performance in some circumstances, or weight simulations for another, or use all the models for another. There are no agreed templates here; the science community building and using these models has deep insights over where one can and cannot use a specific approach and commonly will say “don’t know” when asked about how climate will impact a region, city or suburb. We recognise that we can have confidence in the simulations by models for some problems, but there is deep uncertainty for other problems, and some are simply unknowable. As in any situation, it is vital that users of models understand the limitations of those models and take these into account when using model outputs for making decisions.

Section 2: Uncertainty propagation through the climate modelling chain

Alex Pui, Neil Aellen, Henrik Auestad
Swiss Re Corporate Solutions

While understanding changes to climate variables as a function of global warming forms the backbone for any climate risk related analysis, this alone is not sufficient to develop a robust view on its ultimate impacts to businesses and society. For example, those within the agricultural sector may be more concerned with consecutive dry and hot spells that would adversely impact crop yields, while others in infrastructure planning could be more interested in extreme rainfall and flood risk from a design perspective. Therefore, it is critical to clearly map the pathways in which climate risk manifests in downstream impacts to a particular sector, as well as ascertain the degree of confidence one has in the projections of climate variables of interest, and inherent uncertainties across the modelling chain (Figure 1). To this end, an obvious example is sea level rise projections in the North Sea - simply taking hazard projections would suggest that most of Netherlands would be inundated by the turn of the century, but in reality, this is mitigated through protection afforded by sea walls.

Quantifying climate risk impacts through catastrophe models

An area of physical climate risk modelling that has garnered significant regulatory attention is the impact of climate risk on property portfolios, ostensibly due to heightened risk of wide-spread mortgage default, or property price declines resulting in systemic financial impacts. Here, catastrophe models (cat models) which have erstwhile been mainly used within the insurance industry for premium pricing, capital considerations and risk management, have emerged as a convenient tool to quantify acute physical climate risk impacts.

The allure of the cat modelling framework lies in its ability to conveniently stage various climate risk scenarios by explicitly quantifying economic costs associated with the increased frequency and severity of extreme weather events such as flood, tropical cyclones, wildfires, and convective storms. Namely, the key statistics produced by cat models include “annual average losses” which is the expected economic impact from physical damage to assets and associated business interruption, as well as the loss frequency curve, which provides an estimate of damage values across a range of return periods.

However, cat models are highly sophisticated, and often rely on various simplifying assumptions ranging on the choice of distribution type to characterise occurrence of hazards (i.e Poisson), and resilience of structures (i.e Beta) in response to a specific hazard forcing (such as peak wind gusts for

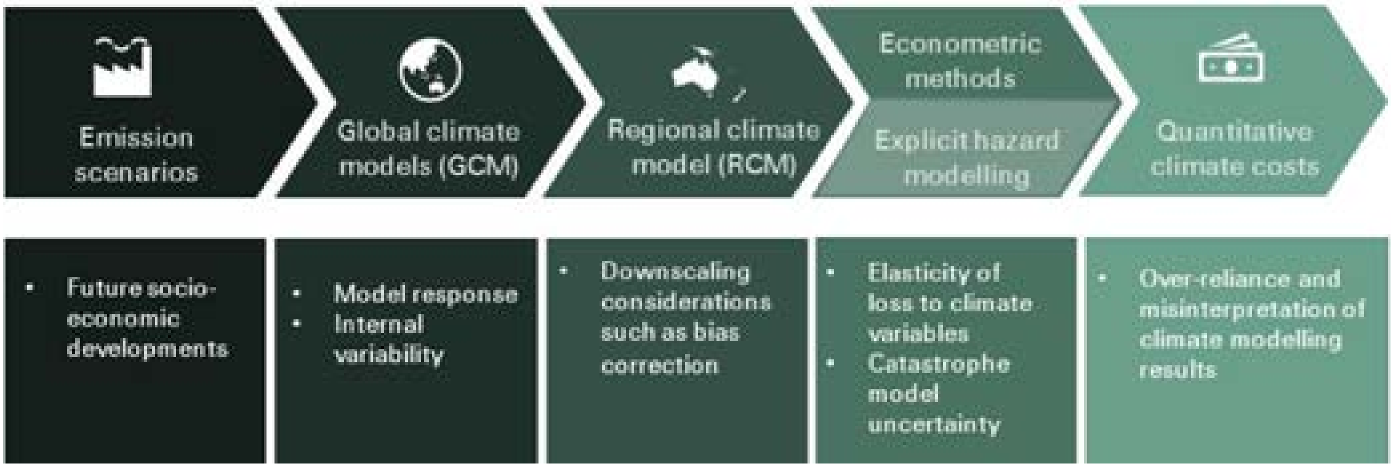

Figure 2: Example of a physical climate risk ‘modelling chain’, and associated key uncertainties introduced at each stage of the chain.

storms/ tropical cyclones, or flood height level) as well as more complex considerations to impart correlation structures within its stochastic event generation engine[2] . Apart from focusing squarely on obtaining key outputs such as expected loss, or specific return period losses, it is also imperative to appreciate the **uncertainty inherent in the production of these results**. For example, with reference to an idealised and simplified tropical cyclone (TC) catastrophe modelling process (see Schematic 2 below), there is uncertainty not simply in projections of changes to future peak wind gusts at a particular location (Step 1), but also uncertainty in the extent of damage conditioned upon different peak wind gusts (Step 2). As such, the overall uncertainty within produced estimates can be characterised by a convolution of the uncertainties that propagate through the modelling process (Step 3 – with the assumption that the distribution is normal, although this may not always be the case), or expressed by metrics such as the coefficient of variation (Step 4).

Hazard aside, key factors that determine the degree of uncertainty in modelling output include location data accuracy and occupancy characteristics of the asset in question. For example, the rating of an entire portfolio compared to a single location ought to be more robust as the law of large numbers help to reduce error assuming they are not systematic. In addition, as there exists more historical claims data available to train models, and theoretical knowledge of structural resilience, there is also more confidence in the modelling rigour of common residential buildings versus irregular/ complex structures such as semiconductors or wind farms. In fact, in pricing applications of cat model output within the insurance sector, uncertainty metrics are explicitly considered - with a higher loading added to expected loss figures for results that show higher volatility/ uncertainty. Further adjustments to default model results are often based upon expert judgement such as benchmarking against notable historical catastrophe events or realistic disaster scenarios, or across different model vendors.

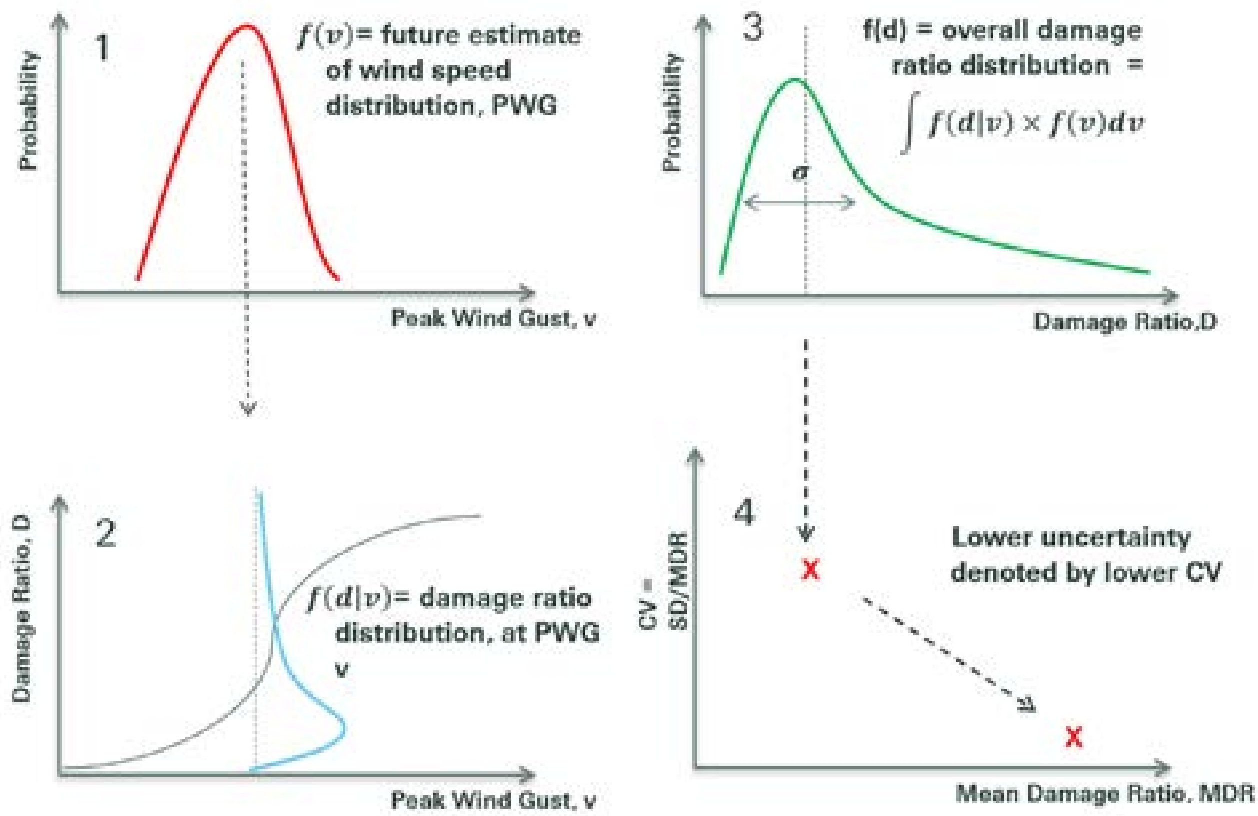

Figure 3: An idealised diagram showing the propagation of uncertainty through the catastrophe modelling process, and how overall uncertainty metrics are estimated.

2 ***Grossi and Windeler, Sources, Nature and Impact of Uncertainties on Catastrophe modelling (2004)***

As such, meaningful climate risk analyses involving the use of catastrophe models should at the bare minimum also come with estimates of uncertainty such that users can establish 'confidence intervals' around the robustness of generated results and help ascertain if there is conclusive evidence of directional trends in peril risk.

Concluding, raw cat modelling outputs have the potential to form a solid basis for further detailed climate risk assessment, but alone may not be sufficient to provide decision useful insights to multi-faceted questions such as climate risk impacts to a bank's balance sheet, property price declines or default probabilities. History has shown that markets do not efficiently price catastrophe risk in property values[3] . In fact, previous major catastrophes ranging from the 2010-11 Canterbury Earthquake Sequence (CES), Hurricane Katrina (2005) and Tohoku Earthquake / Tsunami (2011), have shown that factors ranging from the level of under-insurance, post-disaster government support and incentive schemes, mortgage penetration, lending and borrowing behaviour of financial institutions and societal attitudes all play an important role in determining loss outcomes, and should be used to form a holistic view, supplementing the results provided by catastrophe model.

3 ***Hino and Burke, The effect of information about climate risk on property values, PNAS 118, 17 (2020)***
The effect of information about climate risk on property values, PNAS, 2020 should be used to form a holistic view, supplementing the results provided by catastrophe models.

Section 3: The new business imperative – addressing uncertainty with innovation

Dr Nick Wood and John Evans

Energetics

As discussed in the preceding sections, climate change cannot be treated as “just another risk”. In Section 1 Professor Pitman set out the evidence as to why some climate change aspects can be treated as “risk like” whereas others need to be conceptualised as “uncertainty like”. In Section 2 Alex Pui and his colleagues at Swiss Re Corporate Solutions articulated the power of the extensive tools and techniques developed by actuaries working on natural perils. They also conclude that estimates of uncertainty are fundamental if users are to form a view as to the robustness of the results.

Energetics works with leadership and governance teams from across the Australian corporate landscape and assists them to develop strategic responses to climate change. Consequently, we are familiar with the challenge that the risk / uncertainty dichotomy presents and the line at which dynamic risk management can address uncertainty. The table below outlines the spectrum of considerations for physical climate risk.

Table 1: Feasibility of different types of analyses

Risk	Time scale	Individual building < 1 x 1 km	Metropolitan area < 50 x 50 km	Region / sub-continental < 500 x 500 km	Global
Acute* Volatility – event driven, such as floods, bushfires	1 – 10 years	Yes – if sufficient data exists on the extent of current vulnerabilities	Yes – if sufficient data exists on the extent of current vulnerabilities and the exposure factors have been adequately mapped	Can be aggregated from finer scale data from natural perils loss records and other sources for G20 nations	Availability of data on vulnerabilities for non-G20 jurisdictions may limit analysis
	10 – 30 years	Qualitative insights can be drawn for specific risks linked to exposure and localised vulnerabilities		Qualitative insights can be drawn for some meso-scale events (such as tropical cyclones) as the incidence, frequency and duration are not thought to changes on the decadal timescale	
	30 – 50 years	Uncertainty driven by non-stationarity dominates			
Chronic Long term trend – such as sustained higher temperatures	1 – 10 years	High uncertainty as climate influence cannot be differentiated from natural variability over the next 10 years			
	10 – 30 years	Yes – if the hazard can be combined with information on exposure and existing vulnerabilities		Yes – level of confidence varies by hazard	
	30 – 50 years	Yes – if the hazard can be combined with information on exposure and existing vulnerabilities		Yes – level of confidence varies by hazard	

*Selected losses at future time periods can be modelled within strict limitations

KEY	(blue)	Quantitative risk analysis possible	(orange)	Can be addressed qualitatively	(grey)	Uncertainty dominates: Can only be addressed adequately by the use of scenario analyses (underpinned by climate change projections)

Barriers and the steps that organisations can take to work within climate uncertainty

In Energetics' view, there are three hurdles that leadership teams need to overcome in order to be comfortable with saying "we just don't know for certain" but critically are also able to say, "but we understand the range and drivers of potential outcomes and are therefore taking informed, short-term actions, that can be adapted as the long-term future becomes more certain".

1. Complexity

The first barrier is the pervasiveness and complexity of the subject of climate change (both physical and transitional, as well as acute (volatility) versus chronic (long-term trend) physical changes), and the fact that its roots lie deep in the heart of unfamiliar territory for many businesses - scientific research. As advisory professionals we seek to bring relevant experts, including the climate scientists, into the room and then act as translators or knowledge brokers.

2. Possible and unprecedented new climatic patterns

The second barrier is the fact that climate change is a "new world", quite literally in some cases. For many businesses climate has not historically been a direct factor for consideration in decision making, and it could justifiably be argued that this has not been necessary in a world of stationary climate. As we have explained the non-stationary world of novel climates means this is no longer the case, and climate-related factors that drive businesses key decision-making metrics need to be factored into these metrics and the subsequent decisions that they inform.

Even for business where climate-related factors have been a key driver of their decisions, there are climatic patterns emerging now that are beyond what the science could ever have projected; events so extreme that they break records by very large amounts. The cognitive step into that new world way of thinking is not easy, nor would we expect it to be, but it is a world that cannot be avoided. Advisory professionals need to explain and educate on the new dynamics that need to be considered by businesses in both setting and executing a robust strategic plan.

3. Lack of urgency

The third barrier is the perceived lack of need for immediate action. This can be as a result of one or both of the views that:

- the outcomes of the worst risks presented by the known aspects of climate change may be a few decades in the future
- there is currently insufficient information or certainty on the unknown aspects for actions with guaranteed outcomes to be taken.

Both of these views are, in our opinion, flawed. On the first, actions can be taken today to seek to minimise any locked-in negative impacts that could occur in the future. For example, reducing or at least not increasing exposure to the known hazards. On the second, the call to immediate action is to understand the range of potential possible futures and take actions that will make the business resilient to as many of these futures as possible.

The other really important aspect of managing uncertainty is to know the trigger for your next key decision as the future becomes more certain, and to establish and monitor metrics that will provide the appropriate trigger. Without taking these actions, businesses become "sitting ducks" as the world moves around them. Scenario analyses provide the gateway to understanding potential futures and advisory professionals are well placed to advise on methodologies and run analyses in partnership with organisations.

Energetics observes that some types of business are better at overcoming these barriers than others. While the reasons vary, the defining differences relate to leadership and strategic direction. However, there is one part of the Australian economy where innovation in response to climatic uncertainty can be clearly seen – that sector is agriculture.

Australian agriculture: a case study in innovation

Energetics has been privileged to work directly on climate change strategies with farmers, processors, distributors and retailers as well as agricultural banking entities. What we see is innovation at all levels and across just about every food commodity type. The most significant examples include:

- The development of better spatial capabilities that link the vulnerability of crops to climatic variables
- Digital agriculture which enables much better assessment of conditions, lowers the cost of data and allows cropping using drones for many activities that would have previously required a ground vehicle
- The identification and selection of new genetic varieties of plants which provide farmers with a range of crops that can grow under different conditions whether that be drought or salinity tolerance.

Impressive as these developments are, it is important to note that, as discussed in this article, climate change is characterised by high levels of uncertainty making it difficult to form a view of future developments. From a global perspective, it seems we are not innovating quickly enough. A recent study jointly conducted in the US by the Cornell University and Stanford University and funded by the US Department of Agriculture reached the following conclusion[4]:

> Agricultural research has fostered productivity growth, but the historical influence of anthropogenic climate change (ACC) on that growth has not been quantified. We develop a robust econometric model of weather effects on global agricultural total factor productivity (TFP) and combine this model with counterfactual climate scenarios to evaluate impacts of past climate trends on TFP. Our baseline model indicates that ACC has reduced global agricultural TFP by about 21% since 1961, a slowdown that is equivalent to losing the last 7 years of productivity growth. The effect is substantially more severe (a reduction of ~26–34%) in warmer regions such as Africa and Latin America and the Caribbean. We also find that global agriculture has grown more vulnerable to ongoing climate change.

The world on average has warmed by 1.1°C since pre-industrial times. Warming to 1.5°C is, as Professor Pitman states, "inevitable" and with such large declines in farm productivity already experienced and a growing global population, innovation is needed and urgently.

4. Ortiz-Bobea, A., Ault, T.R., Carrillo, C.M. et al. Anthropogenic climate change has slowed global agricultural productivity growth. Nat. Clim. Chang. 11, 306–312 (2021)

Conclusion: Appropriate analyses must be developed to support decision making

Organisations need to recognise that the climate is becoming non-stationary, meaning it will be experienced from different envelopes of possibilities than those derived from historic experience. Traditional probability-based risk methods and approaches of the past are unable to produce meaningful assessments of potential futures, as they largely depend on the condition of stationarity. Instead, organisations must innovate to develop new or improved approaches such as well-designed scenario analyses that can provide an understanding of the uncertainty associated with potential novel climates.

The assumptions and limitations of the models used for these analyses, and the range of potential outcomes produced, need to be clearly understood and made transparent to end users so that they can be factored into business responses. This may promote the development of supplementary analyses or data to support the making of response decisions. Organisations also need to know under what circumstances their current response to these uncertain futures needs to be adapted, by establishing and monitoring appropriate indicators with associated calibrated trigger levels.

Business decision makers need to improve their knowledge to feel confident in taking short and medium-term decisions that seek to ensure the resilience of the organisation’s success, despite the uncertainty ahead. This will also require them be able to recognise and act to modify those decisions as greater certainty of climate-related change evolves.

Above all, uncertainty cannot be an excuse for not developing relevant analyses to support decision makers, who will otherwise “fly blind”. The strategic response to uncertainty should be one of innovation and as humans, it is the oldest skill we have!

About the authors

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Prof Andy Pitman AO FAA

Climate scientists articulate the way that climate change science works, what the research and complex earth system models can and cannot do and, most critically, illustrate whether we are dealing with climate change risks or climate uncertainties. Professor Pitman heads The Australian Research Council Centre of Excellence for Climate Extremes (CLEX) which brings together five leading universities and a suite of national and international partner organisations. The goal of CLEX is, together with national and international partners, to discover the process-level understanding that explains the behaviour of climate extremes that directly affect Australian natural and economic systems.

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Swiss Re Corporate Solutions leads market practice in natural perils and climate change for the global corporate insurance sector. In this paper, the authors describe how the sophisticated techniques used in the assessment of potential losses from natural catastrophes, based upon historical observation, are essential in the management of climate-related risks the near term but also articulate at what point the risk statistics fail as uncertainty takes over. Alex is currently Head of Natural Catastrophe (Nat Cat) and Sustainability (APAC) at Swiss Re Corporate Solutions based in Tokyo, Japan and he is building global climate advisory services capability for Corporate Solutions. Apart from pioneering climate and other innovative risk solutions, Alex also manages the APAC Nat Cat portfolio. Neil is a Climate Risk Specialist in Swiss Re's Cat Perils & Cyber division (CPC), which is responsible for Swiss Re's global natural catastrophe and cyber risk assessment. He is part of the CPC Portfolio team where he brings scientific knowledge of climate change and natural catastrophes together. Henrik Auestad is a Nat Cat Specialist, working on climate change related topics in P&C Solutions.

Dr Nick Wood

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Energetics is Australia's market leader in climate risk advisory and energy transition strategies, working with ASX200 across all sectors of the economy. Nick Wood and John Evans describe the issues that arise for corporate clients with climate risk assessments and in particular how boards and executive teams wrestle with the spectre of uncertainty. The section provides a case study from broad scale agriculture, one area of the economy where the response to climate uncertainty has been one of innovation. Nick has assisted the leadership teams of global businesses and key decision makers in governments to manage the challenges and opportunities associated with the changing climate and decarbonisation of economies. John is the director of his own independent risk consultancy business, JE Advisory, providing climate risk and broader enterprise risk management expert advice to the financial and wider corporate sectors. He is a regular partner with Energetics on client engagements and is the former Head of Enterprise Risk Advisory at Commonwealth Bank of Australia.

Sustainability at Energetics

Sustainability is core to Energetics' business. We became a 'Climate Active' certified organisation in 2019, adding our services to the certification in 2020, and in 2021 we verified our SBT through the SBTi.

Information security

In February 2022, we achieved our Information Security Management certification. It's internationally recognised and demonstrates our commitment to protecting all client information and data.

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