A Climate Risk Report

# From Risk to Advantage

## General Insurers as Key Agents for Climate Change Adaptation

A Report for Zurich Financial Services Australia


Climate Risk Pty Ltd provides specialist professional services to business and government on risk, opportunity and adaptation to climate change.
www.climaterisk.net

Climate Risk

A Climate Risk Report

# From Risk to Advantage

## General Insurers as Key Agents for Climate Change Adaptation

A Report for Zurich Financial Services Australia

ZURICH®

Climate Risk

Climate Risk Pty Ltd provides specialist professional services to business and government on risk, opportunity and adaptation to climate change.
www.climaterisk.net

**Climate Risk Pty Limited (Australia)**
Sydney: + 61 2 8243 5767
Brisbane: + 61 7 3368 2902
www.climaterisk.net

**Climate Risk Europe Limited**
London: + 44 752 506 8331

This report was prepared by:

**Dr Karl Mallon BSc PhD**
karl@climaterisk.com.au

**Janice Wormworth BSc MA**
janice@climaterisk.com.au

**Donovan Burton B.Env.Plan (Hons)**
donovan@climaterisk.com.au

**Dr Peter Best BSc(Hons) PhD**
cindualpk@bigpond.com

**Sean Kidney**
sean@climaterisk.net

**From Risk to Advantage: General Insurers as Key Agents for Climate Change Adaptation. Version 1.0**

ISBN: 978-0-9804343-5-4

Disclaimer:

Climate Risk provides professional services in relation to climate change risks and opportunities. Our technical and professional staff endeavour to work to international best practice standards using experienced scientists, sector specialists and associated experts. This document is intended to stimulate ideas and generate discussion for Zurich Financial Services Australia Limited. While the information contained is drawn from reputable sources in the public domain, Climate Risk cannot take responsibility for errors or inaccuracies within original source material.

This report does not consider individual investment requirements or the particular needs of individuals, corporations or others and as such the report should not be relied upon as the basis for specific commercial decisions.

Climate Risk support a constructive dialogue about the ideas and concepts contained herein.

## About Climate Risk Pty Ltd

Climate Risk Pty Ltd brings innovative yet accessible analysis to organisations considering how to adapt to climate change and associated strategies. Climate Risk Pty Ltd specifically focuses on the emerging risks and opportunities from all aspects of climate change for corporate and government clients.

Work by Climate Risk for the Telstra Corporation has been used by the United Nations in Kyoto and London. The company has also developed one of the world's first climate risk training packages for general insurance brokers as part of this project with Zurich Financial Services. Climate Risk also has in-house carbon and emission modeling tools which have been used to assist and critique national and international emissions and energy policy development.

Climate Risk is on the Commonwealth Government's Climate Change Risk Management Panel of Service Providers and Queensland Government's Panel for Greenhouse Gas Emissions Reduction Policy and Climate Change Adaptation Policy advisory services through the Environmental Protection Agency. Climate Risk is also the national leader in local government risk assessments in Australia. Originating from Australia, with offices in Brisbane and Sydney, Climate Risk now has staff based in the United Kingdom.

## Climate Risk Team

### Dr. Karl Mallon

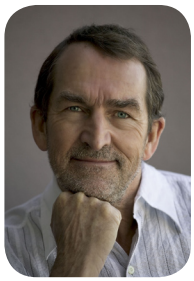
Dr. Karl Mallon is director of Science and Systems at Climate Risk Pty Ltd. He is a First Class Honours graduate in Physics and holds a Doctorate in Mechanical Engineering. Karl has worked in climate change mitigation, policy and technical analysis since 1991. He is editor and co-author of a book on climate and energy policy published by Earthscan (London) and has worked with various international government and non-government organisations since 1997. He currently specializes in climate change impacts risk to local government, insurance, institutional investment and works with large corporations on opportunities for operation under carbon and climate constraints.

### Janice Wormworth

Janice is a technical researcher, writer and communications specialist for Climate Risk. Janice trained in Canada with a bachelor of science in biology and a master's degree in journalism, she has worked as a science communicator for more than 15 years with a major focus on climate change and energy issues. Janice's media background encompasses work for public broadcasters in North America, including the Canadian Broadcasting Corporation in research and production. Janice has worked with a variety of national and international non-government organizations in Australia, Europe and North America including the David Suzuki foundation. Janice is currently working on two book projects on climate change and biodiversity issues, to be published 2009.

### Donovan Burton

Donovan heads Climate Risk's Local Government and Urban Planning section where he works closely with local government and industry to help develop climate change adaptation and mitigation strategies. He has a degree in Environmental Planning and achieved a First Class Honours for his thesis on local climate change mitigation. He has received a scholarship from the Wentworth Group of Concerned Scientists as well as a range of other academic awards. Donovan has facilitated numerous local government climate change risk assessments throughout Australia and is regarded as one of the country's leading professionals in this field. Donovan is currently also undertaking his PhD at Griffith University where he is researching strategies to mainstream climate change adaptation, linking insurers with developers, lenders and local government.



### Dr Peter Best

Qualified with a double first in Mathematics and Physics, a PhD in Theoretical Physics and nearly thirty years of post doctorate research in applied climatology, Peter's professional expertise in quantitative evaluation of model performance for both simulation and forecasting tools in climate, weather prediction and energy pricing supports Climate Risk's team. Building on experience as the Queensland Electricity Commission's Chief Climatologist, Peter has twenty five years of consulting experience in applied weather, climate, energy and air quality forecasting and risk assessment, covering industries from power and industrial processing of all types to intensive livestock, mining, cropping, waste processing and environmental management, renewable energy, water resource planning, transport, expert witnessing and education.

### Sean Kidney

Sean has 25 years experience as a social change strategist. He has been an advisor to governments, NGOs and pension funds, particularly in the areas of organisational development, marketing and communications and political lobbying. Sean is the London-based Europe manager for Climate Risk Ltd as well as the strategy and social marketing consultant to the EU's new European Web Site on Integration. Sean has worked extensively with the Australian pension fund sector on marketing and communications where his company won a dozen Combined Major Superannuation Fund awards. His current focus is on climate change and the intersection between the interests of long-term capital and the progress of economic and social evolution.

## Peer Reviewers

### Dr. Sophie Chemarin

Dr. Sophie Chemarin joined BNP Paribas in 2008, where she currently works in the Group Risk Management Department on scenario-based analysis of risks to the bank and its business. In particular, she works on assessments of the Group's financial soundness under different economic scenarios, as well as its capital management. Prior joining BNP Paribas, Dr. Cheramin was a research analyst at the Ecole Polytechnique, and a Fellow of the French Environment and Energy Management Agency (ADEME). The focus of her expertise and research is emerging risks management. She recently coordinated an extensive European study on insurance and adaptation to climate change for ADEME and Ecole Polytechnique. She was also an organiser of a European workshop on this topic, sponsored by the AXA-Ecole Polytechnique Chair of Insurance and Major Risks, the EDF-Ecole Polytechnique Chair of Sustainable Development, the FFSA and the Geneva Association on Risk and Insurance Economics. Dr. Chemarin holds a Ph.D. in Economics from Ecole Polytechnique.

We would like to acknowledge the constructive comments and input of Dr. Andrew Ash from CSIRO, Australia.

# Foreword

While the non-scientific debate continues to rage about whether climate change is mankind-induced or a natural phenomenon, there's no doubt countries, governments, companies, not-for-profit organisations and society in general are acting upon the premise that climate change is a reality. There's also little doubt that climate change is one of the most serious and complex risks confronting the insurance industry, with a confluence of climate change hazards poised to increase insurers' losses, erode their markets and even test their regulatory compliance. It's also very clear that relatively few insurers have made much progress in preparing their business lines for climate change impacts. Ironically, it's also clear that insurers are uniquely placed to facilitate society-wide risk management and adaptation to climate change impacts and greenhouse gas emission constraints.

Converting these opportunities into real products and services will be critical for the long-term prosperity of general insurers. In addition, reputational benefits can be reaped by insurers from action. Equally, reputational loss is possible if insurers fail to meet society's expectation for adequate and timely responses. Obviously, 2008 will be remembered as the year the global economy and markets had a rollercoaster ride. But this does not make the issues of climate change redundant. If anything, it emphasises that insurers need to factor the impact of climate change into their bottom line alongside the issues of the global economic meltdown.

Zurich Financial Services Australia (Zurich Australia) commissioned the highly regarded climate change consulting organisation, Climate Risk, to prepare this global report, looking at the impact of climate change on the general insurance industry, the issues it faces and what the industry is – or can - do about it. It's clear from the report that, while the general insurance industry faces many climate change challenges, the industry also has an opportunity to play a central role in increasing society's resilience and protection to climate-change risks. For example, flood liability is not mandatory in Australia and many people mistakenly believe their homes and businesses are covered for floods. Repeatedly media point the finger at insurers for 'not paying up' on floods, often in small communities. Under climate change, the incidence of flood is expected to increase.

A strong supporter of recent efforts by the insurance industry to highlight the need for flood cover, Zurich Australia has gone one step further. Recognising the benefits of taking a proactive stance toward managing emergent climate risk, Zurich Australia has taken a leadership role on the flood cover issue. As of September 2008, Zurich Australia, in a first of its kind, has provided flood cover automatically for its commercial customers.

Insurers have a unique opportunity to help society adapt to and mitigate against climate change. However, it requires ongoing dialogue with various stakeholders - from government, the private sector and the wider community - and the continual gathering of data and information, such as this report, to determine where they can best help. Zurich Australia is delighted to be associated with the comprehensive research undertaken by Climate Risk for this report and believes it will prove a valuable research tool for those involved in this global challenge.

**David Smith**
**Chief Executive**
**Zurich Financial Services Australia**

# Climate in the Context of the 2008 Financial Turmoil

As this report is being finalised we are watching a major financial catastrophe unfold, one that has already led to the failure of several large banks; and a liquidity crisis prompting the takeover of AIG, and collapse of Yamato - both insurers of global significance. Does this mean that insurers' response to climate change needs to be put on the back-burner until the current financial storm has abated?

To answer this question it is worth noting something we discuss in this report, which is the phenomenon of multiple, coincident catastrophes – sometimes referred to as 'Cat-following-Cat' events. The challenge of these events is that the first catastrophe causes fundamental weaknesses, leaving society, the economy and infrastructure more vulnerable to the second event. The spiraling underwriting losses that result can cause major drawdowns, strains on reserves and severe erosion of invested assets that insurers require to pay claims.

In this report we present what, in our opinion, is a quite different looming storm of major significance driven by climate change. Global insured weather-related losses are outstripping premiums, population and GDP, and commentators suggest there is already a climate change signal in global economic losses due to weather catastrophes. Current economic turmoil aside, we suggest that general insurers that fail to plan for climate change and manage the associated emerging risks could be faced with withdrawal from their markets, reduced margins, spiraling losses, and a potentially onerous regulatory response.

The effects of climate change risk are a two-way street: major European windstorms during the 1990s caused liquidity problems for insurers that compelled them to sell off large blocks of securities to cover their losses; this in turn can have a knock-on effect for wider financial markets. It is not hard to envision that a repeat of such a sequence of events in the current financial climate could pose still greater challenges.

Insurance is the largest industry in the world and the largest aggregator of global capital. It is therefore in everybody's interest to maintain and protect the health and prosperity of this industry. In this report we find that there are numerous actions insurers can employ to reduce the risks from climate change, and even enhance profits and reputational standing, by meeting the demand of increased climate-change-driven risk management.

To assume that the current financial turmoil has eclipsed the need for insurers to decisively prepare for climate change is akin to assuming that because one hurricane has hit, there is no need to prepare for a second. The reverse is true.

**Karl Mallon**
**Director of Science and Systems**
**Climate Risk Pty Ltd**

# Executive Summary

## 1 Executive summary

Insurance is the world's largest industry[i] (Mills 2005a) and is paid nearly 8% of global GDP (Swiss Re 2007) to be the world's primary shock absorber of risk. Yet climate change is pushing insurers inexorably to a fork in the road. One path forward leads to a downward spiral of escalating losses, diminishing markets and ever-reducing viability. The second path has the potential to lead to a major increase in the economic importance of the industry and a commensurate expansion in scale.The defining difference is not climate change itself, but how insurers choose to respond to climate change. The aim of this report is to shed light on that response.

This global status report finds that climate change may be the most serious risk confronting the insurance industry (Ernst & Young 2008), with a confluence of climate change hazards poised to increase insurers' losses, erode their markets, and even test their regulatory compliance. Research shows that despite this threat, relatively few insurers have moved to seize the numerous opportunities available to climate-proof their business lines.

It is also clear that insurers have a unique capability to facilitate society-wide risk management and adaptation to climate change impacts and greenhouse gas emission constraints. Converting these opportunities into real products and services will be critical for the long-term prosperity of general insurers. In addition, reputational benefits can be reaped by insurers through action. Equally, reputational loss is possible if insurers fail to meet society's expectation for adequate and timely response.

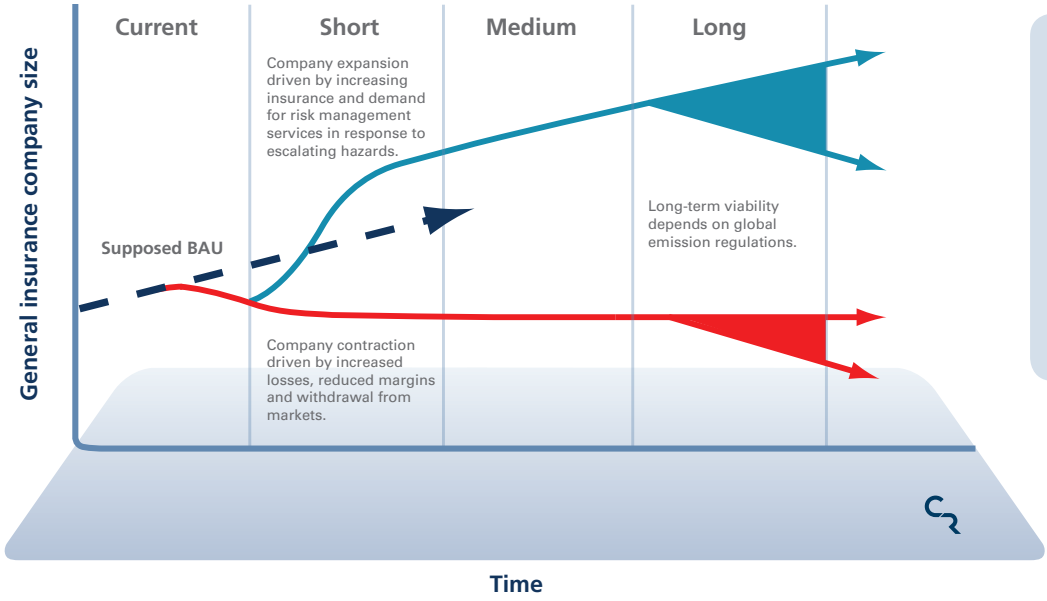



Figure i. A climate-change driven contraction for companies in the global general insurance industry is foreseeable; conversely a major expansion is also foreseeable. Unfortunately, business as usual is no longer in the frame.

i On the basis of gross yearly premium income from all lines of insurance (including life, health, property, casualty). This does not include investment income.

## 2 Navigating a complex problem

This report aims to help shed light on the gap between insurers' considerable potential to address climate risk, and the shortfall of concrete adaptive action on the ground.

A key contribution of this report is the development of a new framework to allow insurers and stakeholders to navigate the complex and multi-fold climate change risks, and identify the levers available to minimise and adapt to these risks, in order to secure a prosperous insurance sector in the face of climate change. Called the Climate Risk Diamond, this framework captures: hazards, vulnerability, exposure, opportunities, and capacity (Figure ii).

The Climate Risk Diamond approach has been used to examine insurers' ability to not only manage risk, but also develop tangible opportunities to increase profitability, grow their business, and secure reputational gains in the face of climate change. The Climate Risk Diamond can be used to describe the position of a company or industry vis-à-vis climate risk and advantage.

## 3 Tackling climate change: The five levers for general insurance

This report employs the Climate Risk Diamond framework to examine the climate change risks facing the global insurance industry and avenues open to it to secure advantage. Whether and how these are being addressed is considered using real-world insurance industry examples from around the globe.

The five key 'levers' available to insurers to respond to climate change are:

1. To reduce the hazard(s)
2. To reduce their vulnerability
3. To optimise their exposure
4. To recognise new opportunities
5. To develop capacity to manage new risks and deliver opportunities.

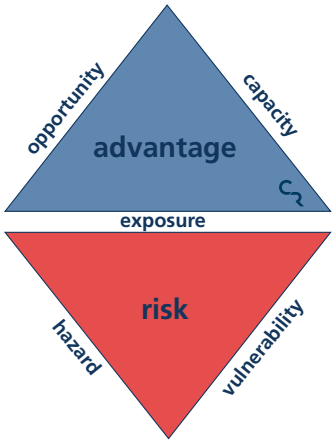



Figure ii. The Climate Risk Diamond framework

## 3.1 Reduce climate change hazards

As the world's primary shock absorber of risk, the general insurance sector is confronting escalating climate change hazards. Many primary (direct physical) climate change hazards are 'locked in' due to greenhouse gases emitted since industrialisation. Largely unavoidable, these hazards may arrive sooner or be more severe than climate models suggest; most general insurance business lines will be affected in some way.

Governments are, and will, continue to react to these hazards by regulating greenhouse emissions and implementing adaptive measures. Consequently, insurers also face a major strategic challenge in the raft of secondary (regulatory) hazards from anticipated standards to deal with the primary hazards, as well as mounting pressure for swift and deepening greenhouse gas emissions cuts.

Insurers will further face numerous 'tertiary' hazards arising from society's auto-adaptive responses to climate change, including changes in behaviour, demography, infrastructure and property values. These changes pose a particular challenge for insurers because they entail complexities and feedbacks, which make these hazards difficult to predict. Not least is the concern that physical climate hazards and regulatory responses could increase expenditure burdens on customers, prompting some to forego the cost of insurance, or to underinsure.

Although insurers have no immediate control over primary climate change hazards in the short or medium term, they can facilitate the reduction of greenhouse gas emissions which cause

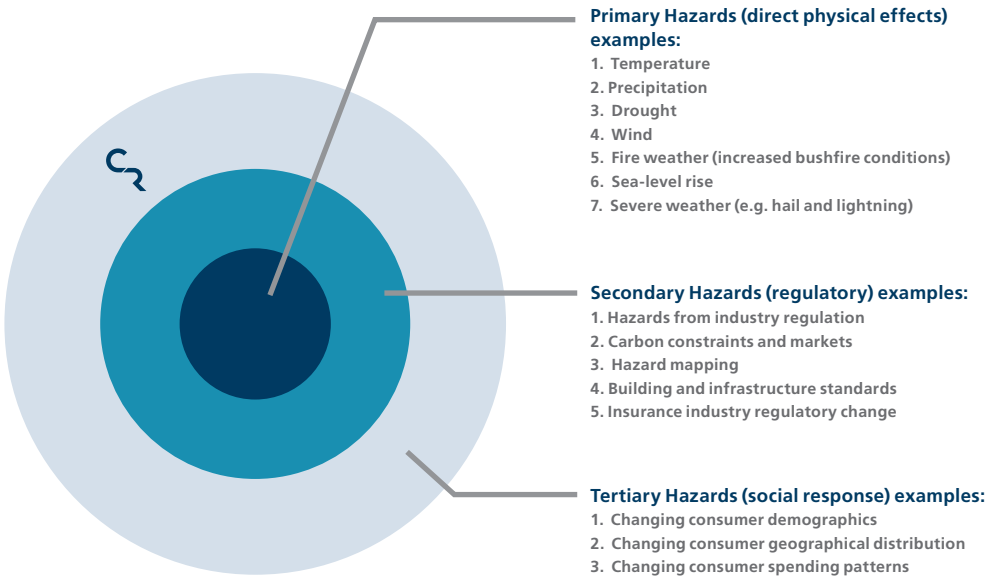



Figure iii. Primary, secondary and tertiary climate change hazards discussed in this report.

climate change. This will help avert a level of climate and weather hazards that could be uninsurable in decades to come; however, this must be balanced with an acceptance that many decades of climate change impacts are already 'locked in', unavoidable and must, therefore, be managed.

The ability of insurers to tangibly reduce secondary and tertiary hazards in the short term is much greater than for primary hazards. Insurers can reduce regulatory hazards by engaging in policy development at all levels of government.

Finally, insurers can tackle tertiary hazards, firstly by resolving and planning for the complex risks arising from society's response to climate change, and secondly by guiding the response of individuals, business and government to minimise the overall risk and avoid maladaptive, counterproductive actions and risk transfer.

## 3.2 Reduce climate change vulnerability

Insurers become vulnerable when they provide cover which may be affected by climate hazards. A major vulnerability for insurers in the era of rapid climatic change is the industry's rear-view approach to climate and weather risk assessment, which threatens to lead insurers straight into the arms of financial risk. Under climate change, past risks are a poor guide to future risks. This leads to a related vulnerability, which is the difficult task insurers face to price insurance in a way that adequately reflects increasing weather-related

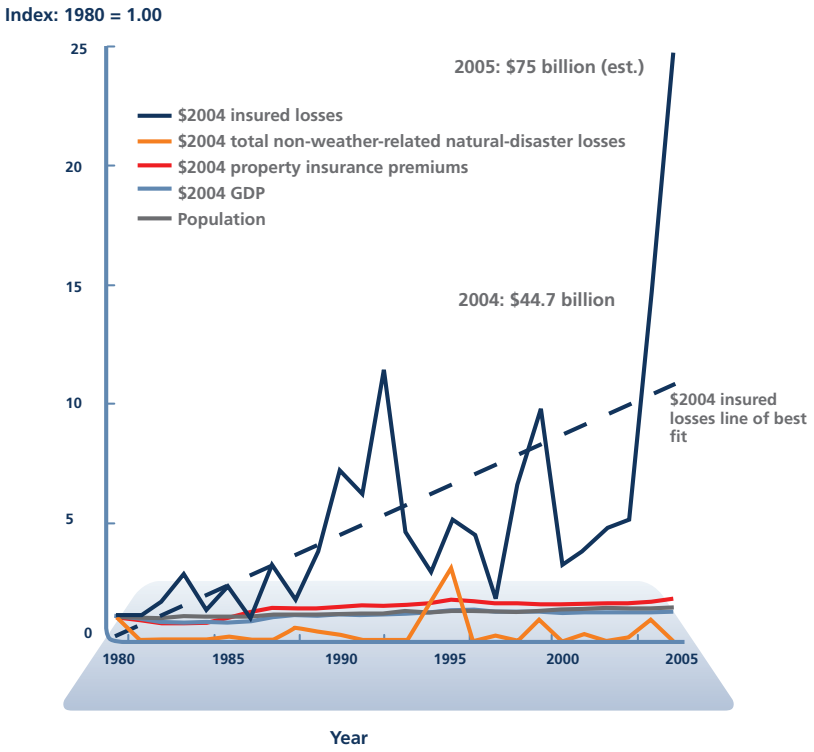



Figure iv. Global insured losses due to weather are rising faster than premiums, population or gross domestic product. Weather-related losses are rising much faster than non-weather related losses. Data exclude health and life insurance premiums and losses (from Mills 2005b). Economic values are inflation adjusted to 2004 levels; original data sources: Munich Re NatCat Service, Swiss Re, Sigma, Lawrence Berkeley National Laboratory.

losses (see Figure iv). These losses could grow to US$1 trillion in a single year by 2040 (UNEP-FI 2007). Regulatory changes and societal responses are also creating direct and indirect vulnerabilities: shareholder actions; burgeoning climate litigation; and entirely new markets for which insurers lack experience and data.

Insurers can be expected to use traditional financial risk management techniques to address vulnerability to weather-related losses through: raising premiums and deductibles, lowering limits and implementing broader coverage restrictions. All of this could backfire on the industry. Insurers will have to consider the sensitive balance between upward price pressure and long-term insurance affordability, as well as regulatory and competitive pressures to keep prices low. Misjudging the balance would lead to a cycle of diminishing markets and margins.

Given that many options exist for climate-responsive insurance products which encourage loss minimisation through increased preparedness of customers and their assets, many commentators suggest that terms should be tightened, and prices raised, only when other measures have been exhausted. However, such proactive measures to reduce vulnerability to physical climate change hazards, as well as the need to respond to regulatory and socially-mediated vulnerabilities, require that insurers increase their capacity to be proactive on climate change.

### 3.3 Optimise exposures

Insurance is the world's largest industry, with markets (exposures) garnering premiums that in total represent 7.7 % of global GDP (Swiss Re 2007). However, climate change hazards are already transforming insurers' exposures, creating entirely new markets, and threatening to erode core business. The industry's exposure to climate change hazards can be both geographical and sectoral. Insurers in many locations already prone to escalating extreme weather events, such as flooding, droughts and wind storms, must also bear the brunt of higher insured losses due to intensifying urban development in these high-risk areas, such as coastal zones around the world. There are also at-risk sectors, including agriculture, forestry, energy-intensive manufacturing industries, and the wider energy sector.

There is a range of options available for insurers to optimise their exposures in the face of climate change hazards. This includes the obvious response of reducing exposures by vacating at-risk sectors or zones, such as coastal regions where insurance availability is already decreasing (UNFCCC 2007). However, this reactive exit strategy has numerous disadvantages, not least of which being that it absents private insurers from markets and income. It also creates reputational hazards for insurers for a failure to provide expected services.

Strategies that permit insurers to sustain or even expand their exposure to vulnerable locations and sectoral

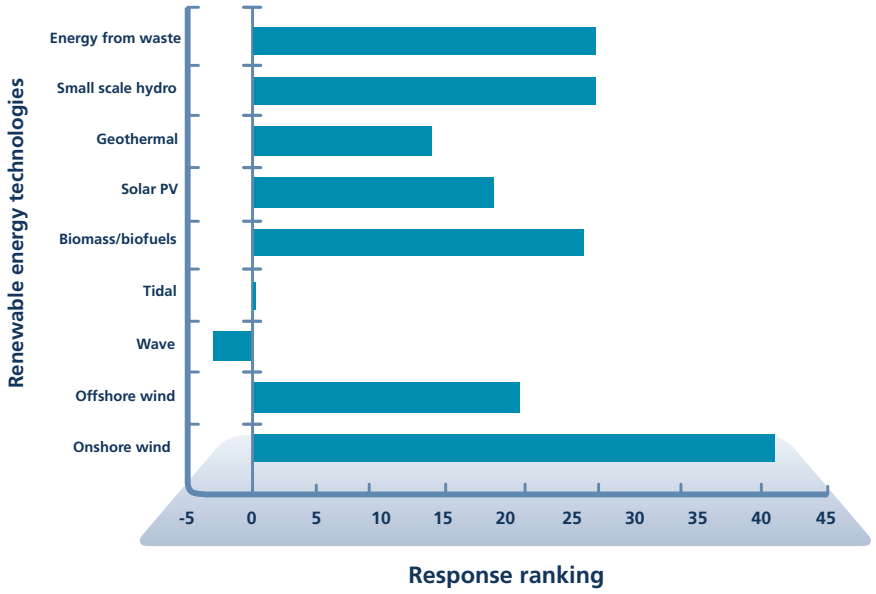



Figure v. Ranking of renewable energy technologies with the greatest business potential for insurers (Marsh 2006).

markets, despite increasing climate change risk, may be both possible and profitable. In addition to traditional financial risk management techniques, insurers may opt for products which serve to 'climate proof' their exposures, via physical risk reduction and loss prevention. Entering new markets (see below) can furthermore provide insurers with new income streams and a useful hedge during a period of rapid change.

## 3.4 Identify new opportunities

As the world's largest industry, with unparalleled access to business and consumers, insurers have a matchless, but largely untapped, opportunity to provide critical risk management services to help society adapt to and mitigate climate change while, at the same time, climate-proofing their industry and gaining the associated reputational benefits.

Although new or escalating climate change hazards threaten to exacerbate damage and loss, they also increase demand for solid risk management products. Well poised to build on a lengthy tradition of proactive and profitable physical risk reduction, insurers can provide products which help communities withstand climate change hazards. Insurers can also build on their core strengths of hazard identification, and risk management advice and analysis, to price risk more efficiently. This could provide disincentives for continued urban development in highly vulnerable zones and discourage building to standards, which are inadequate given escalating weather hazards.

New markets created by regulation to stem emissions provide insurers with an opportunity to facilitate the growth of low-emission industries. The renewable

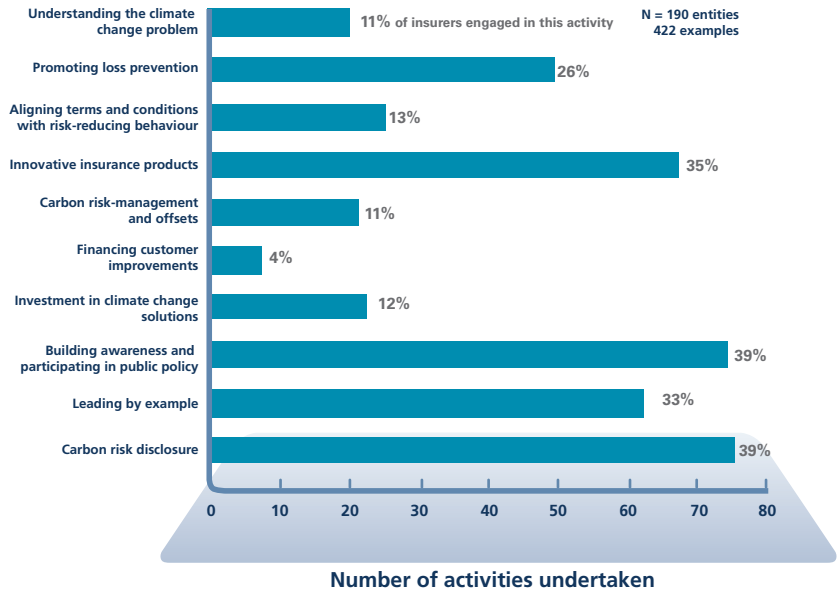



Figure vi. Mills' (2007) international survey finds that although the number of responses insurers are making to address climate change is increasing rapidly, those acting are still a minority.

energy market provides insurers with an opportunity to stake a claim in a growth sector they view with great optimism. Those entering the multi-billion-dollar global sector for energy efficiency services can guarantee energy savings, help break down investment barriers, reduce project costs, and even incentivise greater energy savings. New insurance products for the carbon trading market can cover off risk and help monetise the value of carbon credits. Green buildings and fuel-efficient vehicles provide another opportunity to motivate insurance customers to reduce their emissions.

Finally, as experts in climate and weather-related risk, as well as internationally significant investors, insurers also have a unique opportunity to help shape climate change policy at all levels of government, from future-proofing national infrastructure to maintaining insurance affordability.

Facilitating societies' adaptation to climate change is beyond the individual capacity of any company, industry or government. It is instead an opportunity to forge closer partnerships.

## 3.5 Build new capacity

An advantage can only be realised when an opportunity is captured. Capturing new opportunities, reducing hazards and vulnerability, and optimising exposures will generally require that insurers increase their capacity.

Building on core strengths in hazard identification, some insurers are acting on the realisation that backward-looking models to product specification and pricing no longer suffice. They are taking the first steps to incorporate forward-looking models used by climate scientists, and tying these to insurance loss models to estimate future levels of

risk and loss. However, the overall goal of pricing for climate change hazards, so crucial to sustaining insurer profitability and aligning customer behaviour with risk, remains largely unmet.

Some insurers are also using their traditional physical risk management expertise to help 'climate proof' their current markets through physical loss prevention. Others are encouraging policyholders to rebuild after catastrophes with more robust structures. Products such as these are essential to help society adapt to climate change, however, they remain few and far between despite concrete demonstrations of their feasibility by proactive insurers.

Pioneering insurance firms are also creating products to tap fast-expanding new markets: adapting traditional project-based insurance for renewable energy developments; novel weather derivatives for solar and wind projects (to transfer the risk of underproduction due to unexpectedly low levels of sun or wind); and innovative carbon credit delivery guarantees. Some insurers are also adapting their risk management expertise to provide consulting services on climate risk, such as carbon regulatory risk.

## 4 Conclusions

Our step-by-step analysis finds the following three central conclusions:

### 4.1 Climate change hazards are present, escalating & increasing losses, but insurers are not responding to the scale of risk

An upward trend (of two per cent per annum) for global normalised economic losses due to weather-related catastrophes since 1970 corresponds to rising global temperatures (Muir-Wood *et al.* 2006), and has been described as a 'climate change signal' for such losses. Physical climate change risks are locked-in and increasing; regulatory responses are growing; and the accompanying complex social changes and feedbacks are emerging. Exacerbating this risk is intensifying urban and non-urban development in zones of increasing climate and weather hazards, often built to standards which fail to account for climate change. Meanwhile, (to paraphrase Munich Re [1999]), when it comes to actuarial analysis, the industry essentially continues to drive forward into a perfect storm of escalating or shifting hazards with its vision fixed on the rear-view mirror.

### 4.2 A wicked problem requires a unifying framework for dialogue

Climate change presents to insurers a 'wicked problem', one for which there is no 'silver bullet'; rather management of this issue requires an ongoing and dynamic approach. This highly complex and rapidly evolving issue interfaces with the insurance industry at diverse touch-points, and readily jumps companies' divisional silos. Yet as society's shock absorber for risk, the insurance industry's continued

> As society's shock absorber for risk, the insurance industry's continued profitability is vital to underpin the health of the global economy in the face of climate change.

profitability is vital to underpin the health of the global economy in the face of climate change. Thus, it is crucial for the industry, government and other stakeholders to see these issues though the same prism, to understand what insurers can and cannot do about climate change in the short and longer term, and to establish an ongoing dialogue to develop solutions.

There are five critical levers (set out in the Climate Risk Diamond) that clearly define the range of insurer actions available to minimise risk, maximise opportunities and build resilience. These require a balanced and comprehensive response from the each of the stakeholders.

## 4.3 Scale of response must match enormity of the challenge

As society's risk managers, insurers are paid $US 4 trillion[ii] a year to provide a buffer against losses due to hazards. The industry is now presented with what appears to be the biggest risk to the future global economy: climate change (Stern 2006). While considerable uncertainties remain, an already-large body of climate change science signifies that these risks are not unknown entities.

Furthermore, insurers' lengthy history of risk remediation suggests unavoidable climate change hazards could be proactively and profitably managed, helping society adapt to climate change while accruing considerable reputation gains for the industry.

However, it is our view that the current thrust of insurers' response to climate change appears to be somewhat more focused on new markets and their associated benefit of long-term risk reduction through mitigation. Thus existing markets, which represent insurers' core business, remain vulnerable to escalating losses given the shortfall of concrete action to address primary climate change hazards (eg sea-level rise, drought and cyclones). This imbalance must be remedied if general insurers are to remain prosperous.

A vast amount of preparation remains to be done if insurers are to fulfill their intrinsic role as leaders of society's response to climate change. If this is not accomplished, the public and private sector face the prospect of unaffordable insurance; insurers face the possibility of onerous regulatory response; and the wider industry faces a race to the bottom if insurers respond to weather-related losses by withdrawing from the very markets that most urgently require their risk management services.

It is true that some in the industry, most notably a number of reinsurers, have taken the climate change issue very seriously. However, the scale of response, which sees only a fraction of insurers responding, is still long way from meeting the enormity of the challenge.

ii 2007 premiums for the insurance sector, including life insurance (Swiss Re 2008).

# References


Ernst & Young (2008) Strategic Business Risk: Insurance 2008. In collaboration with Oxford Analytica.

Marsh (2006) Survey of Insurance Availability for Renewable Energy Projects. A Report for the United Nations Environment Programme.

Mills, E. (2005a) Insurance in a Climate of Change. Science 309(5737):1040-1044.

Mills (2005b) Availability and Affordability of Insurance Under Climate Change. Presented at the National Association of Insurance Commissioners Winter Meeting, Chicago, December.

Mills, E. (2007) From Risk to Opportunity: Insurer Responses to Climate Change. A CERES Report.

Muir-Wood, R., Miller, S. and Boissonade, A. (2006) The Search for Trends in a Global Catalogue of Normalized Weather-Related Losses. Workshop on Climate Change and Disaster Losses: Understanding and Attributing Trends and Projections. Hohenkammer, Munich, 188-194.

Munich Re (1999) Topics 2000: Natural Catastrophes – The Current Position. Report 2895-M-e, Munich Re Group, Geoscience Research Group, Munich.

Stern, N. (2006) The Economics of Climate Change: The Stern Review HM Treasury/Cabinet Office.

Swiss Re (2007) World Insurance in 2006: Premiums Came Back to Life.

Swiss Re (2008) World Insurance in 2007: Emerging Markets Leading the Way.

UNEP-FI (2007) Insuring for Sustainability. Inaugural Report of the Insurance Working Group.

UNFCCC (2007) Report on the Workshop on Climate-Related Risks and Extreme Events. Subsidiary Body for Scientific and Technological Advice, 27th session, Bali, 3–11December. Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change.

# Contents

# Part A Introduction, Navigation and Methods

This section begins with an explanation of the framework which underpins the organisation and methodology of this report. This framework is intended to help general insurers, and other stakeholders, to navigate the risks posed by climate change, and to identify ways to secure advantage in the face of this threat. We recommend all readers cover this section, which also lays out key terms and definitions.  Once equipped with this information, readers will be better able to navigate freely throughout the report.

# 1 Introduction

"A stable and efficient insurance sector provides a vital underpinning to society and to economic growth… Insurance plays a pivotal role in directing capital investment to its optimal use, enabling businesses to adapt to changing circumstances by correctly integrating risk into their development and investment strategy".

Reo Research, 2007

**As the international community attempts to identify the best pathways toward abatement of greenhouse gas (GHG) emissions, escalating weather-related losses are already having a real and considerable impact on insurance claims worldwide. According to Ernst & Young (2008a), "The top insurance risk in 2008 is climate change. The threat is typically viewed as a long-term issue with broad-reaching implications that will significantly impact the industry"[1] (see Figure 1). Given the clear need to deal with this threat, this report aims to provide insurers and their stakeholders with a tangible framework to conceptualise the interaction between climate change and general insurance.**

Weather-related insured catastrophic losses increased by factor of 10 from the 1950s to 1990s, doubled again by 2004, and set new records in 2005 (Epstein and Mills 2006). Many insurers realise action is required. Internationally, a minority of insurers are responding - some more assertively than others. Yet sustaining a prosperous insurance sector that can provide affordable coverage remains a major strategic challenge to business, government and the wider society in the face of emergent and escalating climate change risks.

Increasing knowledge about how climate change will impact the insurance sector is reflected in a growing body of international literature and analysis, especially from the reinsurers. Although the literature highlights current and potential climate impacts and hazards, there remains a need for strategic direction and common frameworks to help insurers and their stakeholders improve their resilience in a rapidly-changing climate.

Climate Risk has been commissioned by Zurich Financial Services Australia (Zurich Australia) to present a useful framework that illustrates the interaction between climate change and general insurance, and put forward various options available to insurers to achieve resilience and prosperity in this environment.

This report forms part of that project. It endeavours to build upon much of the existing analysis on climate change risks for the insurance sector, and to relay and manage this substantial body of information through the use of a simple framework. This is intended to help general insurers navigate the numerous and complex threats posed by climate change, and provide insurers and other stakeholders from government, business and the broader society with a

1 Refers to the property/casualty insurance industry.

common platform of understanding on how the sector can respond.

Unless otherwise specified, the content in this report refers to general insurance (see definition in Appendix A). This report endeavours to provide a global snapshot of the general insurance industry, however, it is not within the scope of this document to examine the unique sets of issues related to specific or special insurance markets such as those in developing countries.

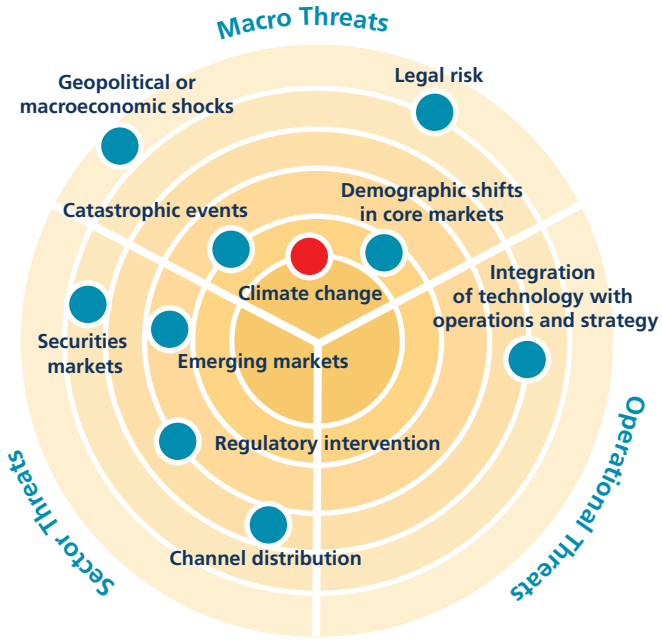



Figure 1. An Ernst & Young (2008a) analysis of the top 10 risks for business finds climate change to be the most serious threat to the insurance industry. Other significant but lesser threats include demographic shifts in core markets, catastrophic events, and regulatory and compliance risks. Ernst & Young describe 'macro threats' as those that "emerge from the general geopolitical and macroeconomic environment in which we all operate".

## 2 Navigation

This report has been written to achieve three objectives: (1) to provide a simple framework for a complex problem; (2) to show the options available for general insurers to manage climate-change induced hazards and opportunities; and (3) to provide examples of how these levers can, and are, being used by insurers and stakeholders around the world.

The report is not designed to be a 'cover-to–cover' read but rather to provide a framework, resource and reference document for general insurance industry stakeholders who must consider climate change. The most important aspect of the report is the methodology section, which sets out the simple yet comprehensive Climate Risk Diamond framework for understanding climate change risks and actions.

We also recommend that all readers cover the first sections of the climate change hazards chapter, which establish important definitions. We note that one challenge for readers of risk-related literature is multiple and overlapping terms and definitions used by different authorities and in different contexts (see Box 1 and 2). Here we attempt to parse out the key aspects of climate-change risk using the work of Crichton (1999) as an underpinning, and we clearly define the terms we employ as they relate to the insurance industry (see Box 1 for definitions).

Readers familiar with these key methodological and definition sections, are invited to freely navigate around the document, equipped with an understanding of how the report's content fits within the overall framework set out in Figure 4 (Climate Risk Diamond).

# 3 Method

For this report, Climate Risk employs a methodology that aims to explore both the risks and the avenues to secure company advantage arising from climate change. This section explains this methodology, which forms the framework that guides discussion throughout this report.

## 3.1 Crichton's risk triangle

The starting point for the methodology used in this report is Crichton's (1999) triangle of risk. Crichton states that communities must understand climate change risk if they are to build resilience and become 'future-proof'. He states that risk, which is the probability of a loss, can be determined by examining hazards, vulnerability and exposure. A risk occurs when there is confluence in these three elements. The magnitude of the risk, which might be thought of as the area inside the triangle, is determined by the extent of the hazards, vulnerability and exposure.

Many definitions exist for the terms 'hazard', 'exposure' and 'vulnerability' (see Box 2). Thus we will clearly define how this report employs these terms within the context of climate change and the general insurance sector.

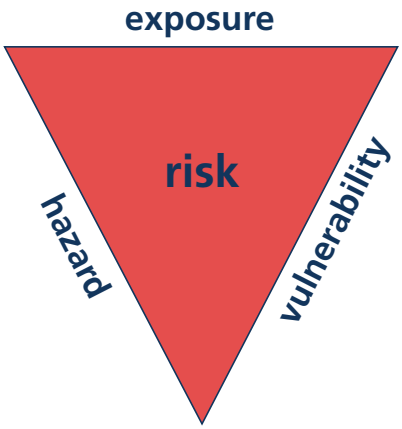



Figure 2. Crichton's triangle of risk (1999). According to Crichton, "Risk is the probability of a loss, and this depends on three elements, hazard, vulnerability and exposure. If any of these three elements in risk increases or decreases, then risk increases or decreases respectively."

## Box 1. Defining climate change 'risk' terminology in the general insurance context

**Climate change hazard**: A climate-change-related event, series of events/variation, (or an action resulting from these), which has the potential to result in a material loss for an insurer, its customers and/or reinsurers. An example of such a hazard would be a projected increase in the number of severe and damaging hail events in Johannesburg due to climate change.

We furthermore note that in the context of this report, a climate change hazard refers to an event with some actual or potential impact on insurers.

**Climate change vulnerability**: The sensitivity of insurers' business activity to climate-change-related loss. This sensitivity encompasses policies, premium setting, internal capacity and loss/premium ratio. An example of this is an insurance policy that covers property damage due to hail, but has been priced at a level that fails to account for an increase in severe hail events due to climate change, thereby increasing an insurer's vulnerability.

Insurers' vulnerability to climate change hazards is mediated through their products and services; if these hazards have the potential to effect a loss for an insurer, they create a vulnerability. (If climate change impacts another party in a way that does not affect an insurer, then it is not termed a vulnerability within the context of the definition used here.) Thus under vulnerability we examine how insurers will be prone to loss if they fail to adequately reflect climate change hazards in the pricing and structure of their policies and services. This includes specific factors within the industry itself which may be exacerbating its vulnerability.

**Climate change exposure**: The market, both geographical and sectoral, in which an insurer is active and the extent/value of that market. For example, an insurer who provides coverage for hail damage for public sector vehicle accumulations in Johannesburg is exposed to a market that is subject to this climate change hazard.

We examine climate change from the point of view of exposure to flag major market-based threats. We seek to understand how changes to insurers' markets, as a result of climate change hazards, are increasing their risk. In the absence of efforts to increase their capacity to proactively manage this risk, many insurers will face increasing losses and may be forced to exit such markets. However, we also examine exposure from the point of view of 'advantage' (see below).

A useful shorthand is to think of:

- hazards as climate change impacts
- exposure as mediated through geographical and sectoral markets
- vulnerability as mediated through products and services.

## Box 2. Alternative definitions: an explanation

This report's definitions for hazards, vulnerability, exposure, opportunity and capacity were developed specifically for the general insurance sector. These terms were further explicitly defined from a risk management perspective, to allow stakeholders to see climate change from the point of view of insurers. Although we have clearly established their use in this report, we point out that these definitions are not absolute, but vary with the perspective and goals at hand.

Indeed, some approaches may demand a greater depth and complexity of definition, such as those of the scientific community, whose work has a greater focus on physical climate change effects on the biosphere and society. For example, the vulnerability framework that is employed by the CSIRO in its assessment of local councils in Australia (Preston *et al*. 2008) uses the Intergovernmental Panel on Climate Change (IPCC) definition of vulnerability as its point of departure: "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." The CSIRO framework then finds that vulnerability is composed of exposure, sensitivity and adaptive capacity[2].

We note, furthermore, that definitions may change depending on the perspective of the party using them. For example, an action by a government to regulate greenhouse gas emissions will be viewed by that government as a step toward climate change hazard reduction, whereas a fossil-fuel intensive industry will view this same regulatory action as an emerging hazard.

2 The terms from the CSIRO framework differ from those used in this report. In the CSIRO framework, exposure "is the degree to which a system is exposed to physical climate variability and change (including climate hazards)"; sensitivity is "the degree to which a system will change or respond to altered climatic conditions"; and adaptive capacity is "the ability of a system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climatic hazards."

## 3.2 The advantage triangle

As well as investigating its climate change-related-risks, the insurance industry must identify possible avenues for advantage if it is to continue to thrive. To explore advantage, this report employs an inversion of the risk triangle. This 'advantage' triangle is delineated by exposure, opportunity and capacity (see Figure 3). In a similar way to the risk triangle, the area inside the triangle can be seen to represent the magnitude of the advantage, as determined by the confluence of opportunity, capacity and exposure.

## 3.3 The Climate Risk Diamond

The overall position of a company in relation to climate change can be described by combining the 'risk' and 'advantage' triangles, which we then refer to as the 'Climate Risk Diamond'. The Climate Risk Diamond captures not only the key elements of climate change risk, but also the key actions that are available to insurers to respond to climate change (see Figure 4).

The shape of the diamond can also be used to visually illustrate the current or intended position of a company or sector. For example, a company at high risk to climate change would have a large risk triangle and small advantage triangle. On the other hand, a large advantage triangle and small risk triangle would signify a more climate change resilient insurer, which is better placed to capture the potential 'upsides' created by this major challenge.

In terms of reducing the size of the risk triangle, the insurer can use one or more of three options:

1. Reduce the hazard
2. Reduce the vulnerability
3. Reduce their exposure

Conversely, to increase their advantage insurers may:

4. Identify emergent opportunities
5. Increase their capacity to deliver products and services that meet their customers' needs
6. Optimise the geographical or sectoral exposure.

The organisational structure of this report reflects this overall methodology, and it aims to provide a clear and simple way to navigate through the positive and negative impacts of climate change on insurers and their sector.

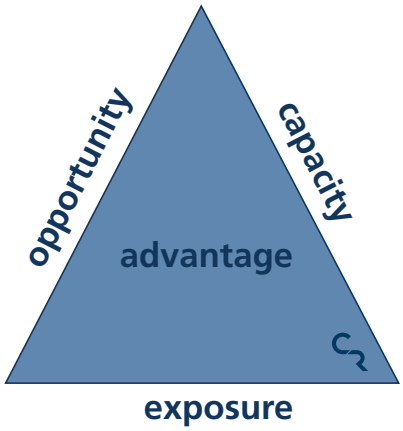



Figure 3. The advantage triangle shares a common 'exposure' line with the risk triangle. However, this triangle identifies the 'opportunity' to minimise climate change risk and meet the emerging risk management needs of wider society. The 'capacity' side recognises the need for insurance products and related know-how to capture these opportunities and turn them to advantage for the company or sector.

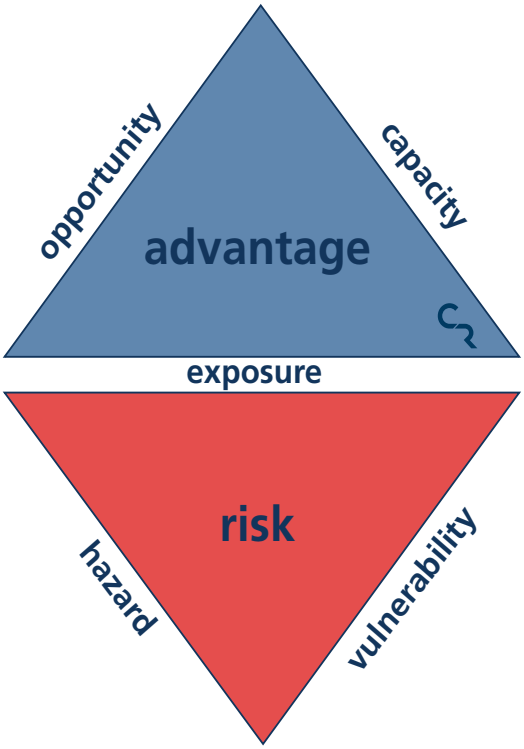



Figure 4. The Climate Risk Diamond for general insurance.

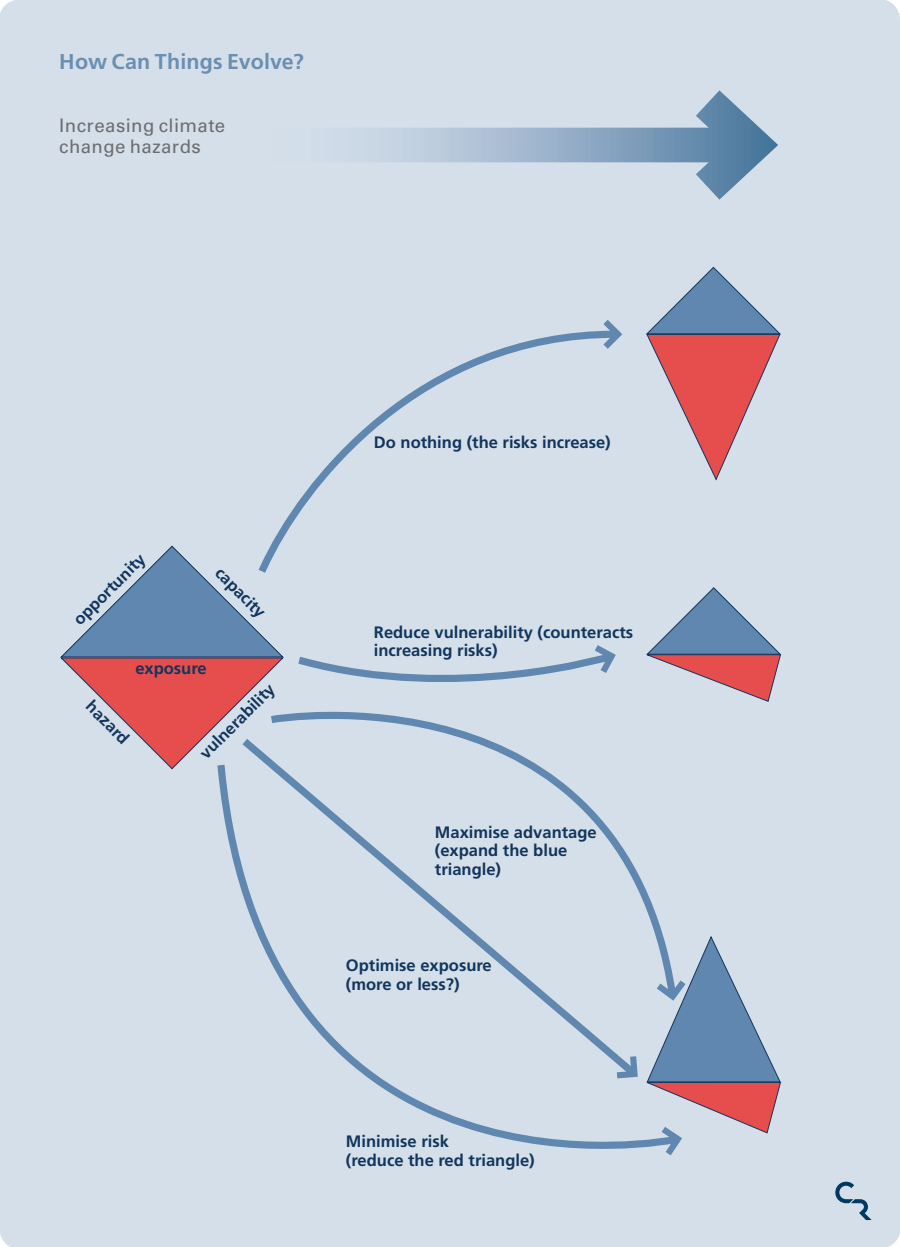



Figure 5. Using the Climate Risk Diamond to illustrate the evolution of risk and the effect of interventions.

## Box 3. Defining climate change 'advantage' terminology in the insurance context

**Climate change exposure:** Here we use the same definition of exposure as above in the 'risk' section. However, while exposure to markets with climate change hazards entails risks, it can also provide advantages. Ultimately, an insurer must be exposed - or active - in a market to earn income. For example, an insurer may choose to expand hail coverage (ie increase its exposure) in the Sydney region in conjunction with an expected increase in the area to be affected by hail events due to climate change.

We examine exposure from the point of view of advantage to understand how insurers are reducing their risk and maximising their advantage in relation to climate change. When it comes to optimising exposure, insurers have essentially four available courses of action: to reduce, maintain or increase exposure in existing markets/locations; and/or to expand exposure into new markets created by society's needs and responses in the face of climate change.

**Climate change opportunity:** The term refers to the potential for an insurer to reduce climate-change-related risks, increase profitability and/or grow business by risk transfers, risk management, risk mitigation and provision of new products. For example, an insurer may recognise the increasing need for car retailers to deal with the risks of more severe hail storms.

Thus opportunity describes the positive outcomes that can arise if insurers tackle climate change; it includes not only the potential economic and reputational benefits for insurers, but also the potential gains for society, which in turn may flow on to insurers.

**Climate change capacity:** This describes the actual policies, product lines, know-how, methods and measures used by insurers to tap new markets emerging in response to climate-change-related events or actions or, alternatively, to achieve resistance or resilience to climate change risks in current markets. For example, the insurer can not only provide increased levels of cover for hail storm damage but also a reduced excess for car yards that erect hail-proof roofs for their outdoor vehicle displays and a claims department able to respond to more frequent and severe hail events.

Unless insurers build capacity to offer 'climate-proof' products and services, they will not be able to capture opportunities emerging from society's response to climate change. We describe capacity in terms of concrete, practical examples of insurers that are gaining traction toward their goal of reducing risks and securing advantage in the face of climate change.

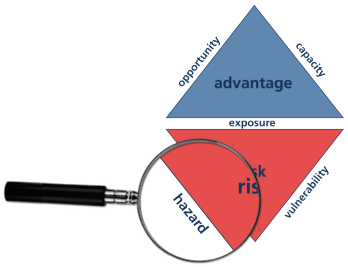
The next part of report (Part B) first seeks to illustrate the risks climate change poses to the general insurance industry through an examination of hazards and vulnerability. Insurers' exposure is also examined in this part of the report to establish how their markets are being affected by climate-change-related hazards and vulnerabilities. This shifting exposure entails both risks, and the potential to gain advantage as we shall see in Part C. In Part C, we also examine the opportunities for insurers to respond to climate change risks and build their capacity, thereby securing an advantage.

Conclusions are presented with regard to the importance of the insurance sector in the era of climate change, and considering the threats to its viability. The options available to the sector to achieve resilience and prosperity are also considered. This includes the role of stakeholders from government, the private sector and the wider community in maintaining a healthy insurance sector that's able to underpin societal risk management.

# Part B Climate Change Risk

This section focuses on the 'downside' of the Climate Risk Diamond; it aims to illustrate the risks posed by climate change to the general insurance industry via an examination of hazards, vulnerability and exposure.

## 4 Hazards: Understanding climate change hazards




"Climate is the context for life on earth…Climate is already changing, and quite rapidly. With rare unanimity, the scientific community warns of more abrupt and greater change in the future."

Epstein and Mills, 2006

In this section, we aim to show the growing climate change hazards of relevance to insurers - to provide the sector and stakeholders with an overview of areas that are potential causes for concern. We begin with a basic overview of climate change science and then proceed through three levels of hazards.

Though not all of the following hazards may be highly relevant to insurers, a thorough examination of any source of potential hazard is crucial. Past failure to properly identify emergent climate change risks has had serious implications in some sectors. An example of this is the effect of water shortages and flows on thermal power station operation in France and Australia (due to water-cooling requirements clashing with environmental management and resource constraints).

While insurers can help reduce climate change hazards over the longer term by facilitating reductions in GHG emissions, there is little insurers can do to reduce short and medium terms hazards which will result from previous emissions already in the atmosphere. Thus the prospect of reducing climate change hazards is limited to the long term. However, there is much insurers can do to help society to adapt to such hazards, and this is discussed under 'Capacity'.

In this report we distinguish between primary, secondary and tertiary hazards in order to elaborate on direct and indirect climate-change related events or actions.

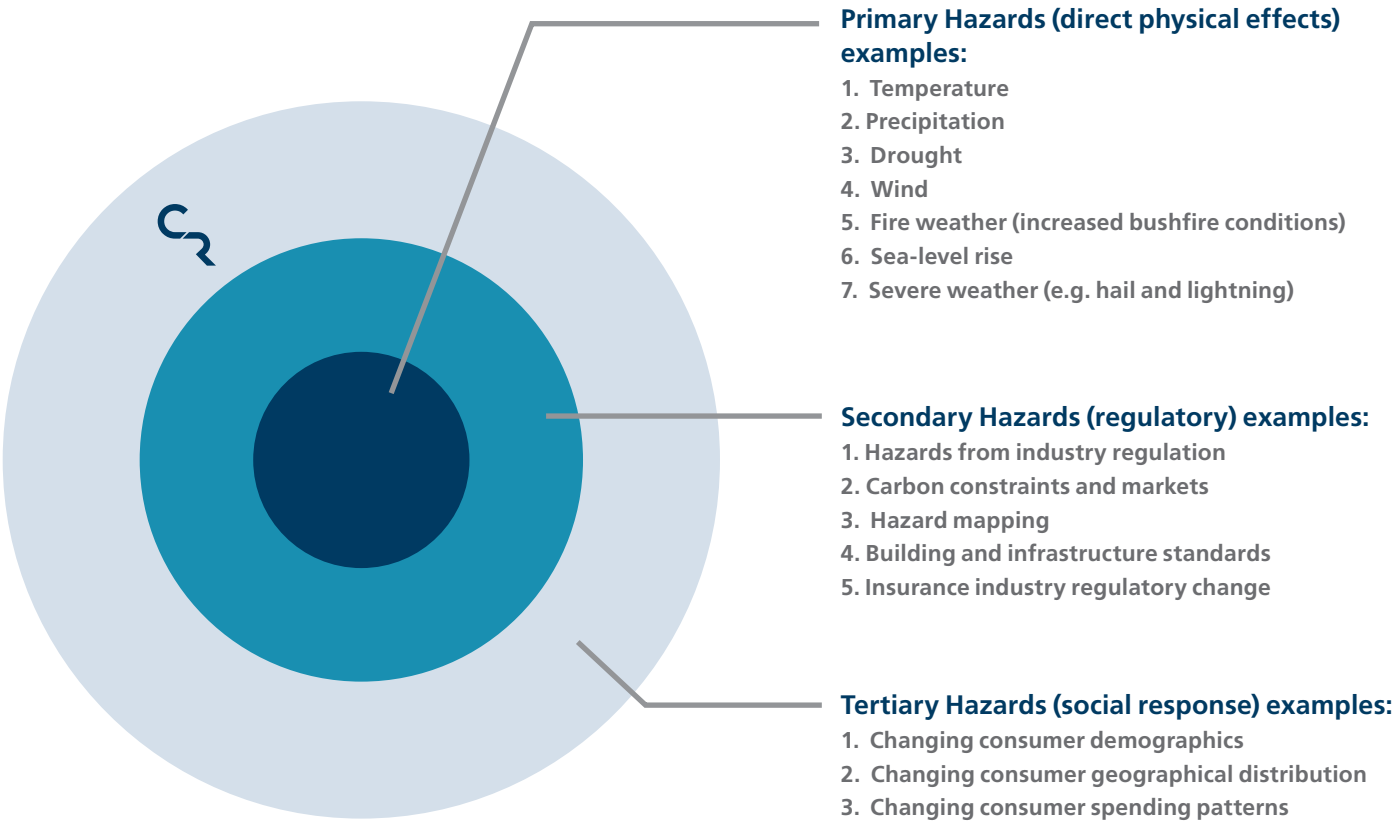
**Primary climate change hazards:** This refers to climate-change-related physical weather or climate impacts. Examples include individual weather events (eg windstorms, hailstorms or cyclones), changes in climate norms or means (eg reduced average annual precipitation) or shifts in climate-linked systems (eg El Niño Southern Oscillation effects or ocean acidification).

**Secondary climate change hazards:** These describe regulatory interventions by government or industry to address climate change. Examples include GHG emissions trading schemes (ETS) or new building standards.

**Tertiary climate change hazards:** This refers to societal reactions to climate change and regulation. This includes auto-adaptation, such as urban residents coping with increases in the number of very hot days by installing airconditioners.

**Climate change hazard:** A climate-change-related event, series of events/variation, (or an action resulting from these), which has the potential to result in a material loss for an insurer, its customers and/or reinsurers. An example of such a hazard would be a projected increase in the number of severe and damaging hail events in Johannesburg due to climate change.

Figure 6. Primary, secondary and tertiary climate change hazards discussed in this report.




Since climate change hazards vary greatly from region to region, a full investigation of global hazards is beyond the scope of this report. As part of the project for Zurich Australia, a detailed examination of climate change hazards of relevance to Australian insurers was made (see Climate Risk 2008a), while the shorter discussion in sections 4.2 through 4.5 below takes a more broad-brush perspective.

## 4.1 A climate change primer

"As climate change advances we must realise that it endangers more than the economy, infrastructure and valued species. Climate change, ominously, is disrupting and weakening Earth's life-supporting capacity. This poses a profound, and growing, risk to human wellbeing, health and survival".

Professor Tony McMichael, Australian Climate Group, 2008

To give perspective to the discussion of climate change hazards, we first provide a brief backgrounder on the causes and implications of human-induced (anthropogenic) climate change.

### 4.1.1 Human vs natural greenhouse effect

The Earth's atmosphere acts as a 'blanket', trapping in the sun's energy to keep the global average temperature at 14°C. This is known as the natural greenhouse effect (Figure 7). Without the atmosphere's naturally-occurring greenhouse gases, the global average temperature would be approximately minus 18°C — making the planet virtually uninhabitable.

Figure 7 illustrates the process of warming driven by incoming solar radiation, which is trapped by the atmospheric greenhouse gases.

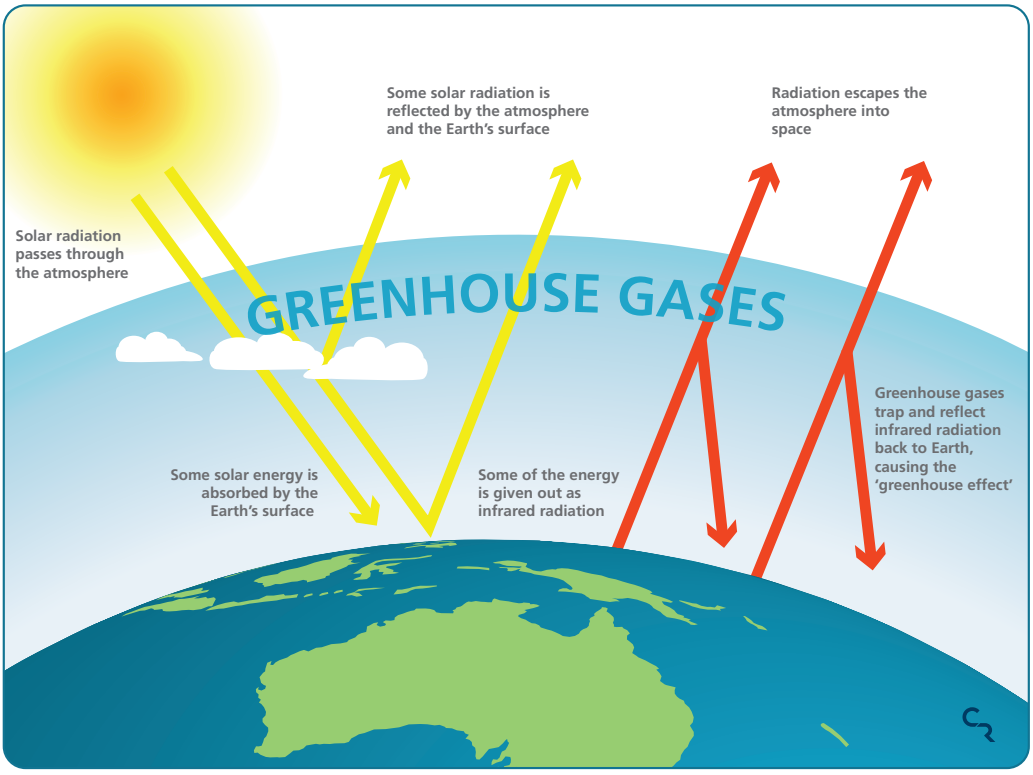



Figure 7. This diagram illustrates the process of warming driven by incoming solar radiation, which is trapped by the atmospheric greenhouse gases.

Human activities, such as burning fossil fuels and deforestation, are changing our atmosphere's composition and altering the Earth's ability to soak up greenhouse gases. This, in turn, is creating an enhanced greenhouse effect, which is increasing average global temperatures.

### 4.1.2 Greenhouse gases

Most of the Earth's air (over 99%) is made up of nitrogen ($N_2$) and oxygen ($O_2$). These molecules are not very good at storing and emitting heat. Greenhouse gases, on the other hand, are capable of absorbing and radiating heat.

The main natural and human-generated greenhouse gases responsible for the majority of global warming are water ($H_20$), carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), and sulphur hexafluoride ($SF_6$), although there are more than 20 greenhouse gases of concern. The dominant greenhouse gas is carbon dioxide ($CO_2$), and the global warming effect of other greenhouse gases is often expressed in reference to that of carbon dioxide (ie 'carbon dioxide equivalent'). The term 'carbon dioxide emissions' is often shortened to 'carbon emissions', which also explains the use of such terms as 'carbon tax', 'carbon neutral' and 'low-carbon economy'.

Over the past century, greenhouse gas concentrations in the atmosphere have increased significantly. This has resulted in an average global temperature increase of approximately 0.8°C over the past century, with warming in the past three decades to 2006 of approximately 0.2°C per decade (Hansen *et al*. 2006). The best estimate of projected temperature increase by the IPCC (2007) is 1.8 to 4.0°C by 2100; the full range of projected increase is 1.1 to 6.4 °C by 2100 (IPCC 2007)[3].

### 4.1.3 The gathering storm

"What is at stake? Warming so far, about two degrees Fahrenheit over land areas, seems almost innocuous, being less than day-to-day weather fluctuations. But more warming is already "in the-pipeline", delayed only by the great inertia of the world ocean. And climate is nearing dangerous tipping points. Elements of a "perfect storm", a global cataclysm, are assembled".

James Hansen, 2008, Head, NASA Goddard Institute for Space Studies

The physical effects of climate change can already be seen throughout the world, particularly in the Arctic, which is heating more rapidly that the global average. Arctic sea ice melt and warmer winter temperatures are threatening the existence of some species (Hempel 2003; Derocher *et al*. 2004).

Recent evidence suggests that GHG emission levels are rising faster

The scientific convention is for global warming levels to be expressed relative to pre-industrial levels, nominally set as 1850. Temperature increases are different across the globe, generally lowest at the equator and highest at the poles, consequently the scientific convention is to refer to global average temperature increases. Unless otherwise stated these conventions are adhered to in this report.

3 For more information on climate change, see Flannery (2005), Pittock (2005), Stern (2006) and IPCC (2007a).

than expected (Canadell *et al*. 2007). Ominously, according to the journal Nature (Andreae *et al*. 2005) there are indications that "global warming may proceed at or even above the upper extreme of the range projected by the Intergovernmental Panel on Climate Change". Climate change 'fingerprints'[4], such as rapidly diminishing Arctic sea ice extent, melting glaciers and higher than anticipated sea-level rise, indicate the climate system is tracking at the higher end, or above, projections from the latest climate change models. For example, recent reports suggest the Arctic may be ice-free in the near future, in years rather than decades as previously suggested (Maslowski *et al*. 2008).

The implications are significant. One cause for concern is that positive feedback mechanisms — which will release yet more greenhouse gases from the natural world or increase the absorption of solar radiation — may be triggered earlier than anticipated, speeding up the global warming process. Examples include melting of Arctic sea ice (exposing the darker surface of open water, which absorbs more solar energy than ice), rapid thaw of Siberian permafrost (causing release of its deposits of methane, a potent greenhouse gas); and an acceleration of Greenland ice sheet melt (darker wet ice absorbing more solar energy than snow-covered ice; Hansen 2007; Stern 2006).

This rapid increase in GHG levels, combined with the global climate system's inertia, means that climate change impacts are already 'locked in' until the middle of the century and beyond.

Because global civilisation is highly reliant on the stable climate that has characterised the last 10 millennia, this rapid change presents a significant risk to humanity, and the impacts are already being felt by markets and society. As we shall see, both the direct physical effects of climate change and the associated societal responses have significant potential to create new areas of both risk and advantage for insurers.

### 4.1.4 Government and societal response

"There is still time to avoid the worst impacts of climate change, if we act now and act internationally… But the task is urgent. Delaying action, even by a decade or two, will take us into dangerous territory. We must not let this window of opportunity close".

Sir Nicholas Stern[5], 2006

Analysis by various scientific bodies on the emission reductions that must occur if 'dangerous' or run-away/non-linear climate change is to be avoided indicate that global GHG emissions must be reduced to a fraction of 1990 levels. The time constraints to achieve these cuts are driving new international and regional policy mechanisms (see Box 4).

4 Signals of widespread and long-term trends toward a warming global climate.

5 At the release of the *Stern Review on the Economics of Climate Change*.

### Box 4. Key policy measures to achieve greenhouse gas cuts

The **Kyoto Protocol** is an international agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). The protocol's main goal is the "stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". In the Kyoto Protocol's first commitment period, which ends in 2012, industrialised nations' GHG emissions are to be collectively reduced by at least 5% below 1990 levels (Australia received a target to increase its emission by 8% above 1990 levels and ratified the Kyoto Protocol in December, 2007).

**Carbon trading** (also known as emissions trading) uses a market based system to abate GHG emissions. It is widely believed that by placing a dollar value on carbon pollution permits by restricting emission allocations over time, appropriate price signals can be sent to the market to encourage an economy-wide reduction in emissions. In theory, this would also indirectly increase demand for cleaner energy production and ultimately facilitate a reduction in fossil-fuel based energy supplies. In practice, complementary measures, such as renewable energy policies and energy efficiency standards, are required to overcome some market failures.

A range of multi-scale measures is needed to achieve the required GHG emissions reductions. These measures include (but are not limited to):

- technological innovation
- carbon constraints
- smart urban planning and building design
- regulatory change
- increased energy efficiency
- increased renewable and low-emissions energy
- deforestation control and reforestation
- behavioural change
- constraints on fugitive and waste emissions
- management of the emissions from bunker fuels for aviation and shipping.

It is important to note that no single measure will in itself be adequate to stabilise the climate; an integrated strategy is needed. Furthermore, the implementation of such strategies must overcome significant political, economic and societal obstacles and path dependencies.

#### 4.1.5 Adapting to what is locked in

"Even if we stopped producing greenhouse gas emissions immediately, we would still experience rising temperatures for decades to come and sea temperatures will continue to rise for many centuries, due to inertia in the climate system".

Lloyd's 2006a

In addition to the above climate change strategies, which largely entail mitigation (reducing and sequestering GHG emissions), measures for adapting to climate change will also be required. This is because we must deal with the physical impacts from climate change now 'locked in' to the atmosphere and therefore unavoidable.

The IPCC (2001) defines adaptation as an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". Adaptation to the changing climate can be anything from the purchase of a stronger umbrella to complex re-design of the urban environment.

#### 4.1.6 A note on uncertainty

"Fierce debate still rages about the extent and rate of climate change and its likely impact. This creates uncertainty and that in itself means greater risk. Insurers need to take action now to manage it".

Lloyd's, 2006b

The knowledge base on climate change is evolving rapidly though considerable uncertainty remains about the level and timing of future hazards. Some of this uncertainty is unavoidable, given that the extent of future impacts will be determined by GHG emission levels, which in turn depend on societal response. Uncertainties will persist, given the prospect of non-linear climate responses and tipping points. However,

unknowns are inherent to risk, and risk is the core business of the insurance industry. Thus it would appear that the path forward will be guided by the best science, while acknowledging the unknowns, variabilities and uncertainties and addressing them within the context of risk management.

## 4.2 Primary climate change hazards are increasing

"The real issue for insurers is natural disasters… [T]he impact of those disasters has been increasing because the climate is changing, which presents some very serious challenges for insurers".

Peter Levine, Lloyd's of London Chairman, 2005[6]

We now turn to the first of the three elements of the risk triangle - climate change hazards - and begin with a broad-brush overview of primary climate change hazards of relevance to general insurers.

Climate and weather are important hazards for insurers and a growing array of evidence links changes in weather events and temperature to non-linear or step-wise increases in insurance claims. These climate change hazards have the potential to impact on the premium-versus-claims balance, transform markets and erode insurers' asset bases, and ultimately even affect the solvency of some insurers. This is discussed further under 'Vulnerability'.

### 4.2.1 Temperature

"The European heatwave of 2003 — widely cited as being related to climate change — caused the deaths of an estimated 22,000 people".

Marsh, 2006a

According to the IPCC (2007a), "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level". The planet's land regions are warming faster than the seas: these temperature increases are widespread across the globe but are most pronounced at higher northern latitudes. Over the past 50 years, the frequency of cold days, cold nights and frost has declined, while hot days and hot nights have increased in frequency. Heatwaves are likely[7] to have become more frequent (IPCC 2007a).

Looking to the future, the IPCC (2007a) projects global average warming of about 0.2°C per decade over the next 20 years. After this period, predictions on the extent of change depend to a greater degree on the level of GHG emissions (ie on whether emissions continue to increase, stabilise or decrease).

The impacts of a warmer climate include heat stress for humans and livestock. For example, the 2003 European heatwave resulted in between 22,000 and 35,000 deaths in five countries in Europe, along

**Primary climate change hazards:** This refers to climate-change-related physical weather or climate impacts. Examples include individual weather events (eg windstorms, hailstorms or cyclones), changes in climate norms or means (eg reduced average annual precipitation) or shifts in climate-linked systems (eg El Niño Southern Oscillation effects or ocean acidification).

6 From Mother Jones Magazine 2005

7 The IPCC specifically defines "likely" as being a greater than 66% probability of occurrence.

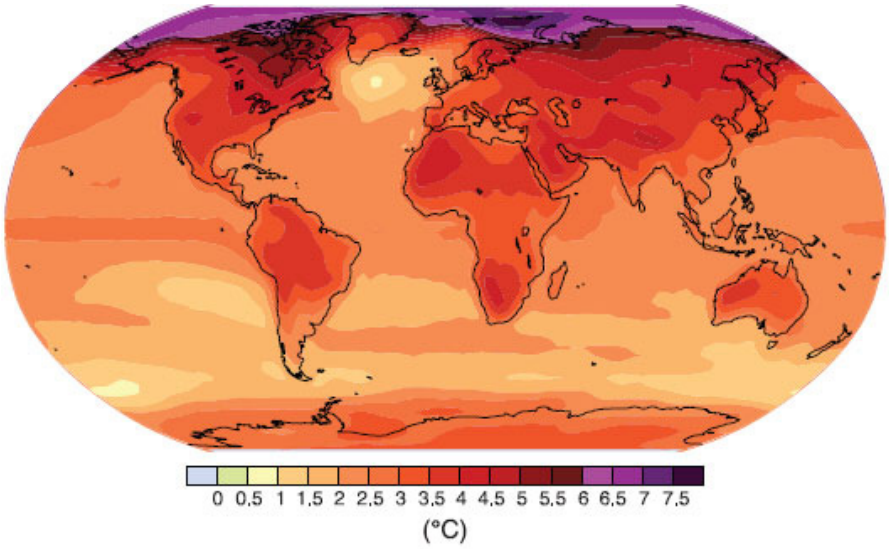



Figure 8. The geographical pattern of surface warming projected for the late 21st century according to the IPCC (2007a; figure SPM.6, A1B scenario); temperatures are relative to the period 1980-1999.

with an increase in respiratory illnesses (Epstein and Mills 2006). Very hot days increase electricity demand for cooling and can result in blackouts and brown-outs. They also impact on crops, and on soils, which can result in loss of forest cover.

According to the IPCC (2001), heatwaves can be expected to impact electricity generation and human settlements and pose a hazard to the following insurance classes: crops, property and business interruption, as well as health and life.

Apart from heatwaves, we can expect higher temperatures, increasing minimum temperatures, and fewer cold days to impact agriculture, energy demand, electricity reliability, health, transport and human settlements, posing hazards for underwriters of crops, property, business interruption and vehicle insurance (as well as health and life insurance).

### 4.2.2 Precipitation

"Rainfall models under climate change for Australia indicate a drier average climate with greater peak events. Greater peak rainfall events will lead to more incidences of flooding in the community as traditional floodwater mitigation and drainage systems fail to cope with larger events".

Insurance Council of Australia, 2008a

Over the past century, precipitation patterns have shifted and precipitation has increased significantly in eastern parts of North and South America, northern Europe, and northern and central Asia. At the same time, however, precipitation has declined in the Sahel, southern Africa, the Mediterranean and parts of southern Asia (IPCC 2007a).

Key for insurers, the frequency of heavy precipitation events has increased in most regions, and in future is very likely[8] to increase further. These events are of concern to insurers because they can cause more flooding and erosion, which in turn will affect infrastructure, water quality, agriculture, forestry and river flow. Infrastructure design standards may have to change to accommodate these trends (CSIRO 2007a).

Rainfall patterns will continue to shift as extra-tropical storms track pole-ward. It's very likely that high latitudes will see increases in precipitation, while subtropical zones will likely see reduced precipitation — in essence continuing recent trends (IPCC 2007a). While river runoff and water availability are expected to increase at high latitudes, decreases are expected in dry regions at mid-latitudes and the dry tropics (although some wet tropical areas will see increases). Many semi-arid areas will see a decrease in water resources (IPCC 2007a).

According to the IPCC (2001), more flash floods can be expected to impact human settlements, thereby posing increasing hazards for insurers of property, flood, vehicle, and business interruption (as well as life and health). Other forms of flooding and inundation, and mudslides can be expected to impact agriculture, forests, transport, water quality, human settlements, and tourism, posing a hazard for underwriters of property, flood, crops, marine, and business interruption insurance.

**Diminishing snow and ice extent:** According to the IPCC (2007a), decreases already observed in snow and ice extent are also consistent with global warming. Annual average Arctic sea ice extent has decreased by about 2.7% per decade, and snow cover and mountain glaciers have diminished on average in both the Northern and Southern Hemispheres.

### 4.2.3 Drought

According to the IPCC (2007a), drought-affected areas around the world are likely to have increased since the 1970s. In future, mid-latitude zones and semi-arid low latitudes can expect more drought.

Increasing periods of drought will increase food and water shortages, and therefore malnutrition, and have impacts on health, increasing illness and mortalities. They will also have significant implications for agriculture and forestry, given drought's potential to reduce production through drier and warmer conditions (Meinke *et al*. 2007). Increased crop failure and livestock deaths are possible impacts (IPCC 2007a).

Droughts also carry serious implications for water security for settlements, irrigation, hydropower supply, electricity demand and reliability and urban supply, and tourism, and can prompt population migration (IPCC 2007a & b). Droughts further impact on saltwater intrusion into estuaries and coastal areas, affecting fisheries and reefs (IPCC 2007b). During 2007 in Australia, the implications for coal-fired power

8 The IPCC specifically defines "very likely" as a greater than 90% probability of occurrence.

plant operation and coal mining also became apparent, as drought-induced water constraints drew attention to the significant water resources required for these activities.

According to the IPCC (2001), other sensitive sectors include natural resources, industry, health, and human settlements. Increasing drought poses a hazard to insurers of health, property, crops and business interruption.

### 4.2.4 Wind

"The insurance industry must expect and plan for increased windstorm activity".

Lloyd's, 2006a

Climate change has likely contributed to changes in wind patterns, and it's likely to continue to do so. According to Lloyd's (2006a), "As climate change causes temperatures to rise further, insurers should be prepared for increased frequency of extreme storms not just in the Atlantic but around the world, as record typhoon seasons in Asia also show. Warmer sea surface temperatures also appear to make windstorm landfall more likely. This combination means that particularly destructive storms are a likely scenario." Epstein and Mills (2006), find that, "Wholly new types of events are also occurring, such as the twin Christmas windstorms of 1999 that swept through Central Europe in rapid succession".

Extreme wind conditions create hazards on land for both the built and natural environment. Over the oceans, they generate storm surges that may inundate coastal areas and cause erosion and, according to the CSIRO (2007), "Even modest changes in wind speed can have a major impact on erosion by altering the wave climate."

In general, the sectors sensitive to extreme winds are forests, electricity distribution and reliability, and human settlements. Increased wind hazards are of concern to underwriters of property, aviation, vehicle, marine, and business interruption, as well as life insurance (IPCC 2001).

### 4.2.5 Fire weather

"The Oakland/Berkeley Tunnel Fire of 1991 was a poignant example of the enormous damage potential of even a single wildfire. The third costliest fire in US history, it resulted in US $2.4 billion in insured losses...including the destruction of 3,400 buildings and 2,000 cars…"

Epstein & Mills 2006

Insured losses due to wildfires are increasing, and climate change is expected to generally increase forest/bushfire conditions in many regions of the world (IPCC 2007a). Conservative modelling of bushfires in California investigates the impacts from climatic change that would follow on from a doubling of the atmosphere's $CO_2$

"Wholly new types of events are also occurring, such as the twin Christmas windstorms of 1999 that swept through Central Europe in rapid succession."

Epstein and Mills (2006)

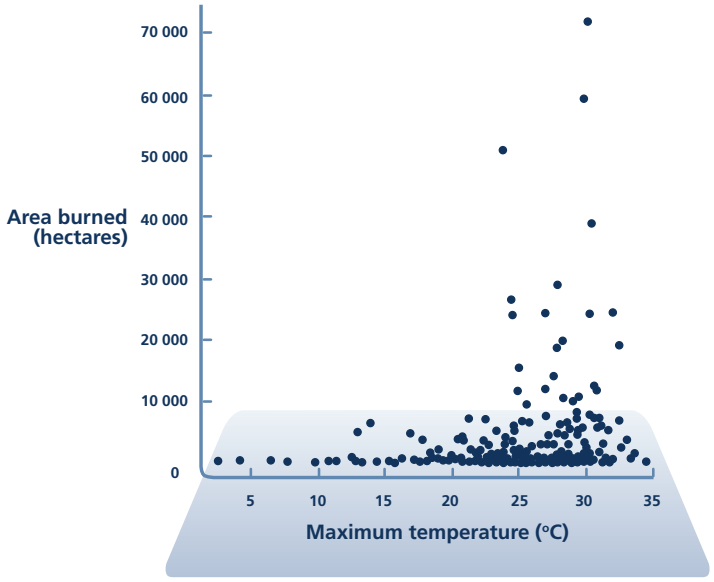



Figure 9. Large wildfires in California and neighbouring states vs average monthly maximum temperature, 1980-99 (from Westerling and Bryant 2008).

concentrations[9]. The results would be dramatic increases in area burned, number of fires, and number of 'escaped fires', increased fire suppression costs — and ultimately increased economic losses (Torn *et al*. 1998, Mills *et al*. 2002).

The social consequences include increased costs of fire suppression, loss of property, damage to forests (which may be economically valuable and insured), respiratory health impacts, loss of life, damage to wildlife, loss of tourism, loss of hydroelectric power and increased erosion due to watershed damage, and a greater likelihood of business interruption (Epstein and Mills 2006).

### 4.2.6 Sea-level rise

"Global warming is going to be much, much worse than experts expected. Total ice lost from the Greenland ice sheet has more than doubled in the past decade. A total melting of the sheet would lead to a 7m rise in global sea levels".

Bill McGuire, Director of the University College London Benfield UCL Hazard Research[10]

The sea level is rising around the world. The average rate of rise was 1.8 mm per year over the 1961-2003 period and 3.1 mm per year over the 1993-2003 period. Since 1993, sea-level rise has resulted from a combination of thermal expansion of warming oceans (57%) and contributions from melting glaciers

9 Without large changes in energy use and forest management, the levels of $CO_2$ in the atmosphere will double by the middle of this century.

10 As quoted in Lloyd's 2006b

and ice caps (28%), with the remainder coming from melting polar ice sheets (IPCC 2007c).

The IPCC (2007c) scenarios predict a rise of 18 to 59 cm by the end of this century, however, these estimates do not include the dynamic contributions of melting ice sheets. According to the IPCC (2007c), "The eventual contributions from Greenland ice sheet loss could be several metres, and larger than from thermal expansion, should warming in excess of 1.9 to 4.6°C above pre-industrial be sustained over many centuries... Complete deglaciation of the Greenland ice sheet would raise sea level by 7 m and could be irreversible".

Other sources also underscore the high degree of uncertainty in current projections due to unexpected rates of glacial melt now underway. Some commentators suggest that rapid increases of up to 1.4m[11] (Rahmstorf 2007) or even 5m by 2100 (Hansen 2007) are within the realm of possibility.

According to Marsh (2006a), "Melting of the polar icecaps and a resulting rise in the sea level could be one of the most serious consequences of climate change". Low-lying coastal regions will be especially vulnerable to increased flooding, erosion, and damage to the built environment and natural ecosystems. Marine, as well as terrestrial, ecosystems could be affected as coastal wetlands and tidal plains are inundated (CSIRO 2007). This hazard, especially in conjunction with expanding coastal urban development and concentration of urban form on the coast or rivers, may pose a challenge for insurers through increased coastal claims related to flood, property and crop insurance, as well as health insurance (Epstein and Mills 2006).

This effect will be compounded by

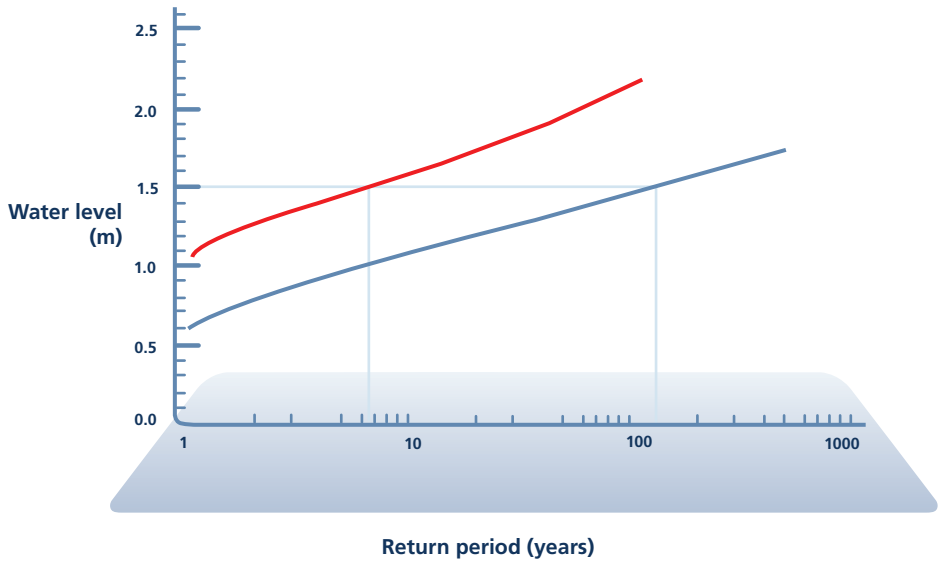



Figure 10. This graph from a UK study[12] on Immingham, east England, illustrates how a sea-level rise of 30 cm (and an adjustment to account for storminess and land movement) changes the 'return period' for a 1.5 m storm surge considerably: essentially, what is now a one-in-120-year event (see blue line) becomes a one-in-seven-year event (see red line), a seventeen-fold increase (UKCIP 2002).

11 Versus 1990 levels.

12 Using a medium-high GHG emissions scenario.

storm surge[13]. Crops may be affected through soil erosion and also if seawater intrudes into fresh groundwater lenses, a particular concern on tropical islands which rely on these sources for water supply. Beaches, roads, homes, hotels, nutrition and livelihoods are also threatened by sea-level rise and storm surges (in combination with loss of wetlands and coral reefs; Epstein and Mills 2006).

### 4.2.7 Severe weather

"A heuristic explanation is that hurricanes get their energy from warm water and, as global warming progresses, the world's oceans warm. As the oceans warm there is more energy available to feed hurricanes".

Charpentier, 2008

Here we examine how climate change will affect some forms of severe weather, including tropical cyclones, lightning and hail.

**Tropical Cyclones**: Also referred to as typhoons, hurricanes, tropical storms, cyclonic storms, tropical depressions and simply cyclones, tropical cyclones are storms formed in maritime tropical air masses. According to the IPCC (2007a), observational evidence indicates intense North Atlantic tropical cyclones have increased since about 1970 (evidence of increases elsewhere is limited). Nonetheless, there is still debate about whether long-term trends in cyclone activity, especially prior to 1970, are due to natural variability or climate cycles. Looking to the future, however, the IPCC (2007a) finds that tropical cyclone intensity is likely to increase.

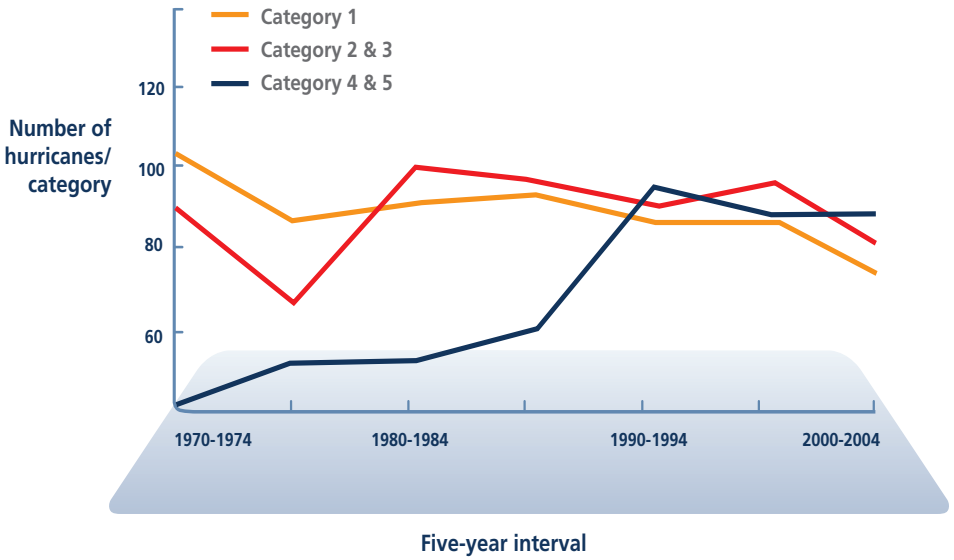



Figure 11. Graph showing trends in hurricane events over time. While the long-term trend for storms in categories 1-3 has changed little, there has been a significant rise in category 4-6 hurricanes (from Webster *et al.* 2005).

13 Storm surge occurs when high winds in combination with very low pressure weather systems, such as tropical cyclones, artificially raise local sea levels for short periods of time and combine to drive water towards the coast, increasing tidal inundation.

Damage to the US southeast coast in recent years from successive severe cyclonic storms, including Hurricane Katrina, emphasises the threat of this climate change hazard to insurers. This hazard is compounded by the increasing concentration of urban form along coasts in many world regions. A detailed discussion of the ramifications of this increased exposure for insurers is found in the 'Vulnerability' and 'Exposure' sections.

According to the IPCC (2001), more intense tropical storms can be expected to impact forests, electricity distribution and reliability, human settlements and agriculture, posing a hazard for insurers of property, vehicle, aviation, marine, and business interruption, as well as life.

**Lightning:** For every degree Celsius of average temperature increase, a 70% rise in air-to-ground lightning strikes can be expected (Epstein and Mills 2006). Lightning strikes are behind 85% of forest lost due to wildfire, by area, according to Epstein and Mills (2006).

Although climate models cannot provide direct information about changes in lightning occurrence due to global warming, the IPCC (2001) notes that, "Any increase in convective activity should lead to more frequent electrical storms and lightning discharges, and it seems likely that global warming will have such an effect in the tropics… and in extra-tropical latitudes". Furthermore, a 1°C increase in average wet-bulb temperature[14] in mid-latitudes brings with it a 40% increase in lightning (IPCC 2001).

This primary climate change hazard not only affects forests, which may be economically valuable and insured, but also plays into a larger picture of loss of business continuity through power outages. In addition to business interruption, underwriters of property, vehicle, aviation, marine and life insurance face hazards from increases in lightning strikes (Epstein and Mills 2006).

**Hail Storms:** Severe thunderstorms, which produce hailstones of 2 cm diameter or greater at ground level, are localised events, thus we will not attempt to provide a global discussion of this hazard here. However, it should be noted that any escalation in severe hail events poses a serious hazard for insurers, as hail damage is extremely costly. In Australia, hail losses made up 34% of the total Australian economic losses for 1967-2003 (Insurance Disaster Response Organisation database 2004), the largest proportion for any natural peril. Australia's eastern coastline, which includes Sydney, will be subject to an expected dramatic increase in hail risk, including a near doubling of large-hail risk, while a decrease is expected along the southern coast (CSIRO 2007).

14 This temperature measurement refers to a system of air and water vapour (or another gas and vapour).

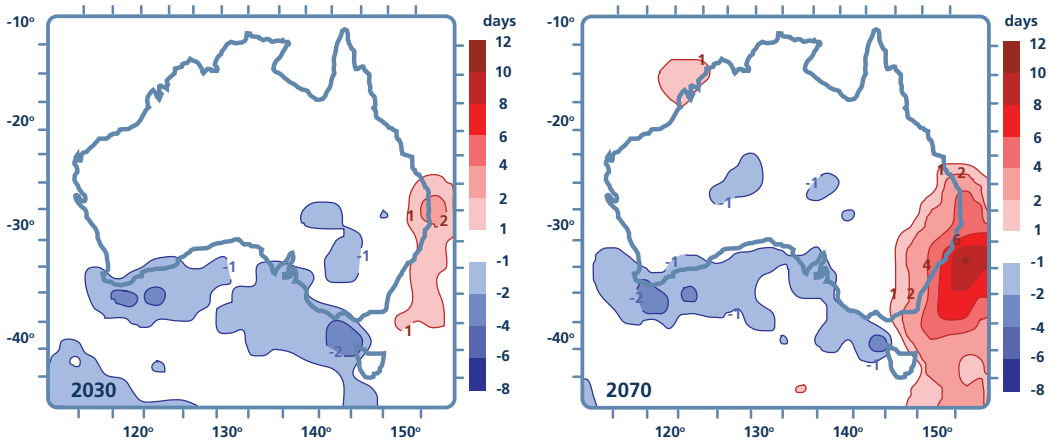



Figure 12. Shifting levels of hail risks in Australia. Blue areas indicate regions of declining risk of days with large hail, while red indicates areas of increasing risk by the year 2030 (left image) and 2070 (right image) according to the CSIRO (2007).

## 4.3 Secondary climate change hazards: regulatory change

"Political uncertainty is a major obstacle to business decisions concerning investment that is energy-intensive, but the increasing urgency of strong action on emissions makes it very likely that a new low-carbon economy is imminent".

Dlugolecki, 2008

This section aims to identify some of the regulatory changes taking place in response to climate change that may be of concern to insurers. It also notes that climate change standards or requirements will increasingly stem from the insurance industry's own regulatory bodies.

As we shall see in subsequent sections of this report, keeping abreast of climate-related regulatory changes is important; failure to do so can leave insurers vulnerable to loss, reduced competitiveness or even non-compliance and litigation in the case of their own industry regulation. Given the severity of the climate change threat and mounting pressure for swift and deep emissions cuts, it may be assumed that regulatory and policy responses to climate change will increase.

These regulatory responses span all levels of government and governance, from the voluntary and local through to international binding agreements (such as the Kyoto Protocol). Here we examine four key sources of future regulation to address climate change: federal, state and local government regulation; and industry regulation, which encompasses standards, regulations or guidelines set by the insurance sector itself.

**Secondary climate change hazards:** These describe regulatory interventions by government or industry to address climate change. Examples include GHG emissions trading schemes or new building standards.

### 4.3.1 Hazards from industry regulation

"The risks associated with climate change go well beyond rising sea levels and reflect the burgeoning regulatory and financial infrastructures being created to address this major societal concern".

Mike Kerner, Zurich's Global Chief Underwriting Officer, 2008

Regulatory regimes aiming to reduce GHG emissions are driving important changes and innovations in technologies and systems. These developments expose incumbent businesses in the supply chain to hazards as well as opportunities, and the insurance industry is no exception. Technologies emerging at the forefront of climate change strategies include (but are not limited to) renewable/efficient energy generation, carbon capture and storage, forestry protection and planting, waste management, genetically modified crops, animal vaccines, information communication technologies, nuclear power reactors, hydrogen use and distribution, biofuels and electric/hybrid vehicles.

**Renewable energy targets**: The push to address climate change is the major driving force behind the growth of renewable energy of the past decade, with security of energy supply and volatile oil prices providing further impetus (Marsh 2006a). The binding EU-wide renewable energy target of 20% by 2020 (from the current level of 8.5%) is leading the push for 'new'[15] renewable energy technologies, including wind, solar and biomass power.

While the expected growth in renewable energy developments provides many opportunities to insurers (see 'Opportunities' section), it also presents hazards. For example, insurers who do not capitalise on these opportunities could face loss of competitiveness if they fail to track changes in market share for given energy technologies and companies.

Furthermore, renewable energy projects are subject to conventional hazards, such as equipment breakdown and loss from natural hazards, such as earthquakes, wildfires and high seas (Marsh 2006b), with lightning damage of particular risk to wind turbines. As noted above, many weather-related hazards are also increasing in frequency and intensity, and this could exacerbate the risk to these projects.

Then there are more technology-specific hazards that could flow through to insurers. For wind power installations, there are issues of remoteness and access to wind power sites, particularly in the case of business interruption. High demand for wind turbines spurred by new regulation, as well as damage due to transit, could also create hazards for insurers. Specifically, demand could translate into long delays when trying to start up operations or replace inoperable machines. The prototypical nature of renewable energy technologies can also be seen as presenting hazards; its

15 In discussions of renewable energy we generally refer to 'new' renewable energy technology in this report - such as wind, solar, wave and tidal energy - as opposed to conventional large-scale hydro power, which is also a form of renewable energy.

impact on insurers is discussed in the 'Vulnerability' section.

Another strand of regulation is renewable energy incentives aimed at consumers, which work to increase the adoption of domestic and commercial solar hot water and photovoltaic (solar power) systems. These items will increasingly become capital assets for homeowners and even renters. However, improperly applied sustainable energy technologies (including energy efficiency improvements; see below) can compromise indoor air quality, create fire hazards and increase the risk of water damage (Mills 2003a).

It is also now apparent that a rapid increase in biofuel production, driven by climate change and energy security concerns, could significantly stress water and land resources, compete with food crops and drive deforestation (UN-Energy 2007).

**Energy efficiency and appliance standards:** Energy efficiency is viewed as a cost-effective means to reduce GHG emissions, thus new standards can be expected in many jurisdictions. High-efficiency appliances tend to have a higher capital cost, but lower running cost. This means an increase in the insured capital cost of replacing current appliances (such as refrigerators and washing machines) and therefore higher premiums, but conversely reduced expenditure by customers on fuel and energy.

**Automobiles and transport policy:** Policy and tax measure are being taken in many jurisdictions around the world to increase overall automobile fleet efficiency, reduce transport-related GHG emissions and shift users away from private automobile use to public transport. In the USA, for example, manufacturers will be required to increase average fuel efficiency of cars and trucks to 31.6 miles per gallon (mpg) from today's 25 mpg by 2015. Another approach can be seen in the UK, where vehicles entering central London during business hours must pay an £8 daily Congestion Charge.

While vehicle and transport regulatory changes could present opportunities (see 'Opportunities' section), they could create hazards for insurers who fail to keep up with their competitors in light of changing regulation and public attitudes.

### 4.3.2 Carbon constraints and markets

"This issue of climate change extends beyond just managing regulatory risk. Climate change and the regulatory and consumer response must be seen as a fundamental strategic challenge".

Jonathan Johns, Head of Renewable Energy, Ernst &Young, 2008b

Emissions reduction targets under the Kyoto Protocol have given impetus to the fast-growing trade in GHG emission rights and offsets. Central to regulated carbon markets are 'cap and trade systems', which permit countries

or companies that produce fewer emissions than stipulated by their cap under the Kyoto Protocol to sell their credits to others that exceed their cap (Marsh 2006a; see also Box 4) .

Countries are participating in this carbon market through various national or regional emissions trading schemes, the largest being that of the European Union (EU), which became operational in 2005. One traded commodity entails credits produced under the Kyoto Protocol's Clean Development Mechanism (CDM)[16] and Joint Implementation (JI) mechanism[17]. A national GHG emissions trading scheme will also be introduced in Australia, where the Rudd Government has committed to its implementation by 2010.

For the insurance industry, this new carbon-constrained economy will provide hazards as well as opportunities. New types of business hazards will arise (Marsh 2006a) in the carbon trading market for businesses in general, including (but not limited to):

- host-country investment and political risk
- technology performance risk
- carbon-financing risk
- resource supply risks (ie fuel and weather fluctuations)
- legal liabilities (ie legal action by shareholders)
- non-compliance risks, including fines and sanctions for missing targets.

However, as we shall see, some of these hazards can also be seen as opportunities for insurers to introduce new products that facilitate the expansion of this market.

Economies and industries heavily supported by the global resources demand, especially coal for electricity supply, have particular concerns. Emissions constraints required to address the scientific forecasts of dangerous levels of climate change are on the table for international negotiation. Such constraints would affect high-emission sectors and may therefore significantly impact the viability of companies that fail to anticipate this shift.

For insurers with Directors and Officers (D&O) lines, this means new possible hazards as senior executives are compelled to navigate the new economic paradigm and policy regimes to the satisfaction of their shareholders and regulators. How this may affect insurers' is discussed in the 'Vulnerability' section.

16 CDM: This Kyoto Protocol mechanism permits countries to earn credits by establishing or assisting with climate-friendly projects in developing nations.

17 JI: This Kyoto Protocol mechanism allows countries to earn greenhouse gas emissions credits by helping to develop climate-friendly projects in other industrialised nations.

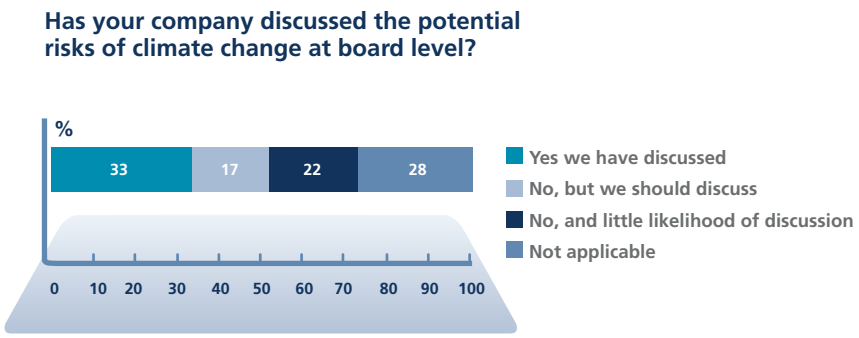



Figure 13. A survey by Lloyd's found that only a third of company boards had discussed the risks posed by climate change (Lloyd's 2008).

**Voluntary carbon offsets**: The separate but related market in voluntary carbon offsets allows individuals, businesses or governments to choose to purchase a certificate or contract to mitigate their own GHG emissions. The offsets they purchase are created through projects that reduce emissions (eg renewable energy, energy efficiency and forestry projects).

One hazard of concern, as noted by the World Bank, is that this sector, which works outside the regulated cap and trade systems, lacks an acceptable standard; this failing puts it - and even parts of the above compliance market - at risk. Climate Risk (2008b) recently outlined the hazards posed to unwitting companies by some carbon offsets that, though often treated as company assets, should actually also be registered as liabilities.

For example, an aviation company might buy carbon offsets created through tree planting, then on-sell these to customers bundled with a 'carbon-neutral' flight. However, the carbon sink (ie the forest planted) must be in place for over a century to produce the claimed effect of mitigation. If it is lost (eg burned) or severely degraded the onus ultimately lies with the aviation company to make good on the offset, possibly at a much higher price. Such scenarios present very severe and long-lasting liabilities (Climate Risk 2008b). This is discussed further in the 'Vulnerability' section.

### 4.3.3 Hazard mapping

Climate change research is providing an ever-increasing flow of information about such hazards, and this data can be expected to reach the public domain (eg governments releasing mapping of future flood risk).

It is logical to expect information about future coastal flood zones to have an impact on local planning regulation in terms of risk management. In a similar way, release of information about precipitation and temperature shifts expected with climate change will influence farmer and agri-business decision-making.

The release of such information, while essential for risk management, has the potential to significantly devalue vulnerable properties and related assets (Yeo 2003). For example, releasing information showing how an urban property may in future be inundated by storm surges - or a farmland may become more arid – is likely to have a significant impact on asset values.

The hazards posed by the release - or even lack of access to - such information (ie where a competitor is privy to the contents) also has the potential to flow on to insurers. We discuss these ramifications in the 'Vulnerability' section.

#### 4.3.4 Building and infrastructure standards

> " … in order to increase community resilience, the hazard resistance of both existing structures and future structures, needs to be increased in order to protect both safety of life and a property owner's financial interest in the asset".
>
> Insurance Council of Australia, 2008a

Local government planning and development assessment can greatly influence the level of sensitivity to climate-related hazards in the built environment. Many jurisdictions are addressing inadequacies in current building standards to equip residential, commercial and industrial buildings for future climate change. New more climate-resilient standards can be expected.

One example of this can be found in south-east Queensland, Australia – one of the fastest-growing regions in the developed world. Its vulnerability to many primary climate change hazards moved the Queensland State Government to enshrine climate change management into its regional planning (Bligh 2008).

While any emerging adaptation strategies may help improve a community's resilience to climate change, mal-adaptation and litigation are potential hazards in areas where development is known to be at risk from climate change impacts. These hazards also arise when approaches to planning on this front remain in a state of flux. This is discussed further in the 'Vulnerability' section.

Some local government planning schemes give very little recognition to climate change, presenting hazards to those who insure these councils. Furthermore, lax enforcement of building codes also presents hazards which may need to be addressed. For example, the USA's Insurance Information Institute found that up to 70% of the losses associated with US Hurricane Alicia stemmed from poor enforcement of local building codes (Woods undated).

### 4.3.5 Insurance industry regulatory change

"Domestic regulators should begin the process of engaging in a dialogue on an insurer's financial exposure to loss resulting from a catastrophe. Regulators should encourage insurers to examine their business to consider the impact of climate change".

National Association of Insurance Commissioners (USA), 2007

Insurers must also be aware of potential hazards posed by regulatory change in their own industry in response to climate change. In the USA, a taskforce for the National Association of Insurance Commissioners has convened regular meetings on climate change, and the International Association of Insurance Supervisors made it a top agenda item at their 2007 meeting. Institutional investors are telling insurers to disclose and analyse their climate-related risk (Mills 2007a), and regulations calling for such disclosure may pose a hazard for insurers who fail to get on top of these requirements.

In the case of major climate-related disasters, regulators in some jurisdictions have mandated that private insurers maintain coverage in markets they may have otherwise departed, posing a potential hazard to the profitability of insurers. For example, after 1992 Hurricane Andrew in Florida, the state's regulators stepped in and forced the industry to continue coverage (Dowlatabadi & Cook 2007). In another example, because some victims of successive storms in the 2004 USA hurricane season had to meet the deductible two or even three times in the 2004 season, the state regulator mandated a 'single-season' deductible so homeowners were required to meet it only once (Florida Insurance Council 2007).

Again in the USA, where the cost of insurance has become an important political issue in some states, regulators (who are elected officials) may keep costs down in ways that prevent insurers from accurately reflecting climate change risk in their policy pricing (Reo Research 2007)[18]. This not only presents a financial hazard for insurers, but may also send the wrong signal to property owners or developers about the risk level in a given locality, thereby perpetuating hazard-prone development.

## 4.4 Tertiary climate change hazards

"The fact that the risk is often determined in part by the behaviour of others gives a complex structure to the incentives that individuals or firms face to reduce or invest in risk mitigation measures."

World Economic Forum, 2007

Here we seek to point out how tertiary hazards, which are essentially society's

**Tertiary climate change hazards:** This refers to societal reactions to climate change and regulation. This includes auto-adaptation, such as urban residents coping with increases in the number of very hot days by installing airconditioners.

18 In some states, regulation even extends to approval and certification of insurers' disaster models (Dowlatabadi & Cook 2007).

responses to climate change, can also pose potential hazards for insurers. Though these tertiary climate change hazards are numerous and complex, this topic will be examined here under a single heading.

Tertiary climate change hazards may include changes in property value, demography and behaviour, as well as changes in infrastructure location/specification and the uptake of new technology.

By way of illustration, a well known example of auto-adaptation is the increase in the number airconditioners installed by members of the public in an attempt to deal with increasing number of hot days. These units constitute new capital investments for householders, thus this adaptation has knock-on implications for insurers of homes. In addition, the peak-hour electricity consumed by these devices increases the strain on electricity transmission assets, potentially triggering brown-outs or blackouts. This in turn may lead to business interruption and damage to property (Mills 2003a).

Loss of power that coincides with times of significant heat stress can impact the very young, infirm and elderly, thereby affecting the provision of health care, and (coming full circle) the reliability of the functioning of airconditioning required by these vulnerable groups. Thus, we see how the human response to a primary climate change hazard, such as an increasing number of very hot days, can create multiple compounding hazards for insurers.

Indeed, climate change and associated hazards will have a range of both direct and indirect impacts on the exposed general population that will subsequently flow on to the insurance industry. Health impacts, such as those noted above, will affect more than just life and health policies. Impacts on individuals can undermine the profitability of businesses, especially small to medium-size enterprises. Furthermore, the impacts and regulatory response to climate change could increase the financial burden for some community members, who may decide to forego the cost and coverage of insurance (see Box 5).

Looking more broadly, some people or groups may choose to adapt by moving to different locations (eg pole-ward) to avoid emergent stressors such as drought (IPCC 2007a). Such shifts will impose a climate change signature on regional, national and international demographics.

### Box 5. Hazards through the lens of socio-economic factors

Ongoing efforts to study local councils' vulnerability to climate change hazards recognises the importance of socio-economic factors in the arena of societal response (Preston *et al*. 2008).

In addition to addressing five climate change hazards (extreme heat and health effects; sea-level rise and coastal management; extreme rainfall and stormwater management; bushfire; and effects on ecosystems and natural resources), a study by the CSIRO also examined "factors such as demographics, economics, landscape and infrastructure that influence the sensitivity of places and populations to climatic changes and their capacity to respond to reduce risk".

These factors have an important role in terms of local council - and societal - response, as they determine the local populations' ability to adapt. For example, the above study found that one council was not only subject to extreme heat, coastal hazards, extreme rainfall and other impacts, but that these hazards are exacerbated by a low capacity to adapt in the council area.

The low adaptive capacity of such areas could be seen as a form of tertiary hazard for insurers. For example, it is possible that such low capacity could predispose customers to underinsurance. And if customers cannot afford to adapt to primary hazards, insurers exposed to such markets could be vulnerable to greater losses and might choose to vacate these segments.

## 4.5 Hazards posed by complexity, confluence and cocktails

"In the case of climate, however, the bewildering complexity of the changes and feedbacks set in motion by a changing climate defy a narrow focus on sectors. For example, the effects of hurricanes can extend far beyond coastal properties to the heartland through their impact on offshore drilling and oil prices".

Epstein and Mills, 2006

As the previous section suggests, the various climate change hazards are not independent from one another or from their associated exposure or vulnerability. Identifying the effects of such risk confluences poses major challenges for insurers, and "Imagining the cascade of effects of climate change calls for a new approach to assessing risk," according to Epstein and Mills (2006). Furthermore, climate-change-related risks must also be considered within the context of the wider arena of global risks. Mills (2003a) makes the following prediction:

> "Realistic future scenarios involve multiple, coincident events, eg consecutive (or overlapping) natural disasters, taking place during a time of weakness in the financial markets and/or non-weather related losses. This was witnessed before in the USA with the Great Depression and the Dust Bowl ... A major weather-related catastrophe striking a US urban centre could have the same or greater economic consequences as '9/11'".

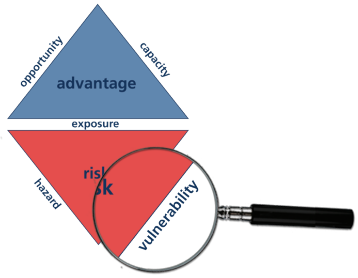
Large events, such as severe hurricanes, are complex, with associated claims taking years to settle. For example, apart from the direct insured losses from Hurricane Katrina (over US$100 billion in physical damage), there are a further 489,000 civil claims for damage and death against the Army Corps of Engineers (which built New Orleans' flood defences), to the tune of trillions of dollars (USA Today 2008). Even if a fraction of these are paid out, it will have a substantial impact on this region.

The twin European windstorms of Christmas 1999 underline climate risk complexity. The storms caused more than US$8.4 billion in damage (IPCC 2001), with US$3.9 billion in damages suffered by France's largest electricity supplier alone. During the 1990s, such European windstorms resulted in liquidity problems for insurers who were forced to rely on the sale of large blocks of securities to pay for their losses. In turn, this can have knock-on impacts for the wider financial markets (Epstein and Mills 2006).

The effect of climate change on the environment is another lens through which confluence of risk can be viewed. The rapid pace of climatic change, combined with habitat destruction, threatens many species; if the global average temperatures increase exceeds 1.5-2.5 °C, the extinction risk for up to 30% of all of the Earth's species will

likely increase (IPCC 2007a). Yet because the global economy is embedded within, and reliant upon, the natural environment, such biodiversity loss also exposes society to considerable impacts — such as the deterioration of 'natural services' like pollination, pest reduction and water management. A recent report by Losey and Vaughan (2006) conservatively placed the annual economic value of services provided by insects in the US at US$57 billion. Thus, any loss or decline of useful species could pose a hazard to agricultural producers and those who insure them.

## 5 Vulnerability: Insurers' increasing vulnerability to climate change




"The core business of insurance, as well as the sector's activities in financial services and asset management, are vulnerable to climate change".

Epstein and Mills, 2006

This section considers how climate change will act to increase the vulnerability of general insurers to reduced profitability. This vulnerability will occur if insurers fail to adequately reflect climate change hazards in the pricing and structure of their policies and services.

In subsequent chapters, we will discuss how insurers can reduce this vulnerability. However, here we look at how standard products and services, which are calculated based on historical risk data and experience-based risk engineering, can lead general insurers straight into the arms of climate change vulnerability and financial risk.

First, we examine how the above climate change hazards interact with some general insurance lines and services to create new vulnerabilities; then we examine specific factors within the industry itself that may exacerbate these vulnerabilities for insurers.

Highlighting the sector's increased vulnerability, the IPCC (2001) found that while there will be isolated benefits, "Recent history has shown that weather-related losses can stress insurance firms to the point of elevated prices, withdrawal of coverage, and insolvency (bankruptcy)". Mills (2003a) states that "Despite isolated benefits (e.g. fewer frost days), climate change scenarios will result in elevated potential for insurer bankruptcies, for large and small firms alike".

All insurance lines are vulnerable to climate change hazards to some degree. According to Mills (2005a), this includes lines that cover "damages to property (structures, automobiles, marine vessels, aircraft); crops and livestock; pollution-related liabilities; business interruptions, supply-chain disruptions, or loss of utility service; equipment breakdown arising from extreme temperature events; data loss from power surges or outages; and a spectrum of life and health consequences".

Climate change is affecting the very foundations of the insurance industry from a variety of angles, including risk pricing, claim and loss rates, regulatory regimes, capital requirements and invested assets. According to Reo Research (2007), "All parts of the insurance sector will be affected, from large reinsurers to small direct insurers". However, because private insurance is a highly heterogeneous industry these vulnerabilities will differ around the world, depending on the nature and degree of hazards and the division of policies - and therefore the exposure.

**Climate change vulnerability:** The sensitivity of insurers' business activity to climate-change-related loss. This sensitivity encompasses policies, premium setting, internal capacity and loss/premium ratio. An example of this is an insurance policy that covers property damage due to hail, but has been priced at a level that fails to account for an increase in severe hail events due to climate change, thereby increasing an insurer's vulnerability.

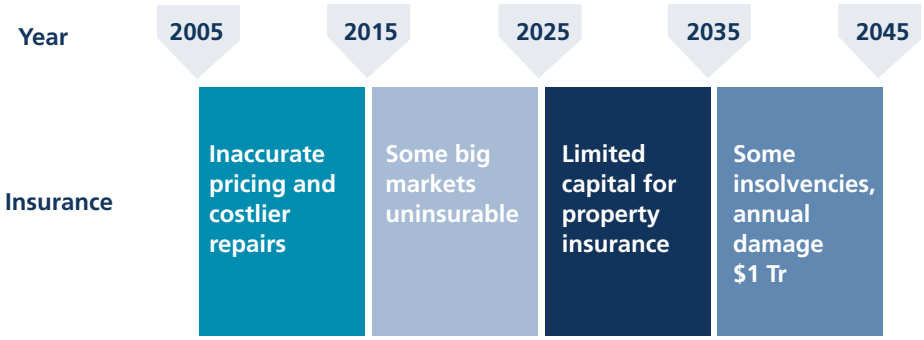



Figure 14. Timeline depicting the impacts of rising GHG levels on the insurance sector if there is no adaptation (UNEP-FI 2006). Source: Adlug Consulting.

Although the insurance industry has considered the implications of climate change longer and more thoroughly than most other sectors (Firth and Colley 2006), most commentators concur that this response is far from adequate and that the global insurance industry's current exposure leaves it vulnerable to increased losses from climate change hazards (Mills 2003a; Reo Research 2007).

## 5.1 Insurers' vulnerability to primary hazards

"… extensive analysis of data on weather losses in key regions suggests that there is a 'climate change signal' within this trend, of about 2 per cent per year".

Dlugolecki, 2008

This section aims to emphasise insurers' vulnerability to primary climate change hazards as an area of heightened concern. Of total catastrophe losses, weather-related losses constitute the largest proportion of total losses for insurers (Epstein and Mills 2006). Of the world's 20 most-costly insured catastrophes during the period 1970-2006, 18 are weather-related disasters in the form of hurricanes, typhoons, storms and floods (Kunreuther 2007). These losses are increasing, despite intensified efforts to fortify infrastructure and increase disaster preparedness (IPCC 2001). The overall costs of weather catastrophes rose ten-fold from about $4 billion[19] per year on average in the 1950s to $US 46 billion in the 1990s, and in 2004 losses were double that again (Epstein and Mills 2006). According to Swiss Re (2008a), "statistics confirm a trend towards an increase in the number – and cost – of natural catastrophes and man-made disasters".

Furthermore, a comprehensive analysis (see Figure 15) of weather-related catastrophe loss data from key developed and developing regions around the globe since 1970, normalised to account for changes in wealth and

19 Values inflation-corrected to 2004 dollars.

20 Resolving the various sources of increasing insured weather-related loss to establish a climate change signal is challenging and remains somewhat controversial. Note that the analysis by Muir-Wood (2006) above found that in some regions, such as Australia and India, normalised losses were actually reduced since 1970, but when balanced against rising losses in other regions, an overall increase was found.

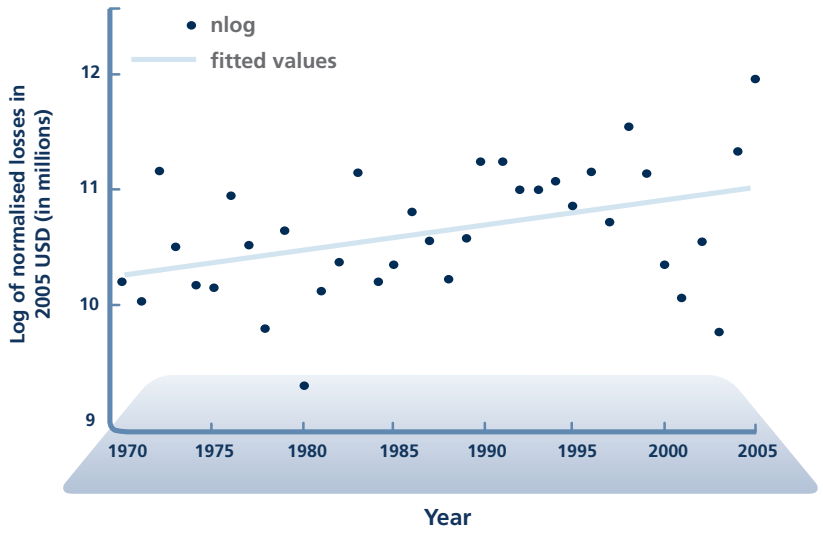



Figure 15. Normalised economic losses from weather-related catastrophes (Muir-Wood *et al*. 2006).

value[20], found a statistically significant increase in annual economic losses of about 2% per year (Muir-Wood *et al*. 2006; IPCC 2007b). According to Mills (2005b, see Figure 16), global insured and total property losses are currently growing faster than premium creation, population or economic growth (excluding life and health insurance premiums and losses). Moreover, according to the IPCC (2001), "Many of the observed upward trends in weather-related losses are consistent with what would be expected under human-induced climate change".

The rate of loss is anticipated to increase; the Climate Change Working Group (CCWG) of the UNEP Financial Initiative (2007) warns that, "On adaptation, the CCWG's most important messages for insurers are — the pace of change in extreme weather events is already fast, and the scale of losses could reach $1 trillion in a single year by 2040". Thus it would appear insurers face a significant challenge to maintain business profitability in the face of climate change.

**A window on future climate vulnerability**: The Association of British Insurers (2005) examined insurers' vulnerability to loss under future climate change scenarios. It found that climate change would increase insured US hurricane losses, Japanese typhoon losses and European windstorm losses by two thirds, such that they would total US$27 billion by the 2080s. It also found that, "Climate change could increase the annual costs of flooding in the UK almost 15-fold by the 2080s under high emissions scenarios. If climate change increased European flood losses by a similar magnitude, annual costs could increase by a further $120 – 150 bn (€100 – 120 bn)"[21]. Further emphasising financial vulnerability, the study found this level of loss could increase the costs of capital for the industry, affect credit ratings and possibly increase risk premiums.

**Insurance sectors vulnerable to climate risk:** Here we provide an indicative rather than exhaustive treatment of some insurance lines vulnerable to

21 Figures are in 2004 dollars; ABI (2005).

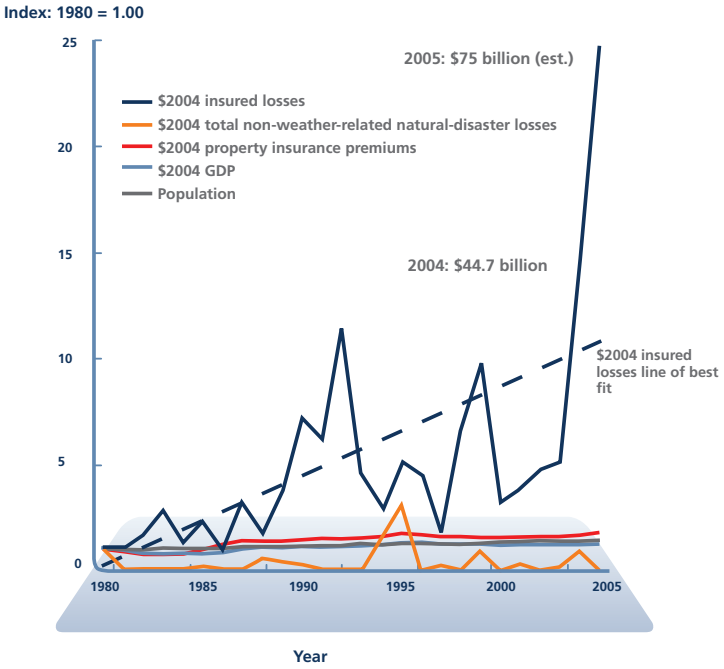



Figure 16. Insured weather-related losses are rising faster than premiums, population or gross domestic product. Data exclude health and life insurance premiums and losses (Mills 2005b)[22].

climate and weather hazards. In terms of vulnerable sectors, primary climate change hazards would be felt mainly on property insurance. Mills (2006b) finds that homeowner, motor, commercial lines and inland marine are all sensitive to these hazards.

In Europe, insurers suffered $10 billion in losses from the 2007 windstorm Kyrill (Mills 2007a). Extreme wind events also result in more losses due to motor accidents (Epstein and Mills 2006).

The prospect of increasing hail incidence is also of concern to property insurers. Ten of Australia's most costly 20 property insurance losses since 1967 involved hail. Moreover, hail events tend to strike in coastal zones, where population density if often high (Hawker 2007). Indeed, Australia's most costly disaster ever was the 1999 Sydney hailstorm, with insured losses of approximately AU$2.2 billion (2006 dollars).

Lloyd's (2006a) advises insurers that their business interruption clauses may be called upon more frequently in a future with climate change, while Mills (2006b) states that business interruption is the least understood type of exposure. Insurers of businesses with operations in geographic areas of higher risk to extreme weather would also face greater vulnerability from the point of view of business interruption and loss, and would be subject to a longer, more costly rebuilding after an extreme event strikes (Reo Research 2007).

Small and medium size enterprises are a particularly high risk sector for general insurers. Research from Canada has shown that over a quarter of small and medium size enterprises which close as a result of a weather-related incident never re-open (Kovacs 2005).

22 Economic values are inflation adjusted to 2004 levels; original data sources: Munich Re NatCat Service, Swiss Re, Sigma, Lawrence Berkeley National Laboratory.

The causes of business interruption are many, for example, comprising 20-40% of hurricane claims, while lightning, flood and wildfire can also be a cause (Mills 2006b). Each year, lightning strikes result in billions of dollars of losses (Mills 2005a). As temperature and lightning strikes increase, so do claims (see Figure 17). Drawing a line under this risk, the US Department of Energy found that 80% of lightning-related losses suffered at its own facilities were due to voltage surges (Epstein and Mills 2006).

Weather hazards are also major drivers of claims for motor cover (IAG/DEC 2006) and thus have major ramifications for the insurance industry. According to Mills *et al*. (2006b), the insurance sector for automobile cover and other transport systems is "more weather sensitive than some realise". High claims follow on from flooding events and adverse weather, including hail, windstorms, rainy conditions and even heatwaves. This is a combination of direct physical weather impacts and/or increased vehicle accident rates.

Vulnerability of the agricultural sector to primary climate change hazards is also likely to flow through to providers of rural insurance. For example, in the USA, Mills *et al*. (2006b) state that government-provided crop insurance programs have suffered from rising losses; these authors argue that climate change will further stress this sector in the US, with potential to rival the infamous Great Dust Bowl drought of the 1930s and drive the public crop insurance program into insolvency. Insurers active in forestry will also be affected, given expected increases in forest fires (Lloyd's 2006a).

> However, the insurance industry will have to deal with an increase in the more exceptional risks. These involve the possibility of extremely large losses, with the risks being highly correlated across many households, businesses or even regions.
>
> Garnaut (2008)

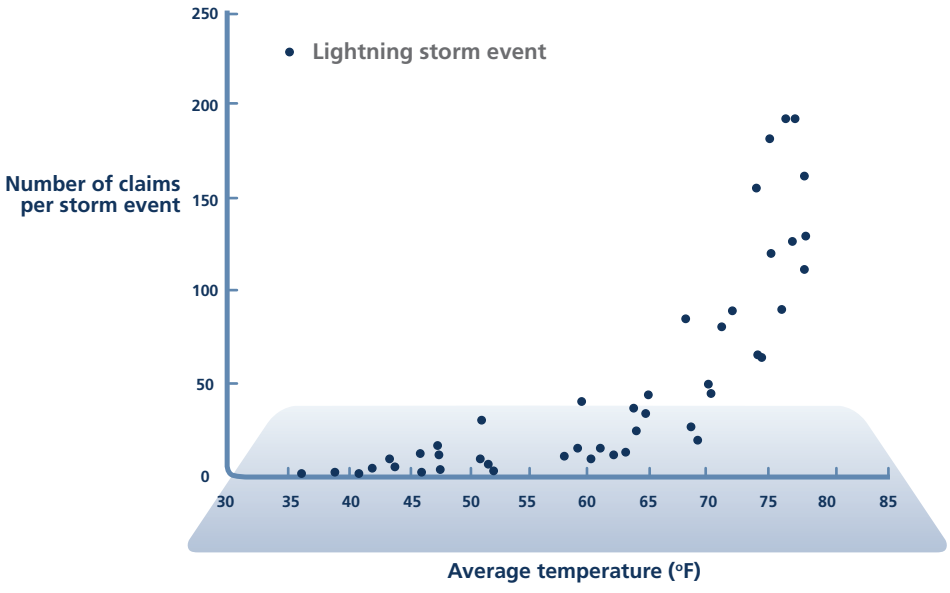



Figure 17. In the continental USA, monthly lightning-related insurance losses (each representing a point on the graph) are shown to increase with temperature (Mills 2005a).

## 5.2 Insurers' vulnerability to secondary hazards

"… a company that ignores climate risk may find itself burdened with higher energy costs, stuck with outmoded technology, mired in shareholder litigation, and panned as environmentally unfriendly."

Marsh (2006a)

This section will describe new vulnerabilities for insurers stemming from the wide range of emerging climate change regulation and policy described above under 'Secondary climate change hazards'. Adding to this vulnerability is the need for such regulation and policy response to be dynamic if it is to be adequately aligned with the evolving predictions of climate change impacts from the scientific community. This could create additional vulnerabilities for firms that fail to track such regulation.

**Vulnerabilities: Pollution responsibility and D&O insurance**

"Climate change commentary and litigation has already commenced a similar trajectory to the history of liability presented by dust diseases and tobacco smoking in the 50's and 60's."

Insurance Council of Australia, 2008a

One area of possible climate-related regulatory vulnerability is D&O insurance. The potential failure of directors of publicly traded-companies to get on top of evolving climate change policies and regulations may increase D&O insurance claims. For example, directors may neglect to inform shareholders of climate-related risks or fail to incorporate these risks in acquisitions and mergers. Illustrating this vulnerability, the year 2006 alone saw 24 shareholder resolutions filed against companies for climate-change related disclosure failings (Kronowitz 2007).

In the US, directors must adhere to the Securities Exchange Commission Regulation S-K, and in particular items 101 and 303, which state that directors must disclose actions pertaining to environmental regulations and disclose issues that that could negatively impacts on their business (LaCroix 2007). A recent US Supreme Court ruling (Massachusetts v. EPA 2007) which identifies greenhouse gases as a 'pollutant' may impact on the D&O insurability, as some policies specifically exclude lawsuits around pollution matters (Kronowitz 2007).

There are other areas of climate-related liability of concern to directors. Attempts are increasingly being made to link historic GHG emissions of particular companies to global climate change and to specific events (Reo Research 2007). As the following quote from Corporate Government Advisor (Donald and Kurdian 2007) suggests, the likelihood of such climate-change related litigation is high:

> "Despite a current lack of success and some substantial hurdles, there are potentially millions, even billions, of dollars in the litigation slot machine. Accordingly, it will be surprising if more climate change cases are not brought".

Moreover, should courts conclude the damage to have been foreseeable, then insurers would be a "likely port of call" in the search for deep pockets, according to Lloyd's (2006a). According to Kronowitz (2007), these types of actions have insurers "beginning to raise issues related to climate change in the underwriting process that precedes issuance and renewal of D&O policies". Although most companies will be vulnerable in some way, the most vulnerable will be emissions-intensive businesses (eg transport, mining, metal works and energy). Of course, this vulnerability may also flow through to those who insure them.

**Carbon regulation and compliance vulnerabilities:** Turning to the emerging regulated carbon trading market, a range of business sectors — especially emissions-intensive industries — are vulnerable to a wide spectrum of regulatory hazards (Marsh 2006a), as already noted in the 'Hazards' section. Emissions trading schemes and their associated regulations and policies may leave some companies open to non-compliance or breach – a vulnerability which could flow through to D&O insurers, especially in jurisdictions which have a greenhouse-intensive economic base.

Investigating the business risk attached to this new market, Marsh (2006a) also questions the appropriateness of existing insurance policies (ie property and business interruption) and their capacity to encompass $CO_2$ allowances and "related improvements in profits and contingent losses and liabilities".

However, many business hazards associated with the regulated carbon market also constitute potential opportunities for insurers to create new products to facilitate the expansion of this market. These are discussed in the 'Opportunities' and 'Capacity' sections.

**Voluntary carbon offset vulnerabilities:** The smaller, related market in carbon offsets is another source of potential vulnerability. As noted above in the 'Hazards' section, this new market has so far lacked an acceptable standard. Recently, the Australian Competition and Consumer Commission resolved to pursue the 'green' claims of companies that may constitute misleading advertising, with a focus on assertions about so-called 'carbon-neutral' products. Indeed, though companies may view their carbon offsets as assets, they may actually constitute liabilities, which could leave them vulnerable to future claims. The cost of remedying these hazards may ultimately flow through to insurers.

**Low carbon industry vulnerabilities:** Turning to renewable energy, we saw above that considerable policy and regulation is being put in place to spur this sector's growth. Awareness of the need for climate change solutions means renewable energy is widely

viewed with favour by the public, and climate change is expected to become a mainstream consumer concern by 2010. Firms that fail to engage in climate-friendly markets (such as renewable energy) are vulnerable to loss of competitiveness if their business opponents seize an early mover advantage, gain market share and achieve reputational and/or economic benefits (Marsh 2006b).

In the 'Hazards' section we saw how the energy companies that make up this new sector will also face conventional and new hazards, including primary climate change hazards. The variability of some renewable technologies, such as wind power, also poses financial hazards that companies may seek to cover through insurance or other risk management vehicles (Marsh 2006a). While this provides opportunities for new insurance products, there are associated vulnerabilities for insurers.

The emerging status of new renewable technologies translates into higher perceived risk for insurers (Mills (2007a). Most insurers are aware of renewable energy's prototypical nature, with almost two thirds (61%) of insurers surveyed by Marsh (2006b) saying this was a major underwriting concern in the case of wind power. This may also explain why insurers were very concerned about the inherent perils of handling, erecting and commissioning renewable energy technologies (see Figure 18).

Furthermore, limited commercial operating history of such projects means there is a dearth of data, leaving insurers vulnerable to the possibility of inaccurate modelling of future loss projections and unsustainable pricing. The small scale of many renewable energy projects may leave underwriters vulnerable to failure to achieve profits. And the lack of technical expertise in these new areas also leaves insurers vulnerable to the inability to carry out adequate project risk assessments or evaluations (Marsh 2006b).

Finally, insurers who fail to track the hazards or opportunities associated with the rising adoption of domestic and commercial renewable energy appliances may also find themselves vulnerable to diminishing market share and future competitive disadvantage.

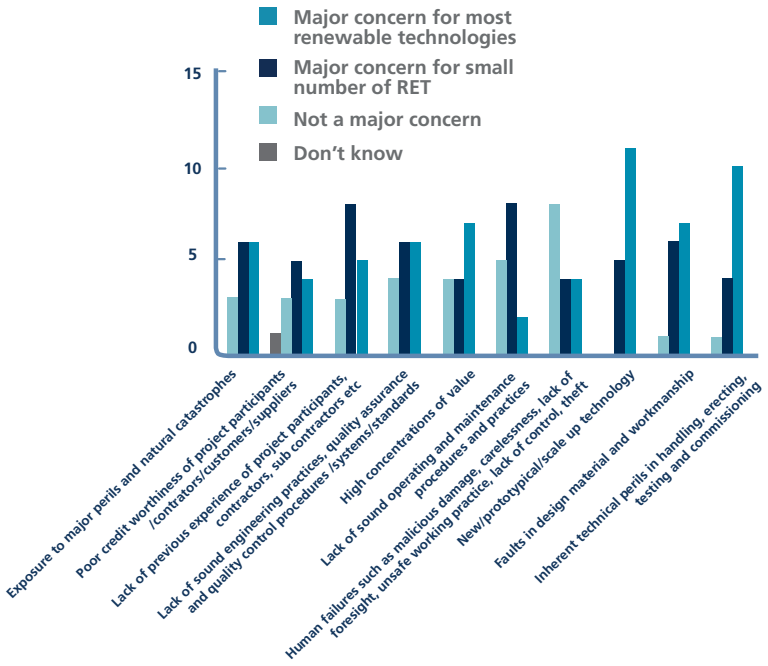



Figure 18. This graph from Marsh (2006b) reveals the degree of vulnerability insurers perceive to the spectrum of hazards entailed in underwriting renewable energy technologies (RET).

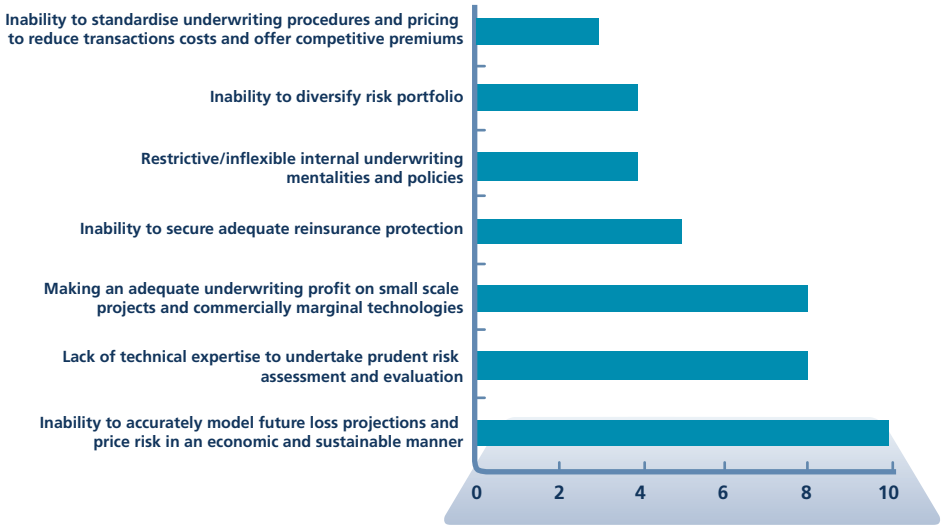



Figure 19. The greatest challenges posed by renewable energy technology for the insurance industry (Marsh 2006b).

**Vulnerability to local government policy and capacity:**

"It all depends on even local areas and even down to the local streets exactly where the water will inundate local communities. At this stage we don't have the science or the maps or the information available to really predict that at an accurate level".

Geoff Withycombe, 2007[23] Sydney Coastal Councils Group (Australia)

In the 'Hazards' section, we observed that regulatory change (or lack thereof) in the built environment may create hazards for insurers. Here we examine how such actions or oversights create vulnerabilities for insurers.

In terms of the overall built environment, planning that fails to consider a carbon-constrained economy may also result in challenging times for insurers' customers. The typical Australian and North American urban area is characterised by sprawling, low-density settlement and poor public transport networks. Inadequate consideration by governments in their urban planning of the need to restrict GHG emissions may leave businesses and homes exposed to transportation vulnerabilities. Indeed, according to the Australian Financial Review (2008[24]), suburbs "are now constrained communities. They are stranded in an oil-dependent age and unable to adapt. Some already refer to those suburbs as 'climate slums'".

Increasing this vulnerability is a response to climate change considerations in the built environment that has been mixed and disjointed in Australia. Harvey and Woodroffe (2008) note that a nationally-coordinated approach to assessing coastal vulnerability is only emerging now; previously, a patchwork approach was taken to mapping climate-related risks.

Although Australia's 750 local governments are at the forefront of risks - being vulnerable to a broad range of climate-related hazards and at the same time uniquely positioned to reduce climate risks - they have limited response capacity to mitigate or adapt. Common skills shortages mean very few staff in local governments possess the necessary skill sets to consider detailed climate-change related hazards. According to a recent paper (Burton and Dredge 2007), the main challenges to a response at the local scale include:

- a lack of clear and direct information about the local impacts of climate change
- lack of debate about climate-related risks and poorly formed perceptions of those risks amongst policy officers and decision-makers
- the uncritical adoption of the dominant frames of adaptation and mitigation that shape the policy response field
- an emerging preference for adaptation over mitigation
- lack of clear understanding about the response capacity of local governments.

23 As quoted in ABC 2007a.

24 Quoting Gareth Johnston, Climate Risk.

Many local governments thus lacking in capacity have simply not yet undertaken a basic assessment of climate risks (McDonald 2007). Around the world this is changing very rapidly as cities and regions commission climate change risk assessments.

However, the promise of rapid growth is also a key factor that leads some local governments to take a cautious approach to restricting development in climate-change sensitive zones; more residents translate into a larger rate base for local governments. Thus some authorities simply choose not to act. McDonald (2007) furthermore finds state based decisions to be "deferential" to local authorities' decisions, implying that the drive for adaptation planning will need to be aligned between different levels of government.

The result is that there are numerous examples of legacy developments that have proceeded in a "risk inappropriate" fashion despite knowledge of climate change (ICA 2008). This failure by local governments to adequately fold climate change into planning schemes when assessing developments results in a downstreaming of this risk to insurers and home owners, increasing their vulnerability to loss.

According to McDonald (2007), "Property owners whose land is regularly flooded will suffer losses in household contents, the costs of technical solutions to protect structural integrity, and lower property values. Properties along the coastal foreshore will lose large parts of their land and associated structures when severe storm erosion undercuts foundations, while properties in peri-urban bushland may experience increased risk of bushfire". Insurers of such properties will be vulnerable as owners seek to make claims for such losses. For example, following the raft of recent floods and extreme weather (eg Australian Hunter Region, Lismore and Mackay) some insurers have downgraded their profit expectations and are considering increasing associated premiums (ABC 2007b).

In the UK, for example, an agreement between insurers and the government has allowed flood coverage to continue in risky areas in exchange for promised government spending on flood defences. However, a shortfall in flood defence spending in 2006, followed by severe flooding in 2007, led some insurers to re-assess the economic feasibility of continued flood coverage in cases that they deem to be a "world-class risk" (BBC 2007).

**Professional indemnity litigation:** Property owners who suffer loss through flooding and other climate hazards could try to sue property developers for damages not covered by insurance, arguing the developments should have been built to tolerate extreme events. This could result in increased claims on professional indemnity insurance (Reo Research 2007). Property owners may also attempt to take legal action against the authority granting approval for the property's development. McDonald (2007) finds that while establishing

liability in connection with the somewhat political process of overall planning schemes may be challenging, property owners may have more success with actions relating to 'tort of negligence' or alternatively claims of 'nuisance' against local councils. According to McDonald (2007), "These questions await judicial clarification, but as coastal property values increase, so too will the stakes for local authorities who face even larger claims for compensation".

Firms providing Councillors & Officers insurance (a local government analogue of D&O insurance) could thus find themselves more vulnerable to such potential litigation-related losses in future. Indeed, according to McDonald (2007), given growing scientific consensus on climate change hazards, every decision on infrastructure made now carries legal risks that could flow on to financiers and insurers of individual properties, government agencies and projects.

McDonald (2007) says that other possible vulnerabilities related to the built environment include: "the spread of water-borne diseases and heat-related health impacts, and interruption to businesses where public services fail or infrastructure such as bridges and roads are damaged." Again, these scenarios leave insurers of property-owners, developers and of local governments vulnerable to potentially increasing claims due to litigation between these parties.

### 5.2.1 Vulnerability to insurance industry regulation

Here we show how insurers are also vulnerable to climate-change related policy, regulations or standards set by their regulators or even their own industry bodies, especially now that such regulation has become a high priority (Mills 2007a).

The 'Hazards' section noted how recent examples entail regulation for disclosure or reporting of climate risk, mandating coverage and preventing insurers from reflecting the full cost of climate risk in their policies. Insurers who do not keep on top of this regulation are vulnerable to regulatory non-compliance or even litigation (see Box 6). In the USA, insurers have fallen foul of regulators in highly-publicised disputes (see Box 11) which cannot improve their reputational standing with customers.

Insurers may also find themselves vulnerable as their own shareholders or investment managers query their directors about company policies on climate change. According to Marsh (2006a), "One of the first questions facing those overseeing investment accounts is: 'Is there a fiduciary responsibility to address climate risk?' When examining the issue from the perspective of public and private pension trustees in the United Kingdom, Mercer Investment Consulting, a Marsh sister company, answered with a definitive 'yes'".

### Box 6. Insurance regulators push for climate risk disclosure

As the regulatory environment of the insurance industry evolves in response to climate change, new vulnerabilities are created for insurers. In the US, a controversial April 2008 proposal from the National Association of Insurance Commissioners would force insurers to disclose detailed climate risks associated with real estate holdings and other investments.

According to Best's Insurance News (2008), "Particularly noxious to insurer representatives is a draft series of detailed interrogatories that would form a new part of insurers' annual financial statements; they see them as bait for litigation and political grandstanding".

Unpopular with insurers, the proposed mandate may not be adopted. However, it does indicate that if insurers ignore climate change, in future this oversight could affect not just their bottom lines but also leave them vulnerable to regulatory non-compliance and possibly even litigation.

### 5.2.2 Vulnerability to mapping and other climate risk disclosure

We discussed earlier in the 'Hazards' section how the release of a fast-growing body of information on flood and other climate-related risks could impact on local planning, agri-business decisions-making and property/land value. Here we discuss how failure to keep up with disclosure of hazards creates a new vulnerability for insurers.

Acting on information in such risk maps, an insurer might seek to raise insurance prices to reflect the elevated level of hazard (eg coastal flood risk). This would create a vulnerability if the insurer were subsequently selected against in the market on the basis of price. Or this hazard could lead to reputational vulnerability and economic loss if the information prompted them to withdraw insurance from affected zones. Release of this information could also lead to greater economic loss through fraud (ie if customers faced with the prospect of devalued assets resorted to insurance-related fraud to recoup their losses). Given the sensitive nature of risk maps, making them public can also potentially make those releasing this information subject to litigation and loss, which could flow on to their insurers.

Conversely, the lack of access to accurate risk maps (which competitors or other stakeholders may possess) is recognised as a major knowledge imbalance and competitive disadvantage by insurers that must currently rely on more outdated or subjective valuations of risk.

### 5.3 Insurers' vulnerability to tertiary (indirect) hazards

"Climate risk cuts across almost every industry in every corner of the world…"

Marsh, 2006a

Society's responses to climate change — including changes in property values, demography, behaviour, infrastructure location and the advent/implementation of new technology — will be myriad and complex, as will the flow-through vulnerabilities for insurers.

Elaborating on the challenges inherent in dealing with such complexity, Epstein and Mills (2006) note that:

> "... the technical literature often takes a 'stovepipe' approach, examining specific types of events in isolation from the real-world mosaic of often interrelated vulnerabilities, events and impacts. For example, analysing the effects of drought on agriculture may be done in isolation, effectively suppressing the linked impacts on human nutrition, financial markets and other hazards — like wildfires and the spread of West Nile virus — that may accompany drought".

Society's response to the massive damage caused by major catastrophes - so-called 'Super Cats' - can give rise to cascading consequences and nonlinear loss amplification, correlation, and feedback. According to RMS (2005), "These effects can increase losses to property and time element coverage and 'switch on' exposure to a wider range of insured lines of business".

### 5.4 Vulnerability stemming from industry - side factors

"The situation we are in resembles that of a driver who approaches a wall of fog and, having only a vague impression of the stretch in front of him, looks into the rear mirror in an attempt to see in the clear view of the road behind some indication of what lies ahead. . ."

Munich Re, 1999

Here we examine specific factors related to the insurance industry itself that exacerbate its vulnerability to climate change. Although insurers may have little or no direct control over climate-related primary, secondary or tertiary hazards, they generally can control their vulnerability to these hazards through policies and services they provide to customers. While we will discuss how insurers are taking positive steps to tackle these deficits in the second half of the report under 'Advantage' (Part C), here we focus on the gaps in knowledge and capacity that prevent insurers from managing these vulnerabilities.

"… the technical literature often takes a 'stovepipe' approach, examining specific types of events in isolation from the real-world mosaic of often interrelated vulnerabilities, events and impacts."

Epstein and Mills (2006)

### 5.4.1 Vulnerability to inadequate resolution of climate risk

"Caught between profitable lines of actuarial risks and uncertain catastrophic risks, the industry is being forced to underwrite and cross-subsidise risk without full knowledge of the extent of exposure (eg the industry was forced to continue to provide residential coverage in Florida after Hurricane Andrew)".

Dowlatabadi and Cook, 2007

One reason that insurers are highly vulnerable to primary climate change hazards, according to Mills *et al*. (2006b), is that "Insurers and their regulators as yet have no comprehensive capacity to assess the cumulative weather-related risks from both catastrophic events and the growing number of small-scale events".

Insurers' ability to stay in business and prosper depends on their ability to resolve risk (Epstein and Mills 2006). Here we will examine how the actuarial process, which mines historical data to produce accurate risk quantification in terms of the past, leaves insurers highly vulnerable to a future that is rapidly diverging from past experience. Thus insurers and reinsurers face a major challenge in an era of rapid climate change. In the USA, the National Association of Insurance Commissioners has recognised this vulnerability, finding that the risk of loss may be underestimated and requesting that insurers start to factor climate change into their models (Marsh 2006a).

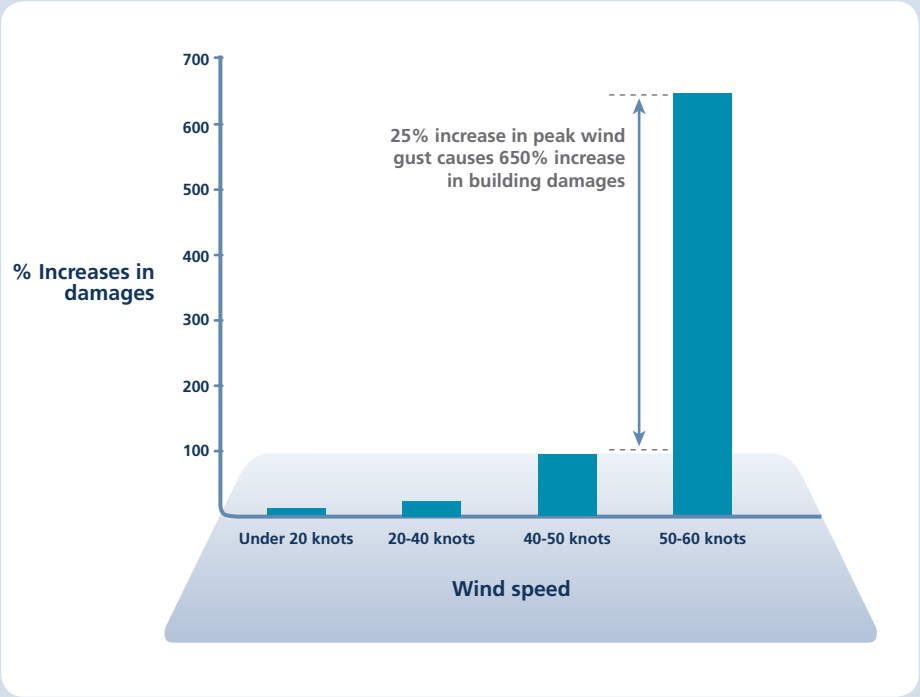
First we will outline some of the ways in which primary climate change hazards are challenging insurers' ability to adequately resolve actuarial risk, thereby increasing their vulnerability to loss.

**Frequency and variability shifts and novel events:** Epstein and Mills (2006) cite how changes in return period (ie more frequent adverse weather events) can result in increased payout for losses. According to UNEP-FI (2006), "When the average value of a factor changes, then the risk of extreme values shifts much faster." For example, a deceptively small rise in average temperatures will cause the risk of severe summer heat in Europe to increase by a factor of 200 times within decades, or an annual rate of over 5%. (See also Box 7 regarding wind damage.)

Furthermore, according to Coughlin (2007), "In a time of change it becomes more difficult to define what is the mean and the uncertainty around the mean increases". The variability of adverse events is also changing and increasing, which makes it harder to resolve actuarial risk.

Climate change has also been linked to unanticipated or 'novel' events, such as the Southern Atlantic's first recorded hurricane - the devastating 2004 Hurricane Catarina. Catastrophe models to date simply fail to predict such events and so they are not included in premium setting.

## Box 7. Vulnerability through non-linear escalation in damage




When critical thresholds for damage are reached, buildings constructed according to uniform building design regulations manifest non-linear damage — and, in turn, a similar non-linear increase in insurance claims . The hazard posed to the insurance industry is elaborated by Hawker (2007), who finds that a 25% increase in wind speed over 50 knots results in insurance claims increases of as much as 650%.

“When critical thresholds for damage are reached, buildings constructed according to uniform building design regulations manifest non-linear damage — and, in turn, a similar non-linear increase in insurance claims.”

**The failure of geographical spreading:** Sequencing can also increase vulnerability. With back-to-back or sequential events, such as drought, followed by intense precipitation or sequential cyclones, "the early events increase vulnerability to the later ones", according to Epstein and Mills (2006). Furthermore, while different events are seemingly uncorrelated, they may actually be linked or coincident through climate processes. Although insurers tend to rely on geographical spreading of risks to avert simultaneous losses, climate change may increase their vulnerability to simultaneous events across widespread geographical areas. Epstein and Mills (2006) cite the example of how "a broad die-off of coral may be followed by an uptick in tidal-surge damages in multiple regions/coastlines". However, climate change has also made it increasingly difficult to identify potential geographic and demographic hotspots for hazards.

**Hybrid events cross business lines:** Finally, Epstein and Mills (2006) cite 'hybrid' events - multifaceted risks that result in losses in different insurance business lines. For example, sea-level rise could result in losses not just for flood insurance policies, but also for property, health and even crop insurance lines.

**Backward-looking models outmoded**

"Historical records will become an increasingly less reliable guide to future weather risk, as greenhouse gas concentrations rise. Additional information is needed to understand how current risks are expected to change with global warming".

Hawker, 2007

Insurers reduce their vulnerability to climate, weather and other hazards through identification of risks (ie estimating the frequency of specific events and likely losses). To do so they typically rely on historical data or scientific analysis of likely future events (Freeman and Kunreuther 2003). Insurers have also used models to predict the extent of sudden, extreme loss through the use of 'catastrophe theory'; yet these models do not entail probability predictions (Epstein and Mills 2006).

Given evidence that the occurrence of weather extremes around the world is changing and will continue to do so in future, using the past to predict the future in an era of climate change may no longer be feasible. According to Reo Research (2007), "If weather hazards rise, and no effort is made to reduce vulnerabilities and exposures, then the risk to human populations will increase. This trend will be superimposed on an already-rising toll of losses from extreme weather". Even events that are not severe can have serious

"Given evidence that the occurrence of weather extremes around the world is changing and will continue to do so in future, using the past to predict the future in an era of climate change may no longer be feasible."

consequences if they are not adequately factored into risk formulations.

However, the dynamic and complex nature of climate change risk poses a major challenge. As noted above, considerable uncertainty surrounds the prediction of climate variability and the frequency and nature of extreme events (UNFCCC 2007c). Meanwhile, computer modelling capability is still limited, and this combines in some cases with a lack of historical data to further exacerbate insurers' inability to resolve risk (Mills *et al*. 2006b; Chemarin 2007).

Mills *et al*. (2006b) also observe that the problem is not helped by a disjointed approach, given the long-term, forward-looking climate change models used by the scientific community and the historically-based catastrophe modelling used by insurers; these two traditions essentially work in isolation.

Figure 20. Considerable uncertainty surrounds the prediction of climate variability and the frequency and nature of extreme events.

### Box 8. Katrina highlights need for reliable cyclone models & pricing

> "Underwriters need to price risk correctly and use more comprehensive modeling that reflects the latest scientific findings. … Climate change is rapidly transforming the nature and gravity of the risks that businesses bear and we need to make use of the latest expertise to underpin our risk management strategies".
>
> Lord Peter Levine, Chairman, Lloyd's (2006b)

Given the scale of losses from Hurricane Katrina — US$45 billion of insured losses and total losses of US$125 billion[25] — the importance to insurers of understanding the future risk from these events cannot be overstated. The science around hurricanes itself is rapidly changing. However, there is growing certainty that: Atlantic basin hurricane activity is higher than the long-term average; similar levels of activity are expected in the medium term; we will not return to pre-20th Century conditions if climate change is the main driver of this change.

Johnson and Watson (2006) point out that, despite the important implications for lives and property, the often suspect data used for tropical cyclone planning and response means the modelling process may reflect the computer science adage: "Garbage In, Garbage Out". For example, an RMS analysis of data from the 2004 hurricane season revealed that information on exposures was outdated, incomplete, poorly resolved or miscoded.

Furthermore, they found that these data quality issues tend to underestimate vulnerability (RMS 2005). In the wake of Katrina, the fact that modelled losses underestimated actual losses led to criticisms about the reliability of hurricane models and demands for their improvement (Johnson and Watson 2006).

According to MMC (2007), modelling firms now include the assumption that storms are increasing in frequency and/or severity. MMC finds that, "in light of the data provided by the storm activity of 2004 and 2005, certain modeling firms made substantial changes to key vulnerability and post-event loss-amplification assumptions. All of these changes dramatically increased the perceived risk of U.S. hurricane activity, and, as a result, pricing on prior cat bond issuances in the secondary market shifted, and sponsors experienced increased reinsurance rates and greatly restricted capacity levels".

Despite these adjustments, combined events such as hurricanes and flooding (as witnessed during Katrina) still pose a major challenge to cat modelling (Chemarin 2008).

25 Munich Re (undated).

### 5.4.2 Vulnerability through inappropriate pricing, policies and exclusions

"At its most basic, insurers underwrite weather-related catastrophes by calculating, pricing and spreading the risk and then meeting claims when they arise. A changing, less predictable climate has the potential to reduce our capacity to calculate, price and spread this weather-related risk".

Stagnitta and Forster, 2004

Here we examine insurers' vulnerability to miscalculations in pricing risk, which is closely related to the above issue of vulnerability to inadequately resolved risk.

We have already noted the climate change signal in global weather-catastrophe economic losses, and the increase in insured losses. According to the IPCC (2001), "There is high confidence that climate change and anticipated changes in weather-related events that are perceived to be linked to climate change would increase actuarial uncertainty in risk assessment and thus in the functioning of insurance markets". Indeed, risk cost and risk pricing is expected to be the most significant area of climate-related vulnerability for non-life insurers, according to Reo Research (2007). Clearly, if insurers inadvertently but systematically under-price risk, profitability will be undermined should claims prove higher than projected.

As observed above, vulnerability can arise when historical models are employed to predict future events despite our changing climate. The variability and unpredictability of extreme events also increases the statistical uncertainty for estimates of potential loss. According to Mills (2003a), "This can present a material impediment to setting actuarially sound rates and making insurance available to those who need it".

Adding to this vulnerability, according to the UNFCCC (2007a), is the fact that "It is not easy to communicate pricing signals related to risk-reduction activities". They further note that, in a time of raised risk, shifting from a non-technical to a technical risk-pricing regime can be challenging and requires a multi-year transition period.

Yet despite demonstrations of escalating climate risk, such as the 2004 four-hurricane season in the USA that underscored insurers' vulnerability in terms of pricing and managing multiple catastrophes, "there is, oddly, continued scepticism when the spectre of new and unprecedented types and patterns of events emerge", according to Epstein and Mills (2006).

Indeed, one obstacle that perpetuates insurers' climate change vulnerability is competitive pressure to keep prices low. Companies that factor elevated climate risk into their premiums could even price themselves out of markets if less forward-looking competitors maintain low prices. The cyclical nature of the market, extreme swings

"One obstacle that perpetuates insurers' climate change vulnerability is competitive pressure to keep prices low. Companies that factor elevated climate risk into their premiums could even price themselves out of markets if less forward-looking competitors maintain low prices."

in pricing and widely fluctuating levels of public scrutiny, which correspond to the year-to-year vagaries of weather, all contribute to this vulnerability, according to Reo Research (2007).

However, insurers that nonetheless raise prices may open themselves up to further vulnerabilities. For example, in storm-tossed Florida, the cost of commercially-available reinsurance reached crisis point and ultimately compelled the State to provide reinsurance cover (Reo Research 2007). Significant and rapid rises in premiums leave insurers vulnerable to reputational and regulatory risk (see Box 11).

There is a societal risk, too, given the central role of insurance in the global economy. Its reduced affordability would profoundly affect society - from homeowners to big energy companies.

Insurers may also find that current exclusions, limits and deductibles leave them vulnerable to financial loss and seek to adjust these. However, along with price spikes, increased deductibles, reduced limits and new exclusions have the effect of hollowing out the market (Mills 2007a). Insurers who cannot adjust prices or policy conditions sufficiently to account for their costs may take the ultimate step to reduce their financial vulnerability — vacating the market. This is discussed further in the 'Exposure' section.

### 5.4.3 Vulnerability to post-cat service shortfalls

"Claims-handling capacity is too low, because the scale (extent and intensity) of destruction in new extreme events is beyond experience".

Dlugolecki, 2008

There are significant service delivery expectations on general insurers; accurate cover, timely assessment of loss, staff competence in settling claims. As with any business, resourcing these areas is established through experience. However, the ability to provide these services competently will be challenged by climate change. For example, because climate change modelling also forecasts an increased frequency of extreme events, insurers must increasingly consider the consequences of sequential 'Cat following Cat' events (eg cyclone following cyclone). If such risks are not included in product and service structure and pricing, the correlated risks from climate change that are likely to elevate underwriting losses could also severely erode invested assets, which insurers use to pay the associated claims (Mills and Lecomte 2006a).

An escalation in the severity and frequency of extreme weather events could leave unprepared insurers vulnerable to economic and reputational loss if they fail to meet customer expectations in the critical post-disaster period of intensive claims servicing. This vulnerability may also

be exacerbated by building codes that fail to reflect rising climate risk, and as a result leave the built environment susceptible to escalating hazards - as discussed earlier.

The extensive damage and surge of claims following the 1999 Sydney hailstorm - Australia's most costly disaster - serves as a warning. Six months after this disaster, only half of building claims were finalised.

The surge in demand for building materials and labour - and therefore costs - following such catastrophes may be inadequately factored into models and policies leaving either the insurer or client vulnerable to underinsurance. According to Stagnitta and Forster (2004), "social impacts of this through inconvenience and temporary loss of quality of life are potentially significant and must be factored into a full assessment of the impact of hailstorms on communities".

### 5.4.4 Financial solvency and assets vulnerability

"There was a disappointingly low level of awareness of the impacts of climate change for asset managers. While there are some examples of good practice, many companies have yet to focus on this area, despite holding large and potentially vulnerable investment portfolios".
Reo Research, 2007

Although largely beyond the scope of this report's focus on general insurance, we will briefly touch on the issue of insurers' vulnerability to climate change from the point of view of financial solvency and assets.

Insurers manage client assets of US$16.6 trillion globally (UNEP-FI 2007; 2005 figures)[26], making this sector the single largest gatherer of investment capital in the global economy (Reo Research 2007). However, sequential weather events or catastrophes - or weather events in parallel with non-weather events such as earthquakes - can result in drawdowns and strains on reserves for paying out losses (Epstein and Mills 2006).

Insurers manage client assets of US$16.6 trillion globally (UNEP-FI 2007; 2005 figures), making this sector the single largest gatherer of investment capital in the global economy

Insurers are vulnerable when they fail to recognise how climate change can impact on the value of their investment portfolios or if they fail to factor this into their investment decision-making process (Reo Research 2007). This vulnerability may stem from primary climate change hazards, changing government regulations and even shifting consumer preferences (Reo Research 2007). Insurers that hold property assets may find these vulnerable to primary climate change hazards (eg hurricanes), as well as secondary hazards (eg through building regulatory change).

The insurance industry has developed financial instruments for Alternative Risk Transfer (ART) to spread underwriting risks, the main form being insurance-linked securities such as catastrophe (or 'cat') bonds. Cat bonds, like reinsurance,

26 This does not include an additional US$20.6 trillion for pension funds and US$17.8 trillion for mutual funds managed by insurers (UNEP-FI 2007).

are intended to decrease the volatility of weather risks. Dowlatabadi and Cook (2007) suggest that the current small size of these markets is indicative of insurers "willingness to explore their utility as opposed to having grown so comfortable with them as to adopt them broadly". In addition to unfamiliarity, a dampening factor for the market in cat bonds is their high price, explained by a high risk premium reflective of existing uncertainties around the probability of extreme events (UNEP-FI 2006), issues which could be resolved with learning. Furthermore, the use of ART solutions is also dependent on reinsurance cost cycles (Chemarin 2008). Nonetheless, 2006 proved to be a record years for cat bonds, a trend MMC Securities (2007) attributes to "Continuing the momentum caused by the record storms of 2004 and 2005".

### Box 9. Investment funds and climate change: A brief snapshot

An important climate change mitigation strategy for the insurance industry will be to incentivise mitigation activities and ensure appropriate regulatory change is implemented by governments around the world.

There is a major role in this strategy for long-term investors, which control a huge portion of the world's assets. For example, The Conference Board reports that institutional investor ownership of companies in the Fortune 1000 is 76% (TCB 2008).

Among institutional players, investors arguably have the most to lose if the forces behind climate change are not adequately addressed and the world economy shrinks by at least 5%, and by up to 20%, as projected by Sir Nicholas Stern in his landmark 2006 report into climate change (Stern 2006).

The three key groups of long-term investors are insurance companies, pension funds and sovereign wealth funds. As we have already discussed insurance investors to some extent (eg see section 5.4.4), here we cover the two additional main groups.

**Pension Funds**: According to consultants Watson Wyatt (2008a), the assets of the world's 300 largest pension funds stand at US$12 trillion — and this figure is rising by 14% a year (Watson Wyatt 2008b), compared to a total of global assets under management of some US$62 trillion (IFSL 2007). And as a submission by the Network for Sustainable Financial Markets (2008) to the OECD has pointed out, "Pension fund management decisions now not only affect the best interests of fund participants but of the majority of our planet's population".

## Box 9. continued

**Sovereign Risk Funds**: At end of 2007 the total money in sovereign wealth funds was estimated at $3 trillion. This is forecast to reach $10-12 trillion by 2012, or over 15% of global equity market capitalisation (Responsible Investor 2008).

The alignment of climate change engagement between the three major institutional investment groups is evolving, though currently these groups act independently. For example, there is already movement in the pension fund sector towards greater engagement with climate change issues. Numerous industry bodies now exist to pursue such agendas, ranging from the Investor Network on Climate Change to the P8 group, a group of the world's largest pension funds brought together by Prince Charles to lobby the G8 on climate policy.

Some of this activity is being driven by concerns about legal liability. As noted in this report, company directors face vulnerability to legal action if they do not act to address climate change threats, vulnerability to which the investment sector is not immune. According to Helen Wildsmith (Personal Communication 2008), Head of Ethical & Responsible Investment at the UK's CCLA Investment Management (and former Director of the UK Social Investment Forum), "With threats being bandied around about legal action against companies who have, despite knowing the evidence, failed to take appropriate action in the light of climate change, we have entered a new era".

The extraordinary weight of science detailed by the IPCC lays out the sort of future we can expect under a range of greenhouse gas emission scenarios. Every director and trustee is duty bound to consider this evidence when making decisions about where to invest assets. If they make decisions that directly or indirectly lead to poorer outcomes for beneficiaries or shareholders, they risk being judged to be liable for the outcomes. This would turn on its head the traditional reluctance to pursue environmental objectives, given that investors considering climate change could cite concerns about the Prudent Man Rule, the US Exclusive Benefit Rule, or Australia's Sole Purpose Test. In short, Trustees and directors will be compelled to manage their assets differently, reviewing their portfolios in the light of new evidence about climate change and its impact on future market directions.

The opportunity to provide a consistent policy and advocacy approach vis-à-vis climate change across all institutional investors would constitute a significant step forward. This would help overcome the tension between reduced returns in the short-term in favour of long-term economic, social and environmental stability — a prerequisite for the long-term returns required by these groups.

### 5.4.5 Vulnerability to general lack of climate-change capacity

"… across the industry as a whole, the response to climate change does not yet reflect the scale of the challenge. In part, this is because there is still a good deal of learning going on – climate science continues to evolve, and government regulation and customer preferences alike are shifting fast".

Reo Research, 2007

Here we examine how a general lack of insurance industry awareness and capacity with regards to climate change is contributing to insurers' vulnerability. In 2006, Epstein and Mills found that: "As of today, fewer than one in a hundred insurance companies, and few of their trade associations and regulators, have adequately analysed the prospective business implications of climate change, heightening the likelihood of adverse outcomes". Reo Research (2007) notes that: "While it is clearly in insurers' and society's interests to encourage customers to reduce the risks they face, examples of this are so far limited".

A general lack of knowledge about climate change impacts means many insurers may not adequately project the changing needs of their customers; this may lead to customer flight to other insurers or even to other risk-management products or practices (Epstein and Mills 2006). A survey of leaders from across business, government, science and insurance by Lloyd's (2006b) also found that 84% thought the insurance industry wasn't doing enough to understand and manage climate risk.

The "wait-and-see" approach to climate risk of some in the insurance industry was highlighted by Dowlatabadi & Cook (2007):

> "The insurance industry was asked at a recent workshop about their preparation for this eventuality [climate change] and whether modelling would be a useful approach to inform them of their potential exposure and any needed revision to the price and terms of coverage. A prominent insurance association representative said that the industry could only learn the true extent of its exposure for director and officer liability in a court case. While this may be true in part, the authors believe that the industry's reluctance to examine its exposure in this area demonstrates a lack of preparedness".

There may be other barriers to appropriate action, including the need to stay competitive on a price basis - as discussed above. Furthermore, individual companies could shirk from requiring their customers to engage in important climate-related risk reduction out of fear of moving too far ahead of the rest of the market - again due to potential loss of competitiveness (Reo Research 2007). This fear of being prejudiced in a market which

fails to respond to their climate change leadership is more likely when government and other stakeholders fail to appreciate and align their priorities with those of insurers.

### 5.4.6 Reputational vulnerability

"In times of significant change comes risk. The future reputation of the insurance industry will be dependent on how we manage this issue when dealing with sensitive areas such as the potential for premiums to rise in relation to increasing risk and the sustainability of the industry's ability to pay in the long term".

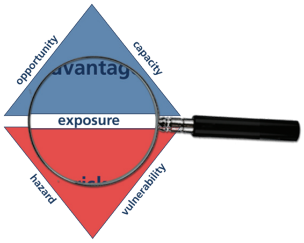
Hawker, 2007

Insurers are also vulnerable to reputational loss in the face of climate change. The impacts insurers themselves face imply that they stand to be 'prime movers' in responding to this threat (Epstein and Mills 2006). Thus insurers' reticence to tackle climate change has been questioned by some commentators (National Journal 2007).

According to Epstein and Mills (2006), a recent survey of UK companies indicates that the failure on the part of insurers to do enough (in consumers' eyes) to prevent losses due to climate change is the greatest market-based risk they face. In particular, insurers' reputations are not enhanced when they attempt to reduce their exposure to climate hazards by withdrawing from markets (to be discussed in detail in the 'Exposure' sections).

However, as we shall see in the 'Opportunities' and 'Capacity' sections, there are many avenues for insurers to improve their reputations while reducing their own and society's vulnerability to climate change hazards.

## 6 Exposure(i): Emerging insurance risk in geographical and sectoral markets




"[r]adical changes in natural catastrophe frequency and/or severity could eliminate certain of our markets [sic] through physical damage, price escalation, or regulatory activity ..."

ACE Limited response to the Carbon Disclosure Project (quoted in Mills 2007a)

This section seeks to explore climate change risk to insurers - the world's largest industry - from the point of view of their exposure in geographical and sectoral markets, which may be affected by climate change hazards.

In the Climate Risk Diamond, exposure forms the base for both the risk and advantage triangles. To reflect both the risk and advantage perspectives , we take a two-pronged approach here to climate change exposure, splitting it into two separate sections.

First, this section looks at existing exposure and its contribution to increased climate change risk to general insurers. The next chapter - Exposure(ii) - looks at how insurers can optimise exposure to manage their risk and secure advantage under climate change.

Providing an indication of insurers' exposure to global markets, worldwide insurance premiums totalled US$4,061 billion in 2007. Of the total, US$1,668 billion was represented by non-life insurance business (ie general insurance; Swiss Re 2008a). In 2006, worldwide total insurance premiums represented 7.7 % of global GDP (Swiss Re 2007)[27].

We noted in the 'Vulnerability' section that insured losses are increasing and that a climate change signal is evident in global weather-catastrophe losses. As Mills (2007a) notes, "The growing destructive power of extreme weather events coupled with increasing insured exposures poses a material financial challenge to insurers."

Here we examine insurers' exposure from two points of view: geographical versus sectoral markets.

The section on geographically-based exposures examines insurers markets by location types (eg coastal) in terms of how these zones are subject to climate change hazards. Our discussion on sectoral exposures, on the other hand, examines how different economic sectors are vulnerable to climate change hazards, such as the fossil-fuel intensive industries confronting new hazards from regulation to tackle greenhouse gas emissions.

**Climate change exposure:** The market, both geographical and sectoral, in which an insurer is active and the extent/value of that market. For example, an insurer who provides coverage for hail damage for public sector vehicle accumulations in Sydney is exposed to a market that is subject to this climate-change hazard.

27 According to the latest OECD (2007) insurance statistics Australia has 130 companies engaged in the non-life insurance sector. In 2005, $21 billion in total gross non-life of premiums were written ($5o billion including life) in Australia. It is anticipated that the total market (life and non-life) will slowly expand to $58 billion by 2010 (Datamonitor 2006), representing trillions of dollars worth of risk.

## 6.1 Geographical exposures

"… the continuous increase of exposed values in high- risk areas and the potential impact of global warming on intensity of weather-related events shall accelerate the number and increase the scale of mega-catastrophes in the near future".

Michel-Kerjan and Morlaye, 2008

### 6.1.1 Increasing geographical exposures

Michel-Kerjan and Morlaye (2008) warn insurers that the combination of markets in high risk areas and the expected increase in extreme events due to climate change will increase the size and number mega-catastrophes in the near future.

Thus, insurers who remain exposed to markets in such high-risk regions without taking steps to reduce their vulnerability will face heightened risks. This is likely to come not only from increasing property claims, but also possible litigation-related claims if developers and local governments are sued by property owners - an issue already discussed in 'Vulnerability'.

**Example: Urbanisation in zones of escalating climate hazards**

Climate related hazards pose a greater risk to insurers' exposures in the property than in the life insurance arena (Mills 2003a). For example, houses face increased risks from subsidence, drying foundations, cracking, wind, rain and hail, bushfires, storm surge and flood. Climate change science further indicates that in some cases human beings are building and expanding economic centres in at-risk zones. Providing a glimpse of the extent of maladaption, a recent report by the OECD estimated that globally the financial impact of flooding on property and infrastructure in 2070 could increase by more than 11-fold, from about US$3 trillion today to US$35 trillion, due to the combination of climate change and urban development (Nicholls *et al*. 2008).

Clearly, one important non-climate related source of increasing risk in current exposures is the concentration of more than half of the world's population in urban areas, and a quarter of the world's population in coastal zones. Of the world's 16 mega-cities (population of more than 10 million), 12 are coastal, and all are experiencing rapid growth (UNEP-FI 2006). Prime examples are: the mega-deltas of Asia, major urban and business centres such as Dhaka (Bangladesh), Shanghai (China) and Jakarta (Indonesia). Another cause for concern is increasing 'sunbelt' development fuelled by retirees, as seen on the Florida coast, in Southern Europe and on Australia's eastern seaboard (see below). Providing an indication of the inherent exposure for insurers, UNEP-FI (2006) finds that US coastal private assets alone are valued at approximately US$7 trillion.

The rapid growth and intensification of urbanisation increases the clustering

of risks in these exposures. Quoting an Association of British Insurers study, Marsh (2006a) noted that if Hurricane Andrew had struck southern Florida in 2004 instead of 1992, the effect of increased coastal development alone over just 12 years would have doubled insured losses.

As Mills (2007a) puts it, "Climate change, of course, conspires with settlement and land-use planning practices that magnify exposures to catastrophes." This increasing urbanisation in areas of risk is occurring even in developed countries, where scientific awareness and identification of hazards is high.

**Example: Increasing risk in Australian coastal exposures**

Reflecting global trends, a major contributor to risk in Australian insurance markets is the concentration of the nation's population in metropolitan centres - along rivers and one of the longest coastlines in the world. Not only are urban populations growing, but regional coastal centres are rapidly developing as well, as part of the 'seachange' phenomenon (Harvey and Woodroffe 2008).

In particular, south-east Queensland is one of the fastest growing regions in the developed world. Prosperous communities are becoming more densely populated, and construction and building costs are also steadily increasing, along with asset value (ICA 2008). A further 575,000 new dwellings will be required in south-east Queensland in the next 20 years - and most are likely to be urban infill on vulnerable coastlines and coastal floodplains (McDonald 2007). Furthermore, according to the Insurance Council of Australia (2008a), "... many thousands of residential properties on Queensland's Gold Coast have been authorised and constructed in locations that place them at extreme risk of catastrophic flooding and coastal inundation".

IAG (2005) finds that approximately 160,000 homes in Australia are now located within current one-in-100-year flood zones, while a study by Risk Frontiers (McAneney *et al*. 2007a) finds that 170,000 properties are currently at risk of riverine flooding (at the one-in-100- year annual recurrence interval). Looking to the future, a recent report for the ICA found that more than 700,000 Australian homes and business could be at risk of flooding from storm surges and long-term sea-level rise[28] (McAneney *et al*. 2007; IPCC 2007b). The biggest concentration of risk is along NSW and Queensland's coasts, highlighting the vulnerability of between 2 and 3% of buildings and therefore the insurers exposed to this geographic market (see Figure 21).

At the same time, other primary climate change hazards, including cyclones, hail, and erosion will further act to increase risk in exposures on Australian coastal zones. According to the IPCC (2007b) there is "high confidence" that areas of population growth in south-east Queensland and Cairns will magnify the hazards of sea-level rise and increased storm frequency and severity.

> "Storm surges, bushfires and other severe weather events may have severe effects on economic and social life in some regions. They will, at a minimum, raise the price of insurance in affected areas. In the most extreme cases, some regions will be rendered less habitable, to the point that there will be a need for communities and industries to relocate..."
>
> Garnaut (2008)

28 Addresses less than 3 km from the coast and less than 6 m above mean sea level; this range was chosen because "because storm surges of this magnitude are possible in some areas prone to tropical cyclones and as a plausible upper bound on sea level rise in the next one hundred or more years."

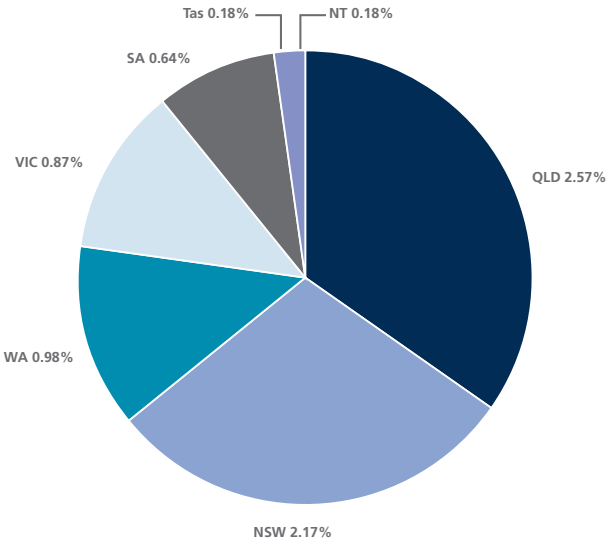



Figure 21. Australian coastal addresses vulnerable to sea-level rise from global warming, by proportion of total addresses in state/territory. (Distance less than 3 km from the shore and elevation less than 6 m above the mean sea level). From McAneney *et al.* (2007a).

Thus coastal Australia provides a prime example of how intensifying development combines with increasing climate change vulnerability to increase risk for insurers exposed to these markets.

## 6.2 Sectoral exposures

"For some high impact industry sectors (eg energy and electric utilities), as much as 15% of the total market capitalization of major companies could be threatened by climate change-driven risks to shareholder value".

Ross *et al.*, 2007

Every industry sector is or will be affected by climate change, but as noted above, certain sectors of the economy may be more prone to climate change hazards than others. These hazards can run the gamut from weather-related hazards to regulatory and societal hazards. March (2006a) sums up the risks to such sectors:

> "... a company that ignores climate risk may find itself burdened with higher energy costs, stuck with outmoded technology, mired in shareholder litigation, and panned as environmentally unfriendly".

This risk can flow on to insurers exposed to such sectoral markets through their policies. Here we provide two examples of sectors that may pose increased risk to exposed insurers who do not act to reduce their vulnerability.

### 6.1.3 Example: Increasing climate change risk in agriculture

Primary climate change hazards are expected to have major global impacts on agriculture, and insurers that are exposed to this sector without taking

measures to reduce vulnerabilities could be subject to loss.

In many regions, especially at low latitudes, reduced water availability will affect agricultural productivity. By 2020, crops dependent on rainfall could be reduced by up to 50% in some countries, and crops grown in the warm end of their acceptable range could face serious challenges. According to the IPCC (2007a), "Agricultural production, including access to food, in many African countries is projected to be severely compromised".

Insurers exposed to markets in Australia's agricultural sector may already be familiar with heightened climate-related risk. Drought relief to the tune of US$1.7 billion paid to Australian farmers from 2001 to 2006 (IPCC 2007b) signals the extent of the agricultural sector's sensitivity to climate-related hazards. Most Australian crop insurance cover is for fire and hail as opposed to drought. However, all of these hazards are increasing with climate change.

More broadly, the expected reduction in incomes due to reduced productivity with climate change could generally increase the risk for insured exposures in the area of farming machinery and other assets. Markets may be eroded in some areas where crop production becomes unviable, due to rainfall reductions for example. Insurers' markets may be eroded if they fail to track a possible gradual shift in agricultural activities, as farmers relocate in response to the changing climate (QFF 2006).

At the same time, agricultural activities or practices, as important sources of GHG emissions including nitrous oxide and methane, will increasingly be subject to regulation. In New Zealand, where methane from livestock production accounts for about half the nation's total GHG emissions, the national government has already proposed a controversial tax on these emissions.

## Box 10. Climate awareness and agricultural risk management

Agriculture and associated sectors, such as irrigation, chemicals, transportation, other commodities and energy, have a long tradition of using insurance to manage 'acute' weather extremes such as frost and hail, and longer-term 'chronic' extremes such as drought. Agriculture is a significant greenhouse gas emitter, even the dominant emitting sector for some countries such as New Zealand. At that same time, agriculture is also highly vulnerable to climate change impacts (Wall and Smit 2005).

Understanding climate variability has always been important to agricultural decision-making and risk transfer. However, as noted elsewhere in this report, anthropogenic (human-caused) climate change reduces confidence in our ability to rely on past climate and weather system data for insurance product evaluation.

Climate change has already led to alterations in insurance products in the agricultural sector, for example, to fewer frost and more hail policies. It has also prompted innovations such as risk transfer via indices of soil moisture or simulated crop yield. Another innovation under consideration is the use of new mitigative or forewarning technologies, such as high-resolution Doppler radars. This radar can determine whether clouds are suitable for rain promotion or require hail suppression efforts, or determine the potential for explosive growth in hurricane intensity.

In an effort to facilitate decision-making around issues of climate variability, precision agriculture[29] has now accumulated more than two decades of experience in seasonal forecasting using 30- to 180-day horizons. In the near future we can expect more detailed predictions, extension of time horizons, improved accuracy, and better understanding of the uncertainties entailed in such predictions. These improvements should serve to deepen decision-making portfolios and encourage the hedging of forecasting errors by weather/climate derivatives (Best *et al.* 2007).

In many developing countries, historical databases for both meteorology and agricultural losses are lacking. Additional challenges include the problem of basis/credit risks and the high costs of carrying out loss assessments. These issues have prompted trials of climate-index insurance as a risk transfer tool for agricultural disaster management (Khalil *et al.* 2007). There is also renewed interest in the use of more comprehensive methods for weather reanalysis products. These products can provide a wide spatial coverage of six-hourly weather variables over the last 150 years, together with downscaling to finer geographic scales. They can also provide a synthesis with forward-looking projections using regional coupled climate models. Recognizing the potential of these innovations, insurers may soon join agricultural forecasters in providing much wider windows of risk.

29 Precision agriculture is a practice which recognizes that a given agricultural site may not be uniform in its characteristics; it therefore matches the varying soil properties and crop requirements with specific treatments, to enhance efficiency and improve the environmental impact.

**Box 10. continued**

Changes in agricultural operations due to climate change may be fundamental. For example, crop types and husbandry may have to change; renewable energy and sustainable irrigation may become integral to operations; carbon offsetting and harvesting could become routine; multi-peril insurance may become multi-indexed risk transfers over longer timescales. To remain viable in the face of climate change, some cropping and animal husbandry organisations may have to seek geographical diversity in regions either previously considered unsuitable or lacking in long-term climate and loss records; thus they would require a full new suite of insurance cover.

Agricultural enterprises are increasingly becoming more integrated with other risk management sectors, such as energy, water supply, currency, and disaster management. As such, new services and products may reach across sectorial boundaries, especially in countries with less historical presence in terms of conventional insurance. Private-public partnerships may be essential in disaster-prone arenas. Thus climate change re-engineering of agricultural and associated sectors is likely to be a great integrator.

### 6.1.4 Example: Increasing risk in energy industry exposure

"Energy and resource companies in Australia have been threatened with class-action lawsuits stemming from climate change issues".

Marsh, 2006a

Insurers providing coverage for the energy industry could be subject to increased climate change related risk from a variety of emerging hazards. Markets in this sector, as noted in previous sections, are subject to a tightening regulatory environment for GHG emissions. This could increase the litigation and non-compliance risk of fossil-fuel intensive companies (eg transport, mining, metal works and energy) that fail to consider this regulatory hazard in their planning, with potential knock-on effects for insurers.

The extent to which this climate change hazard increases the risk for insurers' current exposures is a matter of debate. Marsh (2006a) notes that: "Because climate change is arguably, at its roots, an environmental issue, companies may conclude that their environmental liability policies should respond to these losses. However, at present, it appears unlikely insurers would accept these arguments".

This market will also face hazards as power production responds to carbon emissions constraints, through shifts in sub-sectoral market share and viability (ie toward gas and renewable generation to the detriment of coal). This shift of emphasis can already be seen in the EU, where gas and renewables now dominate new installed capacity. Insurers could be bound to the rising or falling fortunes of the subsectors they cover, possibly losing market share if they fail to shift their exposures to track climate change regulatory shifts.

In the case of the oil and gas sector, primary climate change hazards, as well as the above regulatory hazards, are a cause for concern. According to Ross *et al*. (2007), "Oil and gas producers also face considerable business interruption risks in the face of weather-related catastrophes. With $10 billion in insured losses in the wake of the 2005 hurricane season - including the destruction of 116 oil platforms and 56 more severely damaged by 2004–2005 hurricanes -134 offshore oil producers saw insurance price increases of up to 500% and considerable shrinkage of the insurance capacity available to pay for future losses".

This scenario of escalating primary climate change hazards and carbon constraints thus poses clear risks to insurers which remain exposed to the energy sector yet fail to account for expected increase in severe weather and industry regulation.

# Part C Securing Advantage in an Era of Climate Risk

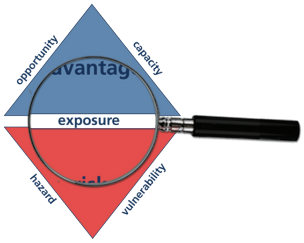
"The [insurance] industry is a 'sleeping giant' much bigger and potentially more powerful than the fossil-fuel industry in shaping the future through financial incentives and disincentives. The insurance industry has much to contribute…"

Crichton, 2005

Despite the many risks demonstrated in the previous section (Part B), insurers also have the potential to secure advantage in the face of climate change. According to Stewart and Fontaine (2007), "In the coming years, insurers who are able to project and respond to the likely effects (or lack thereof) of global warming will be at a significant competitive advantage".

Thus this part of the report investigates the Advantage Triangle - the 'upside' of the Climate Risk Diamond. In our investigation of how to secure advantage, we first touch on the ways that insurers are adjusting their exposures in response to climate change, then move on to investigate new opportunities presented by climate change. This is followed by a study of capacity: concrete examples of insurers increasing their know-how/expertise and using innovation to offer products which reduce their climate-related risk while assisting society to mitigate and adapt to climate change.

# 7 Exposure(ii): How insurers are responding to climate-related exposure




"What is insurable today has to be evaluated in this context of climate change and potential extreme weather risks. According to the new characteristics of weather events, insurers could potentially decide to limit the coverage of different risks and/or refuse to insure others".

Chemarin, 2007

Part B of the report finished with a discussion of the insurance industry's exposure to markets in locations and sectors susceptible to climate change hazards. We commence the next part of this report by again picking up exposure, this time within the context of the Advantage Triangle. How are insurers optimising exposure to reduce their risk and maximise advantage in relation to climate change?

When it comes to optimising exposure, insurers have essentially four courses of action available:

a. to reduce exposure in existing markets/locations; or
b. to maintain exposure in existing markets/locations; or
c. to increase exposure in existing markets/locations; and/or
d. to expand exposure into new markets created by society's needs and responses in the face of climate change.

This section describes how insurers are thus attempting to adjust their current exposures to reduce their climate-change related risk, and expanding into new markets to secure resilience and prosperity.

## 7.1 Reducing or eliminating exposures by withdrawing coverage

"In extreme cases, insurers may refuse to provide insurance at all if they cannot quantify the risks, or if they view the risks as too severe relative to the price levels they are allowed to set, although this option may not be available to them if markets are heavily regulated".

Reo Research, 2007

Here we examine a common but nonetheless rather extreme way for insurers to reduce climate risk in the face of escalating vulnerability in their current exposures: exiting the high-loss location(s) or sector(s).

The exit strategy is a growing trend in coastal exposures in the US, where insurance companies have withdrawn or ceased to renew policies in areas insurers consider to hold exacerbated risk from frequent extreme weather events. Indeed, according to the UNFCC (2007c), "the availability of insurance for climate hazards in coastal areas is decreasing".

According to the National Journal (2007), "Insurance commissioners nation wide [in the USA] are scrambling to keep insurers from using global warming and its effects as an excuse for abandoning their states". Yet in Florida, more than half a million homeowners in this state had lost private-sector insurance coverage in the two years prior to 2007 (Mills 2007a). The state has moved in to fill this void, by forming the Citizens Property Insurance Corporation of Florida (Chemarin 2007) to become the number-one residential insurance provider (Reo Research 2007). In Texas, Florida, the Carolinas, Rhode Island and Massachusetts, state governments are also becoming 'insurers of last resort', picking up exposures that private companies deem to be too risky (National Journal 2007; Mills *et al*. 2006a).

However, reducing exposure by withdrawing from a sector or regional market is clearly not the optimal strategy to reduce risk and maximise advantage in the face of climate change. While a logical response in some cases, it poses challenges of its own. It absents insurers from markets — and therefore from income. Furthermore, the ability to capture sales from emergent opportunities requires being active (ie exposed) in the associated markets.

Flight from markets also leaves insurers open to the 'captive-agent problem', in which their failure to provide homeowners' insurance causes them to lose customers in other insurance lines due to a consumer backlash (Reo Research 2007). Furthermore, according to Reo Research (2007), "insurers who exit a particular market run the risk of being locked out for the medium to long-term, even if the risk profile to that area changes". Reo Research (2007) note that few of the insurers taking this route appear to have weighed its medium to long-term risks, which include reduced market share and intensified competition in future from new entrants or government insurance providers.

Flight of private insurers from a market furthermore compels governments to fill the void for those who are no longer insured. However, governments at different levels have often displayed a reluctance to increase liability and insurance exposure in disaster relief scenarios. According to Mills (2003a), "This tension is a central dilemma facing society and policymakers in the face of rising catastrophe losses".

Government involvement in the insurance sector will sustain the insurability of Florida's coastal property. While this solution to the state's insurance crisis may prevent a political backlash from voters, it has the disadvantage of postponing accurate risk pricing, thereby sustaining complacency, mal-adaptation and even more development in risk-prone areas such as flood plains and coastal zones (IPCC 2001). Additionally, it is likely that costs will ultimately be pushed back onto consumers, because cash-strapped governments tend to limit their payouts (Mills 2005a). Finally, if insurers withdraw from markets they feel are too risky to insure, the unavailability of insurance could in turn have a chilling

## Box 11. Allstate reduces Florida exposure amid controversy

> "Florida is the poster child [of what happens] when you have the collapse of homeowners insurance".
>
> Mike Kreidler, Washington State Insurance Commissioner[30]

Allstate Floridian is Florida's third-largest provider of residential coverage. The company suffered US$2 billion in losses due to property damage claims from hurricanes in 2004 - one of the deadliest and costliest Atlantic hurricane seasons recorded. This eliminated all profits the company had earned since 1992, the year of Hurricane Andrew.

In 2006, Allstate applied to the Florida Office of Insurance Regulation to drop 95,000 homeowners' policies and completely abandon its commercial coverage for Florida small businesses. It stopped writing new policies. And to pay for claims in the 2006/7 season, it bought US$1.6 billion in reinsurance. The company also raised homeowner premiums.

Furthermore, after the 2004 and 2005 hurricane seasons confirmed the risk of higher exposure in East Coast markets, Allstate refused to renew or issue new policies in numerous coastal counties of other states in May 2006, again citing its excessive vulnerability in these exposures (Dowlatabadi and Cook, 2007). The insurer also implemented insurance premium hikes in some markets, and took advantage of regulatory loopholes to drop hail and wind coverage from homeowners in Louisiana who had been with the insurer for less than three years (Times-Picayune 2007).

According to Forbes.com, "Allstate has prospered by jettisoning money losers. That group includes people who live too close to the water". Allstate's withdrawal from these markets was widely publicised, and prompted an angry response from segments of the public and retaliatory action from some regulators (Forbes.com 2006).

30 As quoted in National Journal (2007).

effect on the property market and construction industry of a given area (Mills 2003a).

According to Reo Research (2007), "This is an undesirable outcome both for the insurance industry and for society, compared with the option of allowing pricing to reflect true risk levels".

The effect of property valuation decrease has been estimated in the UK. Work commissioned by the Royal Institute of Charters Surveyors (RICS 2004) indicates quite considerable impact from uninsurability due to the increased frequency of flooding events:

> "Existing policy holders located in Category 3 risk areas are facing the serious threat of substantial increases in premiums and / or insurance excesses. This will also have a knock on effect to the value of the property, with the possibility of up to 80% reduction in market value where properties become branded high risk and / or find it difficult to obtain insurance".

## 7.2 Sustaining exposures despite increasing climate risks

"Climate change is a challenge that companies will be confronting for a long time. They will need to find ways to change and to enhance their resilience in the face of the economic and physical challenges climate change poses".

Marsh, 2006

Some insurers faced with increasing climate change hazards in their exposures are using both traditional and innovative management strategies to remain in the affected markets. These may include finetuning their policies through pricing, exclusions and shifting deductible formations. For example, Lloyd's (2006a) suggests a cap on contents insurance would encourage policyholders to protect their more valuable property (eg putting electronic equipment out of reach of floodwater in homes located in zones at risk of flooding).

More innovative measures entail taking positive steps to 'climate-proof' exposures, for example, by improving the resilience of homes and businesses through some form of incentive to adapt to climate change. These strategies, discussed further in the 'Opportunity' and 'Capacity' sections, have the advantage of allowing insurers to retain exposure to markets now and in the future and as a bonus may even bring reputational benefits.

## 7.3 Increasing exposure to new markets

This section describes how underwriters are increasing their exposure in response to demand for insurance in new markets. First, we discuss the role of increasing primary climate change hazards in driving this trend, and then we move on to discuss new markets (ie new exposures) created for insurers by regulatory or technology change.

### Box 12. FM Global climate-proofs its exposure

> "For nearly two centuries, FM Global has believed that the majority of all loss is preventable".
>
> INTERCEP, 2006

Taking the view that it is better to prevent a loss rather than recover from one, US commercial and industrial property insurer FM Global works with each of its customers to determine specific threats and vulnerabilities to their facilities. It then makes tailored recommendations to reduce potential loss and business interruption (INTERCEP 2006).

The company's experience with the 2005 Hurricane Katrina emphasises the value of loss prevention. FM Global was one of the most profitable insurers following Katrina because its customers implemented nearly all the hurricane loss prevention methods the company recommended.

This reduced policyholders' losses to one sixth of what they would have been without these loss prevention methods. While the recommendations cost $2.3 million to implement, they avoided losses of US$480 million. This constitutes a 208-to-one payback in a single event.

FM Global illustrates that it is possible to remain exposed — and profitable — to markets subject to escalating climate-related hazards.

**New markets for weather and climate coverage:** Insurers may actually seek - or come under pressure – to increase their exposures in response to climate related hazards. According to Reo Research (2007), "Since climate change will result in extreme weather events affecting new geographic areas, insurers that can spot these shifts and provide appropriately-priced risk cover stand to unlock whole new markets. For example, communities farther inland are now in the market for wind cover associated with offshore hurricanes". In a similar way, new markets may form as hail patterns shift or intensify.

Yet another example of this trend is renewed calls for insurers to cover flood risk in response to recent floods. At present, the majority of insurers in Australia (and indeed in most other jurisdictions around the world) do not provide flood insurance to residential

customers due to issues surrounding flood map quality, or simply to avoid catastrophic exposures (UNEP-FI 2006). One exception is Zurich Financial Services Australia Ltd (Zurich Australia), which in an Australian first announced in 2008 that it will provide flood cover as standard to commercial customers (see Box 13).

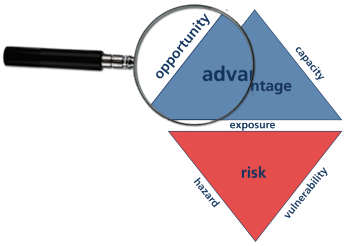
While the expected increase in primary climate change hazards would seem to offer considerable new markets - or potential for new coverage in existing markets - there are few examples as yet of insurers increasing their exposure in this manner. We speculate that this may be due to lack of information, including accurate risk mapping - as discussed earlier. Related to this is the actuarial challenge of resolving climate change risk and adequately pricing it, discussed above in the 'Vulnerability' section. Another possible factor could be competitive pressures, and the lack of public/customer awareness about the growing need for such insurance, again reflecting a shortfall of publicly available information mapping out climate change risks.

**New technology-related insurance markets:** Regulatory and technological change in response to climate change also creates new markets. Not only is there demand for new types of insurance for existing assets, there will also be demand for insurance for new technologies and the assets they produce (Mills 2007a). The emerging trade in carbon furthermore creates an entirely new market. As Ernst & Young (2008) note, these new markets will present new exposures that could secure considerable advantage:

> "The degree of repositioning will vary and will depend on the character of the company, but many firms are finding renewables and clean energy a profitable activity. Measures such as green-friendly tax regimes, carbon trading and carbon labeling on consumer products are, however, accelerating the movement".

Reo Research (2007) observes that exposure in these markets represents only a small percentage of insurance policies at present, despite the potential benefits. The associated opportunities, as well as concrete examples of the relevant insurance products being created, are discussed in the following sections.

## 8 Opportunity: Climate risk creates new opportunities for insurers




"Given that insurance is the world's largest economic sector, and that insurers reach virtually every consumer and business in developed countries, the prospect for their involvement in the development and promotion of climate change mitigation and adaptation strategies stands as an immense but as yet largely untapped opportunity".

Mills and Lecomte, 2006a

This section on opportunities examines how the global insurance industry can play a central role in increasing its own - and society's - resilience to climate change risks.

As awareness of climate change in society grows, new opportunities emerge. Consumers are more prepared to pay for products that address climate change hazards, and these changing attitudes are materialising in the form of demand for new or modified insurance products.

Indeed, insurers could play a vital role in a low-carbon economy that may, according to the Stern Review, eventually deliver as much as US$2.5 trillion a year in economic benefits (ie over the costs of climate change; Stern Review 2007). According to Epstein and Mills (2006), this can be a win-win proposition because, "Certain measures that integrate climate change mitigation and adaptation can simultaneously support insurers' solvency and profitability".

### 8.1 Opportunities to respond to primary climate change hazards

"Change brings opportunity. As insurers we will need to respond to our changing customers' needs through the creation of innovative solutions and the insurance of new risks and assets. These new insurance products and activities can enable us to tackle the causes of climate change as well as the rising weather-related losses".

Hawker, 2007

Here we investigate the opportunities for insurers to address the rising weather and climate-related hazards posed by climate change.

#### 8.1.1 Opportunities to improve risk resolution and pricing

Identification of hazards is a traditional core strength of insurers, and those best able to identify and track these hazards and improve their actuarial analysis have an opportunity to price risk more efficiently.

**Climate change opportunity:**

The term refers to the potential for an insurer to reduce climate-change-related risks, increase profitability and/or grow business by risk transfers, risk management, risk mitigation and provision of new products. For example, an insurer may recognise the increasing need for car retailers to deal with the risks of more severe hail storms .

Insurers also have an opportunity to use their expertise in weather and climate to engage in climate research and promote the use of science-based methods and modelling (Hawker 2007). This will not only improve insurers' resilience, but could also inform public policy discussions, assist wider society to become more climate-ready and provide accurate price signals to discourage investment in highly vulnerable zones (Reo Research 2007). Insurers who develop this expertise may also choose to take the opportunity to sell these services to others within and outside their sector.

### 8.1.2 Opportunity to improve disaster management

Given the expected rise in the frequency of weather-related natural disasters, prudent insurers would take up the opportunity to plan for more robust response systems for the customer demands of claims and repair processes that follow on from disasters (Reo Research 2007; see also related section under 'Vulnerability'). According to Hawker (2007), "It is at this time of extreme hardship where the insurance industry can show its real worth by helping our customers rebuild their communities".

Helping communities rebuild is thus an opportunity for the industry to increase its public standing (see Box 20). Planning for these scenarios would also provide an opportunity for insurers to avoid the escalation of material and labour costs that follow on from constrained supplies in disaster aftermath. Planning could further help address the excessive stress levels amongst insurers' staff and other human resource impacts, such as increased resignations, which may result from high workplace demands during such crisis situations.

### 8.1.3 Opportunity to facilitate society's adaptation

> "There are indeed huge incentives to develop innovative insurance products for reducing climate-related losses while trimming the emissions that cause global warming".
> Chemarin, 2007

Insurers that take up the opportunity to work with policyholders to increase these customers' resistance and resilience to primary climate change hazards (such as floods or extreme winds) stand to see reductions to property damage and insured losses, while sustaining and even enhancing premium incomes (see Box 12).

Insurers may do this by encouraging loss-reducing behaviour or by using the opportunity of rebuilding after a claim or a catastrophe to climate-proof property (Chemarin 2007; see 'Capacity' section). The growing number of green building developments also presents opportunities to transform a hazard (eg a building vulnerable to extreme weather) into an opportunity (climate-hazard-proofed building, which is also low in emissions).

In summary, Chemarin (2007) states that insurers increasingly realise that the proactive stance of physical risk reduction (ie reducing primary climate change hazards) is more profitable compared to the reactive approach of simply paying claims. Insurers are moreover uniquely positioned to assess the risks and advantages of such actions, in comparison to state intervention, particularly with regard to flood risk.

### 8.1.4 Opportunity to provide risk management services

Yet another important new market opportunity for insurers, as experts on risk, is to provide climate-risk management services. In addition to insurers, the insurance brokers which function as risk advisers to corporations are very well placed to seize this opportunity (Mills 2007a). Concrete examples of such services are discussed in the 'Capacity' section. Zurich Australia has piloted the 'Climate Ready' training of general insurance brokers.

### 8.1.5 Opportunity to provide coverage for primary hazards

Insurers have an important opportunity to help society adapt to climate and weather hazards. Above, we noted how insurers may choose to increase their exposure to markets or lines where primary climate change hazards - such as flood, wind or hail - are increasing. Indeed, such opportunities may increase as insurers become better able to resolve the climate and weather-related risks.

For example, flood liability is not mandatory in Australia and this risk is also poorly quantified (IPCC 2007b). However, new flood risk mapping information may create more opportunities to cover this risk. One development in this regard is a joint CSIRO/Sydney Coastal Councils Group vulnerability assessment released in April 2008. The assessment uses climate change projections and socio-economic data to map vulnerability to five climate change impacts (see Figure 22).

Providing such flood cover is also an opportunity to improve insurers' reputational standing. Consumers often mistakenly believe they are covered for flood (ASIC 2000). And because this type of damage has a potentially devastating impact, clarifying and/or covering for flood offers an opportunity for insurers to avoid conflict with clients.

Other coverage previously shunned in the built environment may also present new opportunities. For example, insurers whose customers undertake appropriate risk management may be able to insure for mould and moisture risk - an area the industry has traditionally avoided. Many of these problems are a legacy of poor design of energy-related systems. According to Mills (2007a), "By making a previously uninsurable risk insurable, insurers open a large new market for themselves while also benefiting consumers".

"By making a previously uninsurable risk insurable, insurers open a large new market for themselves while also benefiting consumers."

### Box 13. Zurich Australia provides 'first of kind' flood cover

> "Zurich Australia prides itself on being proactive in managing emerging risks, particularly those brought on by climate change, and identifying new opportunities that may arise from these changing market conditions".
>
> Zurich Australia, 2008

Like many other countries, Australia has a lack of readily available flood cover, and this shortfall already poses a serious reputational risk for the industry. Under climate change, the incidence of flood is expected to increase. A strong supporter of recent efforts by the insurance industry to highlight the need for flood cover, Zurich Australia has gone one step further.

Recognising the benefits of taking a proactive stance toward managing emergent climate risk and seizing the related opportunities, Zurich Australia is taking a leadership role on the flood cover issue. In a first of its kind, Zurich Australia will provide flood cover automatically for its commercial customers by the end of 2008.

According to Zurich Australia, "Despite the current unavailability of detailed three-dimensional flood mapping, Zurich Australia has decided to move ahead of the industry and provide flood cover for our commercial clients. This is in part as a catalyst for the rest of the industry, as well as acting on our belief that it is the industry's role to address this current and contentious gap in the insurance market"[31].

31 Excerpted from Zurich Australia's submission in April 2008 to the Garnaut Commission.

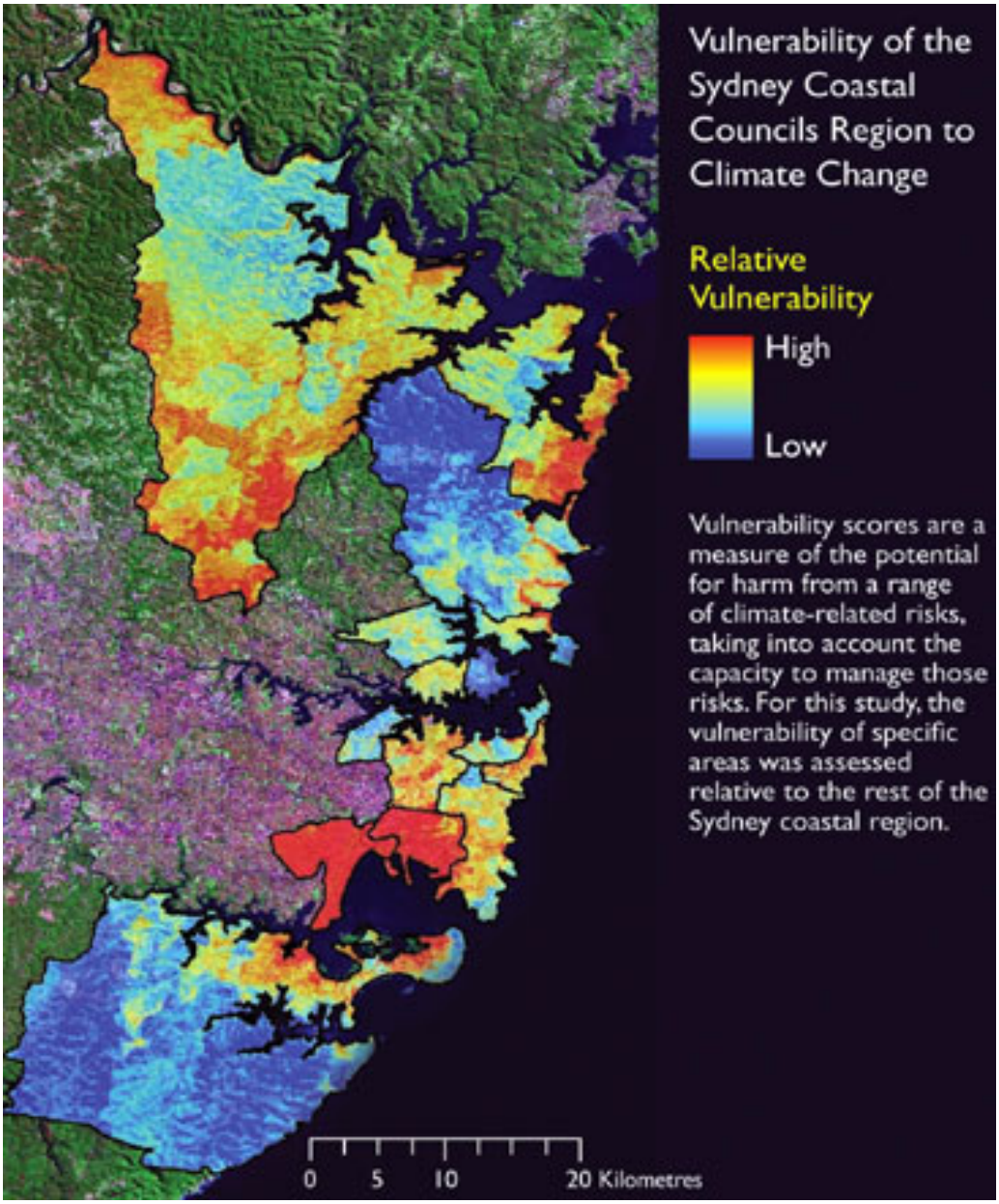



Figure 22. A new flood risk mapping initiative by CSIRO/Sydney Coastal Councils Group uses climate change projections and socio-economic data to map vulnerability to five climate change impacts (Preston *et al.* 2008).

## 8.2 Insurance opportunities arising from secondary hazards

"We can expect a future of carbon labeling on products, carbon trading worldwide, and tight regulation and heavy taxes on carbon. Companies must make a fundamental decision about where they want to be in the new carbon economy".

Ernst & Young 2008b

Here we examine opportunities that may arise out of new and evolving regulations and policies to address GHG emissions and the related technologies/ systems they are driving.

Insurers have a long history of promoting auto, fire and consumer product safety. Building on this experience, insurers could play a vital role in bringing new technologies to the market that would help meet regulatory requirements to cut GHG emissions, some of which may simultaneously increase customers' resilience to primary climate change hazards (Mills 2007a).

There are important opportunities for insurers who can capitalise on these regulations and technologies. According to Reo Research (2007), "climate change will impact large sectors of the economy in varying ways from high-emitting oil companies to highly efficient environmental service providers. Insurers that understand the changing risk profiles of their clients will be better able to weather the effects of climate change across the economy".

### 8.2.1 Opportunities for insurers in low emission technology

"In 2004, we saw US$27 billion invested in clean energy worldwide. I thought it would take until 2014 to see US$100 billion per year being invested. In 2006, we tracked US$71 billion. We now expect to hit US$100 billion by 2009".

Michael Liebreich, CEO, New Energy Finance, 2007[32]

**Overview of clean tech opportunities:** Insurers and their clients have the opportunity to spur the development of new low-carbon technologies through new policies and products. As noted by Epstein and Mills (2006), insurers can play a part similar to their facilitative role in the construction of skyscrapers last century, at which time they provided insurance only to those buildings that installed sprinkler systems for fire management. Insurers can also facilitate the entry of investors into these new low-carbon markets by creating insurance products which take on some of the perceived risk, helping overcome this barrier to capital.

The level of opportunity for insurers vis-à-vis the new technologies being harnessed in response to climate change varies: it ranges from the fairly well-established and insurable (wind

32 Quoted in: Climate Group 2007.

power installations); to the uninsurable (nuclear power stations) and the unproven (carbon capture and storage for coal power plants).

Signalling the extent of opportunity in some of these emerging markets, Clean Edge (2008) found that revenue in 2007 for four benchmark clean-energy technologies – biofuels, wind power, solar photovoltaics and fuels cells – grew 40% over 2006 figures to US$77.3 billion, and are expected to achieve revenues totalling US$254.5 billion within a decade. Clean technology is also the fastest-growing sector in venture capital and private equity investment (Climate Group 2007).

According to the UNFCCC (2007a), "The renewable energy target in the EU has marked the growth of many low carbon technologies…There has be [sic] great optimism among insurers to provide conventional and innovative insurance risk coverage options for these existing and emerging mitigation technologies". Insurers which move quickly to provide coverage for these new industries stand to seize the first-mover advantage (Reo Research 2007).

Decentralisation is another characteristic of many low and zero-emission energy technologies. These range from cogeneration facilities in city buildings, through large grid connected renewable energy plants on agricultural land, down to solar panels on many thousands of homes. This presents a major shift in the physical make-up of the energy system, making it likely that insurers will increasingly be required to move from a handful of major policies for large power plants, to dozens or even hundreds of policies for smaller renewable energy installations. The continued uptake by consumers of renewable energy technology, such as rooftop solar power, will further serve to decentralise and transform the structure of energy production.

As for carbon capture and storage, this technology presents unique impacts and liability in terms of carbon dioxide leakage, technology risks and intergenerational liability (UNFCCC 2007a). Insurers have taken the view that governments or the owners of the carbon dioxide in the storage sites should assume long-term liability exposures after five years. In Australia, the fossil-fuel industry position is that the government should assume liability for any leakage (DITR 2004). Future regulatory structures for this new technology will greatly affect potential opportunities for related insurance products (UNFCCC 2007a). However, at the same time, such regulation could be informed by insurance industry views on the options available to handle these liabilities.

**Energy efficiency opportunities:**

"The ESI [Energy Savings Insurance] industry is clearly in its infancy, yet has considerable upside potential".

Mills, 2003b

Energy efficiency is a large-scale and cost-effective way to reduce energy use and significantly lower global GHG emissions. A study by Australian federal and state governments found that today's technologies could slash Australia's residential, commercial and manufacturing energy use by 20-30%, while providing a $1.8 billion economic boost and creating 9,000 new jobs[33] (NFEE 2003).

Globally, the expected tightening regulatory environment for GHG emissions in many countries will provide incentives to reduce the use of cheap but greenhouse-intensive coal power. In many jurisdictions, cost-effective energy efficiency opportunities will be the first to be seized as they constitute 'low-hanging fruit'.

In several countries, this potential is already being realised. In the UK, residential energy-efficiency measures averted the generation of 28 million tonnes of $CO_2$ emissions per year. This is almost as much as the combined emissions of all UK coal-fired power stations (Climate Group 2007).

The energy services industry, which implements these efficiency gains, is already a multi-billion dollar global sector, despite its relatively nascent state, with a potential US$1 billion market in terms of premiums in the US alone (Mills 2007b). It consists mainly of private companies that provide customers with efficiency or load reduction services for a fee, sometimes in conjunction with third-party financing paid back through energy savings (WEEA 1999).

However, these energy services companies (ESCOs) face important risks, such as uncertainty or potential disputes over attaining projected energy savings. This risk translates into opportunities for insurers. Mills (2003b) notes that financial methods to manage risk in this sector are relatively underdeveloped, and that ESCOs often lack appropriate insurance coverage. This coverage is crucial in North America, where governments commissioning energy-savings projects for their assets require energy services insurance, or performance and payment bonds to guarantee energy savings (Mills 2007a). By providing such cover, insurers will also have an opportunity to transfer and spread risk over a wider pool of projects, thereby reducing the barriers to smaller energy services firms that cannot self-insure for this risk.

Mills (2003b) notes that properly applied energy savings insurance also provides an opportunity to reduce energy-savings project cost by reducing lenders' interest rates. It could even encourage those implementing such projects to go beyond standard measures. For example, as proponents of energy savings measurement and verification techniques, insurers could provide an incentive for ESCOs to exceed standard measures and achieve greater energy savings (Mills 2003b). The relevant insurance products are discussed in the next section (see 'Capacity').

33. Accessing these benefits would cost $12.4 billion over 12 years, generating energy savings of approximately $26.9 billion and achieving a 26% internal rate of return on investment.

**Renewable energy opportunities:**

"Encouraged by the increasing traction of international climate change policy, the financial services industry has got behind renewable energy and clean technology in a big way".

The Climate Group, 2007

The rapid average annual growth rates of renewable energy over the 2000-2005 period — 29.1% for solar photovoltaic, 26% for wind and 17.1% biofuels — stand in sharp contrast to the far slower growth rates of conventional energy sources: 4.4% for coal, 2.5% for natural gas and 1.1% for nuclear (Climate Group 2007). According to a survey of the insurance market by Marsh (2006b), "Onshore wind, energy from waste, offshore wind and small-scale hydro are perceived by respondents to offer the greatest future business opportunities for (re) insurers". Of all renewable energy investment, wind power has seen the largest growth in recent years (UNEP-FI 2007). As for the solar sector, its global market capitalisation almost quadrupled from US$6 billion in 2005 to US$22 billion by the end of 2006.

Renewable energy, in conjunction with energy efficiency, also provides opportunities to address the growing insurance risk associated with electricity reliability. This can reduce the impact of power outages, which result in significant business interruption and property damage. Renewable energy can play a role in backup power for the provision for emergency shelters, water purification, fuel pumps and safety lighting (Mills 2003a).

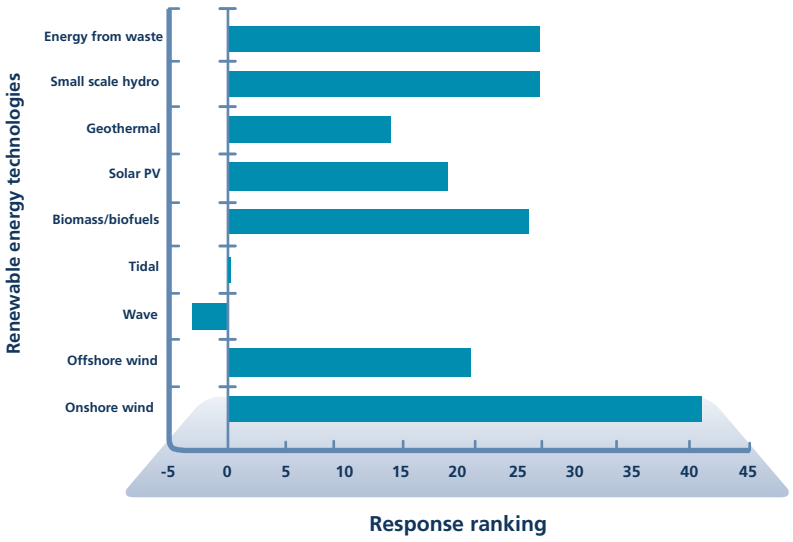



Figure 23. Marsh's (2006b) survey reveals that insurers rank onshore wind as the renewable energy technology with greatest future business potential; wave and tidal energy were the least favoured, reflecting the fact that they are highly prototypical and not yet at a stage of development that warrants consideration from insurers.

### Box 14. Opportunity in the wind

> "Wind power is far and away the leader in the renewable energy market".
>
> Marsh, 2006a

Half of the world's global renewable capacity is wind power. According to the Climate Group (2007), total installed wind capacity almost doubled between 2002 and 2005 - to 59.3 GW. This figure is set to quadruple by 2012 to 200GW - sufficient to provide enough power for half the homes in the EU. New wind equipment installed in 2006 alone was valued at US$23 billion.

In Australia, which has excellent wind resources by world standards, the domestic wind energy industry had enough installed capacity in 2006 (817 MW) to power 350,000 homes. An expanded national Renewable Energy Target of 45,000 GWh by 2020 is providing the industry with a further boost. Given wind power's affordability, it is likely to fill the lion's share of the target.

Globally, insurers are already seizing the new opportunities from wind power by providing both new and traditional forms of insurance products. Some firms are even making direct investments in wind; Australia's Allianz Group has pledged hundreds of millions of dollars worth of investments in new wind installations.

Marsh (2006b) finds that although the prototypical nature of the renewable energy industry causes unease amongst underwriters (see 'Vulnerability' section), all insurers interviewed saw insurance for this sector as a growth area. The increasing commercialisation of these technologies, along with greater provisioning of manufacturer warranties and guarantees, may be helping to reduce this perceived vulnerability (Marsh 2006b). Furthermore, the growth of insurance products for such projects would, in turn, create the opportunity for more companies and investors to participate in renewable energy development (Mills 2007a).

#### 8.2.2 Carbon market opportunities for insurers

> "Markets for carbon emissions are likewise growing rapidly. Insurers can, for instance, protect companies against swings in the price of European emissions allowances, or provide insurance that covers the delivery of clean development mechanism (CDM) projects in developing countries".
>
> Reo Research, 2007

Products related to the new carbon market, as insurable assets, present a new opportunity. According to Mills (2007a), "combined expertise in risk analysis and finance makes insurers natural participants in the emerging markets for carbon offsets and trading. A growing number of insurers are moving into these business areas, and the opportunity will be large as increasingly aggressive carbon regulation is adopted around the world".

**Carbon trading opportunities:** At the end of 2007, the rapidly growing global carbon-trading market was worth 40 billion Euros (US$62 billion; up 80% from 2006 values) and could reach US$3.1 trillion dollars by 2020 (Point Carbon 2008a). The lion's share of the trading involves the EU, which accounted for 70% of the market's 2007 financial value (Point Carbon 2008b).

As the largest regional carbon market, the EU emissions trading scheme (ETS) involves more than 12,000 individual facilities (Marsh 2006a). By March 2007, 57 carbon funds were in existence, with a total of US$8.5 billion under management.

Although the first carbon fund was set up by the World Bank in 2000, New York and London are now the main carbon fund hubs, with these financial centres being the base for two-thirds of carbon fund managers (Climate Group 2007).

According to Marsh (2006a), "Both CDM and JI mechanisms represent a significant growth area for meeting Kyoto targets and for new investment opportunities." However, one obstacle for such emissions reduction projects — the possible non-delivery of credits due to factors such project insolvency — is translating into an opportunity by insurers, through products such as credit-delivery guarantees (Marsh 2006a). Seeing this opportunity to enter an expanding and potentially vast new sector while facilitating its growth, insurers are already offering a range of new products to allow participants in the carbon trading market to better manage risks and barriers. These products are discussed further in the 'Capacity' section.

**Voluntary carbon offset opportunities for insurers:** The separate, but related, market of voluntary carbon offset schemes, which allow companies or individuals to offset their GHG emissions on a voluntary basis, could account for 400 million tonnes of $CO_2$ by 2010 according to the World Bank (cited by The Guardian 2007). As noted in the 'Hazards' section, there is a risk that offsets, which companies tend to view as assets, could actually constitute liabilities (Climate Risk 2008b). However, the lack of an acceptable standard for this industry could present an opportunity for insurers, who gain full disclosure of the risks entailed, to respond to the likely need for increased D&O coverage in this area. Furthermore, products that are founded on a scientifically rigorous understanding of climate change and GHG emissions can be expected to meet any future regulations and standards.

**Opportunities in forest carbon 'sinks':** Another potential niche associated with carbon markets relates to the

forestry sector; trees act as 'sinks' for carbon because they absorb carbon dioxide as they grow. Thus, planting them can provide for a form of carbon offset. According to the UNFCCC (2007a), the sector represents a considerable opportunity for insurers. The requirement of long-term stability of forest carbon sinks over intergenerational periods provides an excellent entry point for insurers to provide the security that a seller of such products cannot.

This opportunity is hampered by technical issues that include lack of insurance sector expertise in the forestry sector and lower demand for forest-related carbon credits due to issues such as permanence. However, some technical barriers to insuring forestry projects could be overcome with remote sensing technology and GIS tools.

It must be noted however that insuring carbon sinks is in fact very different from insuring conventional plantations. The risk that climate chnage may undermine forest health is quite real, meaning a supposed sink may become a source of carbon release into the atmosphere.

### 8.2.3 Opportunities for insurers in the built environment

We have already discussed how regulatory responses (or lack thereof) to climate risks in the built environment can create vulnerabilities for insurers. Here we concentrate on the opportunities for insurers associated with reducing both their own and their customers' risks in the built environment sector.

Insurers see building codes and planning regulation as an important opportunity to reduce climate change hazards, and they are calling for stricter controls (Friedman 2007). Building standards targeting energy consumption also present a key opportunity for emissions reductions since buildings account for roughly one-third of energy use globally; increased energy efficiency could cut global carbon emissions by 1 Gt by 2050 (Climate Group 2007). New regulation that promotes adoption of efficiency standards and renewable energy technologies, such as solar photovoltaic systems, also increases the capital value of buildings; this essentially creates new assets to insure, thus providing insurers with an opportunity to increase the value of their markets.

As well as providing health and economic benefits, such as improved indoor air quality and reduced employee absenteeism due to illness, 'green' buildings that have their own power sources (eg solar or wind power), and/or possibly even onsite power storage, can also provide an opportunity to reduce costs of business interruption and business loss during grid-power outage (eg through preventing loss of refrigeration).

Energy efficiency can also provide many other benefits: energy-efficient windows can reduce the risk of breakage due to fire, windstorms or even due to theft; energy-efficient lighting can reduce fire hazard; and insulated

> Appropriate approaches to regulation, particularly in land use planning and zoning decisions, will improve insurability ... and minimise pressures for the expansion of this role [as insurers of last resort] for government.
>
> Garnaut (2008)

concrete-form building envelopes have greater resistance to flying debris and even possible benefits in the case of fire due to reduced infiltration (Mills 2003a). Epstein and Mills (2006) give the example of a US$1,000 roof treatment that decreases heat gain and lowers the risk of heat-related illness and mortality, while resulting in US$200 per year in energy savings.

Green buildings are increasingly seen as a key element to achieving the 'triple bottom line' goal of economic, environmental and social sustainability. US developers expect 20% of their portfolios to be green buildings by 2012 (Green 2006; Mattson-Teig 2007), while Mills (2007a) reports that US residential green building will be a US$40-50 billion market by 2010. Meanwhile, recent research by the Association of British Insurers revealed more than a third of people in the UK are interested in switching their home insurance to a climate-proof policy (ABI 2007).

One illustration of the climate-proofing opportunities of green buildings is the US Virgin Islands Harmony Resort, an off-the-grid eco-tourism destination. It withstood successive hurricanes without any interruption to its solar power and hot water, although other facilities on the islands were disrupted for weeks (Mills 2007a). The resort shows how buildings that generate their own power or heat can endure natural hazards without the costs that power outages impose on their non-green counterparts - benefits that can flow on to insurers.

This explains why insurers around the world are beginning to acknowledge and reward customers who have more sustainable and resilient buildings with new insurance products, discussed further below (see the 'Capacity' section).

Turning to the topic of sustainable urban planning, we find another opportunity to reduce insured losses while saving energy. For example, increasing the number of planted trees and lightening the colour of roads and buildings reduces the urban heat island effect and the potential for extreme heat and urban smog. These measures can cut airconditioning use by 40-60%, while reducing health-related impacts of extreme heat and smog (Mills 2003a).

### 8.2.4 Transport sector opportunities for insurers

As noted previously, many jurisdictions are providing incentives for lower-emission vehicles or measures to achieve a shift away from automobile use. The green vehicle market is growing quickly; by 2010, one million hybrid cars will be sold globally, 7.5 million by 2020. In the US, the biggest market for hybrids, Toyota expects hybrids to account for 20% of all its car sales by 2012 (Climate Group 2007).

Entering the growing market for green vehicles and other types of 'eco-insurance' creates an opportunity for insurance providers to distinguish their products from competitors without relying on price, and it could give them a competitive edge in the motor market

(Marketwatch 2007). Furthermore, some insurers also see an opportunity in the connection between consumers who choose environmentally-friendly products and risk-averse behaviour, according to Mills (2007a), ie a correlation between fuel economy, environmental protection and safe driving.

### 8.2.5 Appliance evolution creates new opportunities

New, more efficient appliances present a considerable opportunity to reduce emissions and bring consumer savings. In the US, an estimated two billion Energy-Star labelled products have saved consumers a total of US$84 billion in energy costs (Climate Group). Providing coverage tailored for the growing market in energy-efficient appliances offers insurers with another opportunity to distinguish themselves from their competition. In addition, while energy-efficient products are generally less costly to operate, their purchase prices may be higher; this provides insurers with an opportunity to increase the value of their markets.

## 8.3 Opportunities arising from tertiary hazards

Climate change does not act in isolation, but alongside other global challenges.

Accounting for society's response to climate change is challenging. However, insurers able to resolve and plan for complex risk will have a competitive advantage. For example, insurers have been encouraged by the Association of British Insurers (2005) to examine how "socio-economic factors could exacerbate or alleviate the effects of climate change on costs of extreme weather".

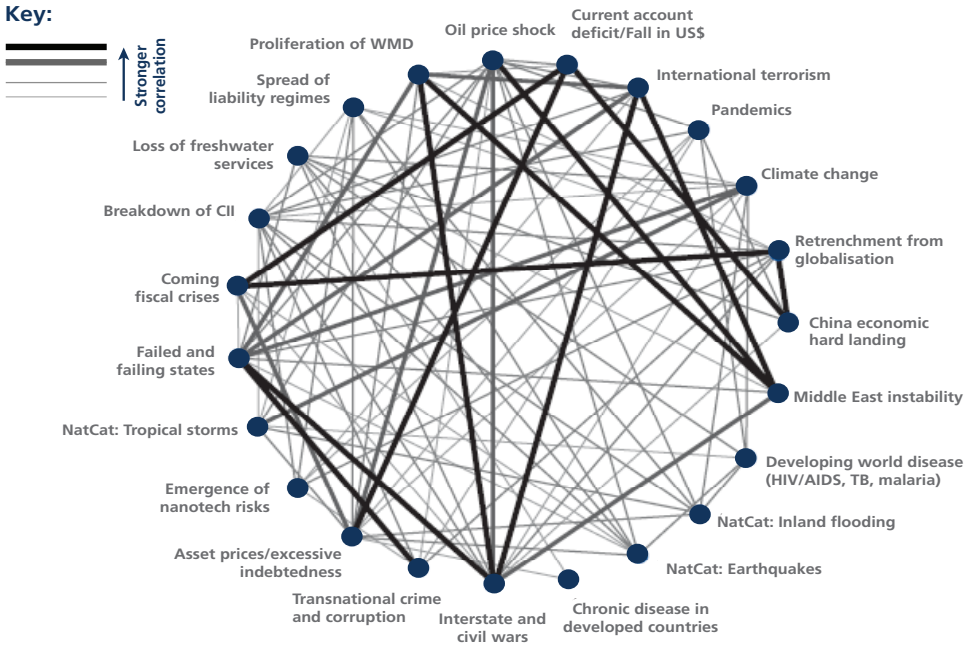
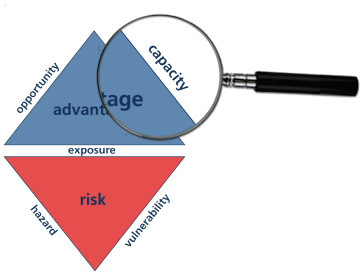



Figure 24. Resolving risk interconnectedness. Climate change does not act in isolation and must be considered along with other global challenges (World Economic Forum 2007).

# 9 Capacity: Increasing insurers' capacity to address climate change




"To us, risk is our comfort zone, it's why we're in business, and it's what we specialise in. If we don't step up and do what we can to address the risks associated with perhaps the greatest risk facing the future of our planet then we are abdicating our role in society".

James J Schiro, Chief Executive Officer, Zurich Financial Services Group, January 2008

It is one thing to identify an opportunity and quite another to have the capacity to seize it. As the advantage triangle implies, for insurers to realise an advantage they must: have exposure to the relevant market; see the opportunity within that market; and use their capacity to tap that opportunity.

This section aims to provide concrete demonstrations of how insurers can increase their capacity to address climate change. This includes specific general insurance products or services to tap new or evolving markets, as well as measures for insurers to climate-proof their current business lines and increase society's resilience to climate change hazards.

## 9.1 Global overview of insurers' capacity

"Beyond higher claims, though, climate change will affect the very foundations of the insurance industry, including how it is regulated, what kinds of capital requirements are in place, and how it evaluates and prices underlying risk. The sector needs to prepare itself for these fundamental changes".

Reo Research, 2007

As we discussed in the 'Vulnerability' section, the current capacity of the global insurance industry to deal with climate risk is rather low; thus far, only a small minority of insurers have taken concrete action to address climate-change related risk (Dlugolecki 2008; Phelan and Taplin 2007; UNEP-FI 2006).

We have also noted that the insurance industry is highly heterogeneous, and this diversity is reflected in the varying response to climate change across nations and regions. Despite some notable exceptions, European insurers have taken earlier and more aggressive action than US firms (Reo Research 2007; National Journal 2007), likely reflective of deep divisions in the US about whether climate change is really happening (Lloyd's 2006b). Even within Europe, different responses to capacity

**Climate change capacity:** This describes the actual policies, product lines, know-how, methods and measures used by insurers to tap new markets emerging in response to climate-change-related events or actions or, alternatively, to achieve resistance or resilience to climate change risks in current markets. For example, the insurer can not only provide increased levels of cover for hail storm damage but also a reduced excess for car yards that erect hail-proof roofs for their outdoor vehicle displays.

building may be evident. For example, in the UK, which has a private insurance market for weather risks, insurers have focussed their efforts on climate change adaptation for some time; this is not the case in France where the state, as an insurer of last report, offers an unlimited guarantee for coverage (Chemarin 2008).

Although the proportion of insurers acting may be a minority (see Figure 25), the capacity of the industry to address climate change is now growing rapidly from this small base. Mills' survey of insurance industry responses to climate change across 26 countries in 2007 found double the number of activities versus their results 14 months earlier;

**Box 15. Zurich expands capacity with global climate initiative**

In January 2008, Zurich Financial Services Group launched a global Climate Initiative, aiming to become a leader in the identification and management of climate-related risks. The initiative will also prepare Zurich to take meaningful and sustainable steps to manage its carbon footprint (Zurich 2008a).

The initiative will establish a consistent and focused approach to this risk class globally, and it will facilitate economic and policy-oriented research that can then be integrated into the Group's product development activities. As part of this effort, Zurich has established an internal Climate Office that's charged with driving an understanding of climate-related risks across its businesses.

Zurich has also established a Climate Change Advisory Council of internal functional leaders and external advisers, who directly report to Zurich's Group Management on strategic and operational issues associated with climate change. In addition to former British Prime Minister Tony Blair, who in April 2008 commenced advising Zurich on climate change as well as other matters, advisers include two high-profile climate change policy experts: former US Congressman Sherwood Boehlert; and Ernst Ulrich von Weizsäcker, the Dean of the Donald Bren School of Environmental Science and Management at the University of California in the US.

Finally, Zurich is launching an applied climate change research program with organisations and institutions to examine critical economic, finance and policy issues. This will begin with funding of a distinguished visitors program at Dean von Weizsäcker's Bren School. The school will also assess Zurich's carbon footprint and help the company to develop an approach to manage carbon emissions in a sustainable manner.

and 15 times the number of responses compared to their 1999 compilation (Mills 2007a). Munich Re has shown an interest in climate change since the 70s, while some reinsurers and large insurers (Swiss Re, Storebrand and Lloyd's of London) have taken part in public policy discussions of climate change since at least 1995 (Mills 2007a).

The most prominent recent insurance industry effort to address climate risk is the ClimateWise strategy. An action by 38 leading insurance companies, including Zurich (UK), it recognises that some aspects of climate risk cannot be tackled by single companies acting alone, and it aims to build a framework to help insurers factor climate change into their business operations (ClimateWise 2007).

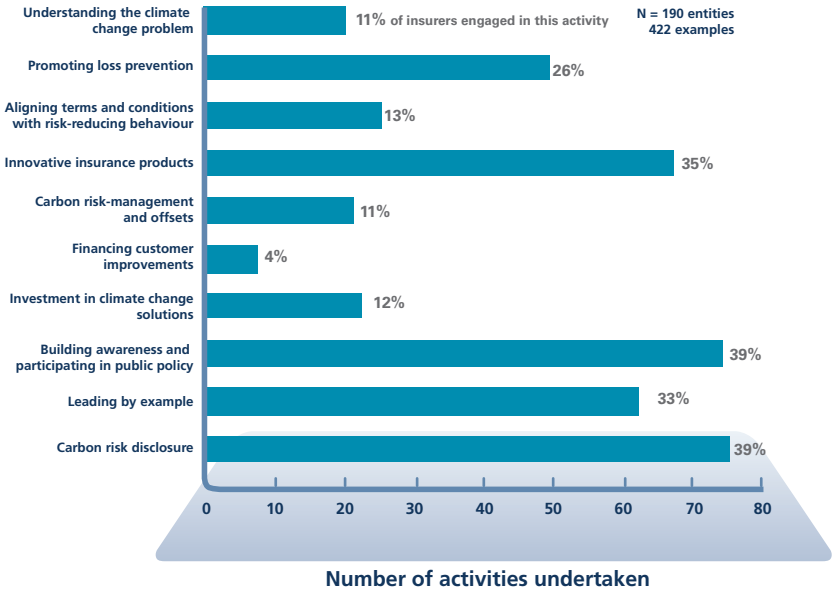



Figure 25. Mills' (2007a) survey of insurer actions to address climate change finds that "only about one in ten of the insurers in our compilation are working in a visible way on contributing to understanding the mechanics and implications of climate change, with a similarly small proportion incorporating these considerations into asset management. A third are offering innovative products and services, and only four in ten have disclosed climate risks to shareholders. Insurers engaging in the policy discussion of climate change, or leading by example through energy and carbon management in their own operations, remain in the minority."

## 9.2 Avoiding losses

### 9.2.1 Increasing capacity by building awareness

"The process of change will not be easy, and for some it will be painful. But the earlier the sector responds to the changes that climate change will inevitably bring, the lower the costs will be, both to the insurance industry and to society as a whole".

Reo Research, 2007

Here we discuss how insurers are increasing their capacity to tackle climate risk both in their operations and by building awareness amongst their customers. Key steps for insurers include analysing the implications of climate change on business and investments, sharing this analysis with shareholders, and making greater use of risk management (Mills *et al*. 2006b).

Taking steps to increase information on climate risk, both internally to staff and to the public, is also important. Indeed, the ability of the industry to gain traction will in turn depend on the greater adaptive capacity and awareness in the general community. For example, if insurers are to successfully offer new products which address climate change, their success will depend to some extent on the public's awareness of the value of such products.

Such steps should cover climate change risks and adaptation, as well as emissions mitigation. Mills (2007a) cites numerous examples, including energy efficiency guidebooks for customers, educational materials for school curricula, websites and web-based tools such as carbon calculators, 'property climate-proofing' courses for policyholders and advertising in insurance trade journals to educate those within the sector.

Some insurers are also beginning to dedicate specific staff resources to climate change (see Figure 27). Zurich Financial Services Group has launched a global Climate Initiative and has established an internal Climate Office (see Box 15). Axa has created a 'Climate Core Group' task force within its Group Risk Management division, led by a Group Senior Vice President, and the company has appointed a full-time Climate Change Director (Reo Research 2007). Others, including Swiss Re, are embedding climate change into their strategies as an issue of top importance.

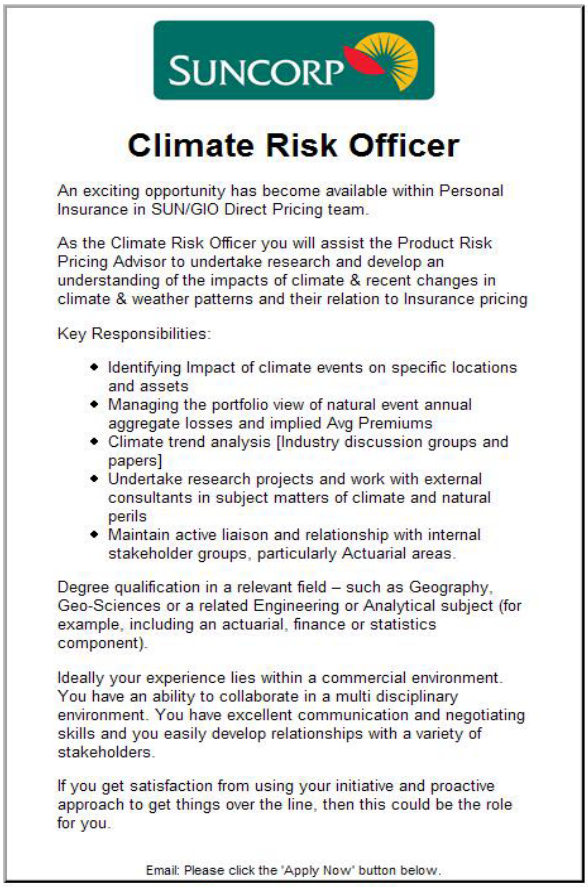
## Box 16. Increasing capacity to reduce insurance sector emissions

Because insurance company activities generate GHG emissions through, for example, real estate holdings and travel, the change that can be made if insurers lead by example is not insignificant. For example, the 20 insurers reporting to the Carbon Disclosure Project had emissions of four million tonnes of carbon dioxide per year for a total of 1.3 million employees. Some, such as IAG, Swiss Re and Folksam (Sweden), aim to become carbon neutral by 2012, while others (Aviva, Royal & Sun Alliance, Fortis, HSBC and FP Marine) have already done so. Actions being taken include: energy efficiency and uptake of renewable energy; purchase of carbon offsets; sustainability progress reports; occupying green buildings; and employee incentives and corporate responsibility training (Mills 2007a).

Figure 26. ANZ's new 'green' headquarters, scheduled for completion in 2009 in Melbourne's Docklands precinct, "will reflect ANZ's commitment to reduce its environmental impact." To be Australia's largest single-tenanted office building, it will have its own wind turbines and solar power, stormwater re-use and cooling with river water (ANZ undated).

In particular, 'full and frank' disclosure of carbon-related risk and strategies is a key step to allow an insurer to assess and increase its capacity to address climate risk, and to assist consumer, investor and regulator assessment of insurance companies.

However, while Reo Research (2007) suggests companies should give an account in their annual report of any foreseeable material risks or liabilities associated with climate change, it found that only three out of five insurers referred even briefly to climate change in these reports, while Mills (2007a) reports that only four out of ten insurers disclose climate risks to shareholders. Indeed, when it comes to reporting to its regulators, "The insurance sector has the poorest record on climate disclosure of any industry sector in the United States" (Mills 2007a).



SUNCORP

**Climate Risk Officer**

An exciting opportunity has become available within Personal Insurance in SUN/GIO Direct Pricing team.

As the Climate Risk Officer you will assist the Product Risk Pricing Advisor to undertake research and develop an understanding of the impacts of climate & recent changes in climate & weather patterns and their relation to Insurance pricing

Key Responsibilities:

- Identifying Impact of climate events on specific locations and assets
- Managing the portfolio view of natural event annual aggregate losses and implied Avg Premiums
- Climate trend analysis [Industry discussion groups and papers]
- Undertake research projects and work with external consultants in subject matters of climate and natural perils
- Maintain active liaison and relationship with internal stakeholder groups, particularly Actuarial areas.

Degree qualification in a relevant field – such as Geography, Geo-Sciences or a related Engineering or Analytical subject (for example, including an actuarial, finance or statistics component).

Ideally your experience lies within a commercial environment. You have an ability to collaborate in a multi disciplinary environment. You have excellent communication and negotiating skills and you easily develop relationships with a variety of stakeholders.

If you get satisfaction from using your initiative and proactive approach to get things over the line, then this could be the role for you.

Email: Please click the 'Apply Now' button below.

Figure 27. Early evidence of a new paradigm? A recent Suncorp advertisement on seek.com.au for a Climate Risk Officer to "understand the impacts of climate change . . . and their relation to insurance pricing" (seek.com.au 2008).

The advertisement indicates that the insurer considers climate change risks to be an issue of sufficient concern to warrant specialised staff who can embed climate risks into premium pricing. (Source: www.seek.com.au)

### 9.2.2 Increasing insurers' capacity to identify primary hazards

"The first obstacle is that adapting the historically-based catastrophe models to take climate science into account is a complex and time-consuming task, particularly as climate change science does not give precise answers as to exactly how and when extreme weather patterns will change".

Reo Research, 2007

We have discussed how the challenge of resolving climate change risk poses major problems for insurers and how better risk resolution could bring opportunities. Here we examine concrete steps being taken by insurers to increase their capacity in this regard.

Adapting to future risk entails recognising that climate activity will significantly depart from the long-term baseline (RMS 2005). To manage price risk, insurers must integrate climate change into catastrophe modelling and shift from backward-looking models to the forward-looking models used by climate scientists (Mills 2007a ).

"To manage price risk, insurers must integrate climate change into catastrophe modelling and shift from backward-looking models to the forward-looking models used by climate scientists."

While the Association of British Insurers (2005) notes that more sophisticated use of models, better data and computing capacity has enabled the development of more realistic scenarios, other commentators state that this task is complex, time-consuming and incomplete, which means that pricing for climate-change risk remains "an aspiration rather than a reality" according to Reo Research (2007). This appears to be an area where capacity building is lagging, as Mills' (2007a) survey of insurer actions found that only one in ten were visibly working to understand these issues[34].

Yet identification of hazards is traditionally a core strength of insurers. To increase their capacity to identify climate hazards, ClimateWise (2007) recommends that insurers: study climate change research, understand and analyse associated risks; commission research; and establish partnerships with experts to share knowledge. Some of their specific recommendations include: the regular reviewing and updating of tools and models to track changing weather patterns; testing extant models for new catastrophe patterns; collaboration with scientists to better resolve changing climate conditions, along with their economic implications; and development of accurate flood mapping tools (ClimateWise 2007).

Toward this goal, the Association of British Insurers and Swiss Re have integrated climate models with insurance loss models to produce estimates of future insurance losses and estimates of required risk capital (Mills 2007a; ABI 2005). Insurers are also working directly with researchers (see Box 17). These include Arkwright Mutual Insurance Company (now part of US-based FM Global), Munich Re, AIG, Lloyd's of London, the Insurance Information Institute and the Millea Group of insurers (Mills 2007a; Millea Group 2007).

Some insurers and reinsurers (including Munich Re, Tokio Marine Nichido and CGU) have also recently contributed to the work of the IPCC (Mills 2007a), the premier scientific body on this subject.

While European firms are ahead of US firms in terms of slowly starting to incorporate climate change into catastrophe risk models, US firms are ahead in terms of catastrophe risk modelling based on historical events (Allianz and WWF 2006). Insurance companies are using firms that specialise in such modelling to assess risks at the account and portfolio level; this work also allows firms to explore and mitigate vulnerability and risk correlation (RMS 2005). However, this approach may have risks of its own (Chemarin 2007). For example, some firms have faced criticism for insufficiently high risk assessments for US Atlantic hurricane seasons. These discrepancies may explain why catastrophe modelling firms still face challenges in terms of market and regulatory acceptance.

In Australia, the Insurance Council of Australia, ICA (2008), signalled the need for better data, calling for a

34 Such as analysing loss trends, vulnerability assessment, integrating climate change into traditional catastrophe modelling.

Coalition of Australian Governments scheme, "requiring the state by state development, maintenance and publication of present risk data and a projection of changes to the risk over the next 100 years " to provide "government endorsed risk data regarding temperature extremes, coastal inundation, extreme rainfall events, windstorm, hail, bushfire and flooding risk". The Australian Government, seeing the need since 2005 for a national coastal vulnerability assessment, has studies planned or underway toward the goal of a National Climate Change Adaptation Framework, according to Harvey and Woodroffe (2008). One example, discussed already, is the joint CSIRO/Sydney Coastal Councils Group vulnerability assessment.

## 9.3 Maintaining profitability and coverage

### 9.3.1 Increasing capacity in current markets and product lines

"… the insurance industry can play a material role in decreasing the vulnerability to weather-related natural disasters, while simultaneously supporting its market-based objectives and those of sustainable development … Loss prevention is 'in the DNA' of the insurance industry".

Epstein and Mills, 2006

**Box 17. Insurers join forces with hazard researchers**

In 1997, London-based Benfield, a global broker and reinsurer, became the first insurance market entity to sponsor academic research. Joining forces with researchers at the University College London in 1997, they created Europe's first dedicated natural hazard research centre.

Dubbed the Benfield UCL Hazard Research Centre (BUHRC), the facility has a Tropical Storm Risk forecasting group, sponsored by Benfield and other partners, which focuses on prediction of Atlantic hurricanes, Australian cyclones and NW Pacific typhoons.

This centre has become a top forecaster of tropical storm activity throughout the world, and its modelling and cyclone prediction have forged a number of breakthroughs, which include the effects of climate change on these hazards (ClimateWise 2007).

This section examines the ways in which insurers are increasing their capacity to manage climate-related risk, which is vital if they are to sustain their exposure and profitability in existing insurance markets and product lines. Despite the opportunities noted in the above section, Mills (2007a) finds that only a third of insurers are offering innovative products and services that address climate change.

*9.3.1.1 Increasing capacity to minimise policyholders' risk*

"Rather than withdraw, and jeopardise entire markets, insurers can also incentivise policy-holders to protect themselves against damage, so as to limit potential losses".

Reo Research, 2007

We have discussed how improved management of policyholders' physical risk provides an important opportunity to reduce insured losses, while allowing insurers to sustain exposure to current markets. Here we look at concrete examples of how insurers are increasing their capacity to achieve loss reduction.

While most such initiatives are focused on the built environment and transport, Mills (2007a) notes that such climate-change loss prevention strategies could be equally applied to other business lines: crops, roadway safety, marine settings and life/health, as well as business interruption. For example, one innovation is a new US-based captive insurance program for businesses called GREEN. The first initiative of its kind, it aims to reduce insurance premiums for companies committed to sustainable business practices, based on the argument that the culture of these companies translates into lower insurance liability and stronger safety records (Insurance Journal 2007).

Despite the promise of such initiatives, the current capacity of the insurance industry for loss-reduction strategies still remains at an early stage. Mills (2007a) finds that the "dearth of innovative products that would reduce climate risks and preserve insurability for homeowners is a particular concern, especially when considering the more than half a million homeowners who have lost private coverage in Florida alone in the past two years." Reo Research (2007) comments that, "There seems to be a generalised expectation that the onus lies with government to lead on large-scale, publicly-funded infrastructure investment, such as flood defence".

**Increasing capacity to reduce hazard risk in the built environment:**

In the US, some companies (including the American National Property and Casualty Company, AAA Chicago Motor Club and Mississippi Windstorm Underwriting Association) are offering up to 25% reductions in premiums for those who adhere to the Institute for Business and Home Safety (IBHS) new 'Fortified Home' design standards.

These Fortified Homes offer code-plus

upgrades to make them more resistant to climate hazards including high winds, wildfires, floods, freezing weather, hail and water damage. Specific features include: pressure-rated windows and doors that can withstand high winds and flying debris; better connections to tie roofs to walls and walls to foundations; stronger, thicker roofs that stay dry longer; landscaping and exteriors that consider fire risk (IBHS undated); and energy efficiency (Mills 2007a).

**Climate risk audits:** Insurers can also require a form of audit or inspection to more accurately determine a policyholder's climate change related risk. Although climate change risk auditing constitutes an additional expense, inspections in the US for steam boilers, which substantially reduced accidents, provide a historic demonstration of this strategy's effectiveness (Freeman and Kunreuther 2003). One successful US example is FM Global (see Box 12), whose high profitability during the year of Hurricane Katrina was due to its program of evaluating policyholders risk and recommending hurricane loss prevention methods (Mills 2007a).

**Increasing capacity in the transport sector:** Insurers are working in this sector to reduce carbon risk by creating products that reward customers who drive less, reduce emissions and lower the probability of a loss.

There are numerous examples of products that reward consumers for reducing miles driven or reducing vehicle emissions. This includes 'pay-as-you-drive' (PAYD) policies, discounts on premiums for low-emission vehicles, and carbon offsets bundled into automobiles policies.

Research indicates that PAYD products can reduce miles driven by 10-15% or more. At least 19 insurers offer PAYD insurance products, and the number is growing. French insurer AGF has 250,000 PAYD policies in force, and about 20% of its new customers choose this coverage (Mills 2007a). New developments in GIS-based tracking can help insurers eliminate fraud or error in mileage reporting.

In terms of products for low-emission vehicles, Zurich pioneered discounted premiums in North America for hybrid and alternative fuel vehicles as far back as in 2005, and the company has similar offers in Germany and Switzerland (Climate and Insurance 2005). In the USA, auto insurer Travelers states the 'preferred' driving characteristics of hybrid vehicle drivers is one reason the company provides them with a 10% premium credit. Tokio Marine & Nichido gives automobile insurance premium discounts 1.5% for low-polluting, energy saving and low-emission vehicles. As of 2006, 6.23 million policyholders were eligible for this discount, representing 48% of the company's total auto policy customer base. The company also encourages 'environmentally friendly' repairs of vehicles through recycling and reuse of parts (Millea Group 2007).

**Box 18. UK: Norwich Union leads on flood management**

In the UK, over half of those affected by flooding restore their homes exactly as before, without taking any measure to prevent future flooding. This is one finding of the UK-based Norwich Union's report, 'Flood Resilience Research'. The insurer is a sponsor of the pan-European Project Flows, which is examining the issue of flooding.

The research also revealed that, despite widespread fear of flooding, four out of five homeowners would not entertain home improvements to protect against flood damage. Given this clear evidence on the need to educate the public on how to take steps to limit flood impacts, the project launched the UK's first flood-resilient demonstration house in 2005 in conjunction with the Norfolk County Council. It includes flood alarm systems, pump-and-sump systems below floorboards to remove water, and one-way valves in drainage pipes to prevent sewage from backing up into the house .

According to Norwich Union (2005), "If flood protection has been put in place, costs for restoration could be lowered from £48,564 to as little as £8,560 per household. And because damage is on a lesser scale families can return home more quickly."

In October 2006, a real flash flood caused neighbours to vacate their homes, but the flood-resistant measures of the demonstration home allowed its occupants to carry on as normal after simply mopping the floor (ClimateWise 2007).

See: www. floodresilienthome.com

*9.3.1.2 Capacity to address climate risk in D&O insurance:*

Insurers are starting to raise the issue of shareholder claims, due to directors' failure to disclose or consider climate risk. This is happening before some insurers issue and renew D&O policies (Kronowitz 2007; see Box 19). Mills (2007a) argues that climate-related D&O risk can be managed and that insurers can actually use their expertise in proactive risk management to induce their policyholders to raise their awareness, deal with their climate-related risk and avoid liability. Reflecting this approach, the world's largest insurance broker, Marsh Inc, in collaboration with Yale University and CERES, announced a collaborative

### Box 19. D&O climate risk: the 'wait-and-see' phase is over

Since 2002, Swiss Re has considered climate change risks as criteria for evaluating risks under corporate D&O policy. It first assesses this risk by examining a company's response to the Carbon Disclosure Project (an independent, non-profit organisation that compiles GHG data for 3000 of the world's largest companies.)

Additionally, if that information is lacking, Swiss Re may require the company to respond to a questionnaire that details: the jurisdiction of its operations, emissions and GHG accounting system; how it plans to address possible liabilities in the face of the Kyoto Protocol and other emissions reduction regulation; and data comparing its emissions to its financials.

However, Mills (2007a) notes that, "Swiss Re has yet to actually decline a policy or apply exclusions based on climate risks alone".

program in 2006 to educate corporate board members on both the liabilities and opportunities climate change creates for companies (Dowlatabadi and Cook 2007).

#### 9.3.2 Increasing capacity in risk pricing and other insurance policy measures

"The good news… we have time to apply climate science, economics, risk management, and (lest we forget) common sense to the problem of pricing, managing and mitigating extreme weather risk".

Valverde, 2006

Lloyd's (2006a) states that "Climate change must inform underwriting strategies – from the pricing of risk to the wording of policies." We have already noted the opportunities, as well as some pitfalls, that follow on from accurately pricing risk and adjusting other aspects of insurance policies in light of climate change risk. Indeed, one way insurers are expected to increase their financial capacity to address increasing costs and rising numbers of claims is through traditional financial risk management techniques. This includes raising premiums and deductibles, lowering limits/implementing broader coverage restrictions and purchasing reinsurance. These avoid the extreme actions of non-renewal of existing policies or even withdrawing from markets (Mills *et al*. 2006b; Mills 2003a).

*9.3.2.1 Increasing capacity to harmonise price with risk*

"… insurers need to consider whether products make sense from an actuarial point of view – in other words, whether the premium reflects the actual level of risk involved in providing the insurance".

Reo Research, 2007

We have seen how inadequately resolved risk and miscalculations of insurance pricing pose major challenges for insurers; at the same time, we have suggested that insurers who resolve these challenges have the opportunity to increase both their own resilience to climate risk and society's as well. Here we see how insurers are increasing their capacity to adequately price insurance.

Despite the challenges to resolving risk noted in the 'Vulnerability' section, improved actuarial analysis is becoming more feasible as efforts to identify climate-related hazards improve through modelling. This is increasing insurers' ability to price insurance based on scientific predictions for the season ahead (Lloyd's 2006a; RMS 2005), as some of the insurers described above have recognised (see Section 9.5). Taking an important step toward this goal, the Association of British Insurers (2005) integrated insurance loss models with climate change scenarios to produce future estimates of insurance losses due to major storms, and required risk capital (the projected losses are discussed under 'Vulnerability'). Swiss Re and Munich Re have also been carrying out significant research and analysis to determine how climate shifts will affect their risk pricing (Reo Research 2007). And the reinsurance industry generally has already made catastrophe cover more expensive in response to recent natural disasters (Dowlatabadi and Cook 2007).

Looking at how the insurance sector response could play out as it interacts with regulation, Valverde (2006) argues that high losses (eg from storms) could result in three scenarios: a regime of insurance prices sufficiently high to reflect the frequency and severity of losses; a controlled-price regime with scarce insurance (due to the fact that insurers can't cover risk when prices do not reflect that risk); or increased subsidisation of insurance through state-sponsored insurance and reinsurance facilities (likely a short-term response as "these mechanisms are freighted with well known incentive and fiscal problems," according to Valverde).

However, Valverde (2006) finds that, "Though it would seem obvious, enormous effort continues to be expended in trying to escape the reality that where places, things, and people are expensive to insure, insurance will be expensive".

*9.3.2.2 Exclusions and other coverage restrictions:*

Some insurers, especially those suffering recent climate-related losses, have also responded by writing policies

"Though it would seem obvious, enormous effort continues to be expended in trying to escape the reality that where places, things, and people are expensive to insure, insurance will be expensive."

Valverde (2006)

that shift more liability to the consumer. For example, US insurers implemented new 'wind' deductibles, on top of existing deductibles, after Hurricane Andrew. Insurers further reduced their exposure to hurricane hazards by shifting their deductible formations from a fixed figure to a percentage of total loss. According to Epstein and Mills (2006), "The effect of such changes is substantial: for example, in Florida, 15 to 20% of the losses from the 2004 hurricanes were borne by consumers..."

However, Mills (2007a) suggests insurers should only "Tighten terms and conditions, withdraw from markets, or increase insurance prices only when the aforementioned best practices have been exercised to their fullest cost effective potential".

Indeed, many insurers recognise that increasing their capacity to provide more proactive and holistic approaches will reduce their own and their customers' climate-related risk, increase their revenues and enhance their reputations (Mills 2007a). Concrete examples of such initiatives are given below.

### 9.3.3 Increasing insurers' disaster-management capacity

As noted in the 'Opportunities' section, more robust disaster response would give insurers an opportunity to help communities rebuild after disasters, such as severe cyclones or 'Cat-following-Cat' type events, and address other vulnerabilities that arise at this time. Some insurers are now addressing this need by expanding their emergency response capacity and systems. For example, Zurich has created a Catastrophe Claims Centre and Catastrophe Response Team (see Box 20).

### 9.3.4 Increasing capacity to manage capital reserves and transfer risk

"Conventional reinsurance arrangements may in future cover a smaller proportion of total losses if extreme events increase in frequency and/or severity. There may be insufficient capital available to insurance markets to cover these losses. Insurers are already looking to other alternative risk transfer mechanisms to help diversify their capital".

Association of British Insurers, 2005

Although issues of capital and investment are outside the scope of this general-insurance focused report, improved risk transfer and asset management is another area for which the insurance sector is building capacity in relation to climate change risk. For example, in contrast to Hurricane Andrew (1992), which pushed six insurers into bankruptcy, the 2005 US hurricane season — which produced more than twice the quantity of losses — only forced one bankruptcy. The central difference appears to be improved asset

"The global market for reinsurance has supported primary insurers by providing a range of financial instruments ... The recent innovation and deepening in these market shows their considerable potential to promote adaptation to climate change...

Garnaut (2008)"

### Box 20. Zurich ensures needs are met in times of catastrophe

Recognising that the aftermath of catastrophes, such as Australia's Cyclone Larry and Newcastle floods, are crucial times to ensure customers receive optimum service, Zurich Australia has adopted a new approach to see this through (Zurich 2008b).

The company will allocate permanent office space in its Sydney headquarters that can be swiftly converted into a Catastrophe Claims Centre. The insurer will see a predetermined team of internal claims staff, called the Catastrophe Response Team, deployed to this centre, where they will handle all requests from Zurich Australia's '1 800' catastrophe claims number and all other claim issues related to the catastrophe. The team will work under Zurich Australia's business continuity management framework and Crisis Management Team, who will in turn deal with all non-claim issues, such as communications, HR, IT and property.

A separate group of assessors and senior claims managers, called the Local Response Team, will be deployed to the catastrophe site, supplied with wireless laptop PCs and BlackBerries with GPS capability - to enable swift communication to the Catastrophe Claims Centre. Zurich Australia is also assembling a 'catastrophe box' containing the necessary equipment for the Local Response Team, including safety equipment, satellite phones, banners and other items that will help customers locate the claims managers.

management (Dowlatabi and Cook 2006).

According to the ABI, "Insurance markets could become more volatile, as the costs of capital required to cover such events increased." This area is significant given the importance of insurers' assets to their ability to pay policyholders, especially if conventional reinsurance arrangements fail to cover losses. It explains why the US National Association of Insurance Commissioners Executive Task Force on Climate Change is looking into insurers' invested assets (Mills 2007a). Munich Re has moved to address its capacity in this regard by performing an analysis of climate-related hazards and opportunities across its investments and incorporating the findings into the mandate of its asset management company (Reo Research 2007). The increasing awareness of the Australian insurance sector is signalled by this comment from Tony Coleman of IAG (Australian Climate Group 2008):

"...The Australian Prudential Regulatory Authority requires all licensed Australian insurers to be managed so as to be able to withstand combinations of events expected to occur only once in every 200 years. These levels of risk – 0.5% p.a. or less – are completely dwarfed by the risk levels to our way of life that are now reliably attributable to potentially catastrophic climate change impacts, unless we act with urgency to rapidly reduce greenhouse gas emissions".

Another important and related area is the growing capacity for Alternative Risk Transfer (ART) techniques. This includes catastrophe bonds, as well as weather derivatives (which address climate variability). These instruments allow investors in capital markets to play a more direct part in the provision of insurance protection. ART is additional to private and public partnerships for pooling arrangements being developed in Europe (Chemarin 2007).

Yet another related area where insurers are increasing their capacity is green lending and investment. Banks with insurance arms - or insurers with investment arms - are in a position to achieve co-benefits by funding projects that will abate emissions or reduce vulnerability to climate change hazards.

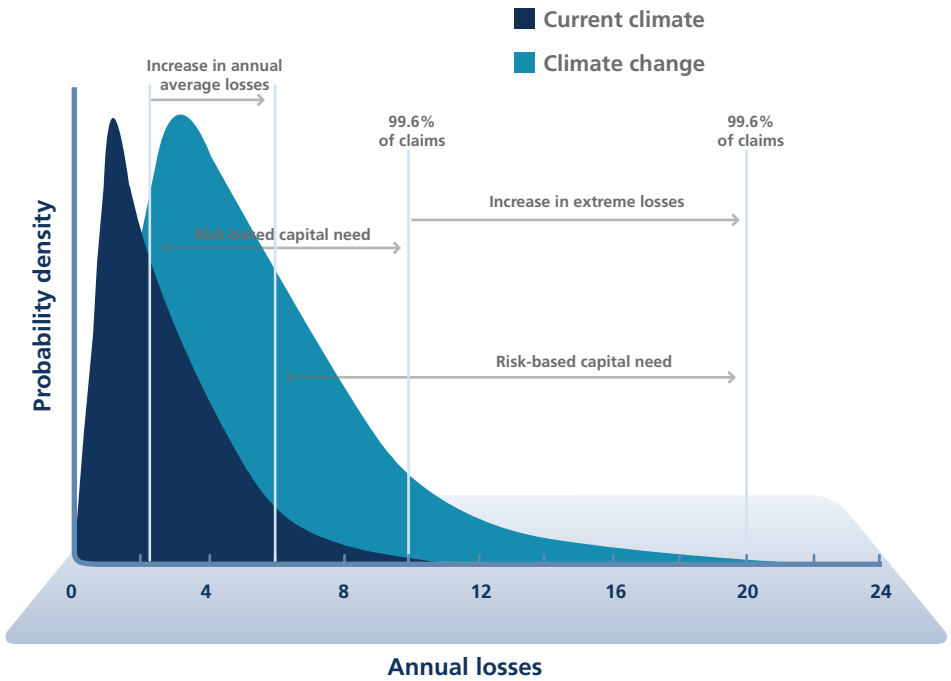



Figure 28. The Association of British Insurers (2005) examined the impact of climate change on probability loss distribution and the implications for risk capital requirement. They find that under high emissions scenarios (a doubling of carbon dioxide levels; see light blue line in figure), "insurers' capital requirements could increase by over 90% for US hurricanes, and by around 80% for Japanese typhoons. In total, an additional $76 billion could be needed to cover the gap between extreme and average losses resulting from tropical cyclones in the US and Japan. Higher capital costs combined with greater annual losses from windstorms alone could result in premium increases of around 60% in these markets".

## 9.4 Creating growth

### 9.4.1 Increasing capacity in new markets and products

"[current efforts] indicate a vast potential for insurers to introduce new climate-friendly products and services through their core business, and to participate in the coming 'green' revolution in the financial markets through their extensive investments".

Mindy S Lubber, President CERES, Director of Investor Network on Climate Risk, 2007[35]

We have discussed above how society's response to climate change is creating opportunities for insurers to gain exposure to new markets and products. Here we discuss how insurers are increasing their capacity to provide specific new products, or adapt conventional products to new and evolving markets and assets. Recognising the vast potential, industry bodies in Europe (eg the Association of British Insurers and the European Insurance and Reinsurance Federation) have called on insurers to preserve private insurance markets by increasing their capacity to pursue climate change solutions (Mills 2007a). However, despite the sector being designated "a key agent in adaptation" by the IPCC (2001) seven years ago, most insurers have yet to experiment with such products.

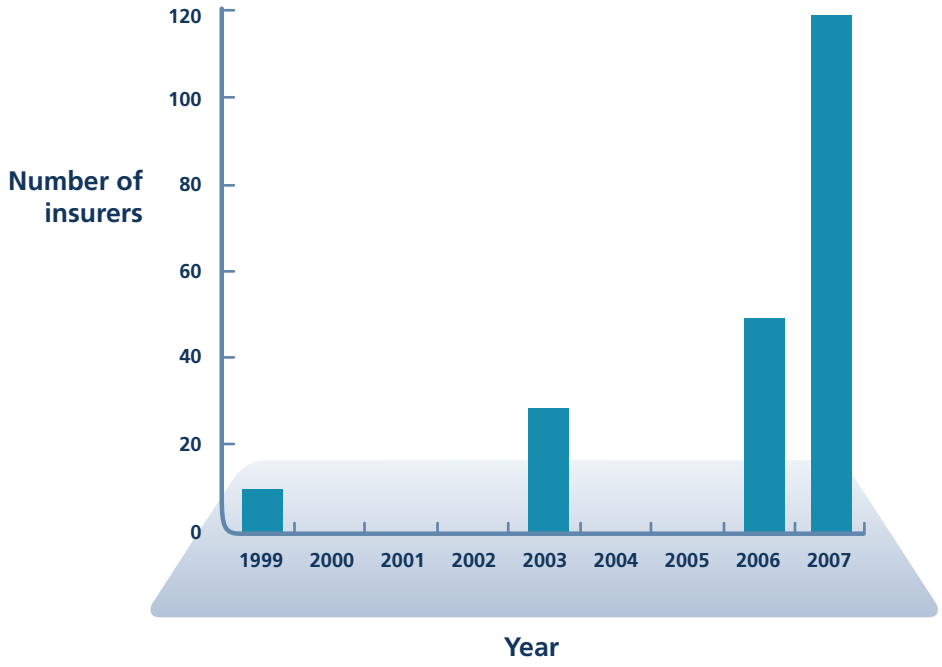



Figure 29. Mills' (2007a) survey finds an increasing number of insurers with climate-friendly products and services.

35 From Mills (2007a).

**Box 21. Zurich builds capacity with dedicated renewable energy team**

> "Through this dedicated team, Global Energy will be able to focus on new technological developments and the changing risk characteristics of the renewable energy market".
>
> J. Peter Connors, President and CEO, Zurich Global Energy, 2008

In 2008 Zurich Financial Services Group created a new team to address all phases of risk management and insurance for the renewable energy sector - on a local and global level.

The team is made up of international underwriting experts for onshore property, exploration and production, casualty, ocean cargo and energy risk engineering. It draws on the Zurich Global Energy business unit's experiences as a leader in the wider energy insurance market, including years of experience in renewable energy coverage.

Zurich's current renewable energy coverages include property, general liability and cargo, covering risks for equipment from the time it leaves the manufacturers' door, through to construction and the operational phase of an energy facility. This provides up to US$100 million of capacity for both onshore and offshore renewable energy projects, according to Zurich (2008c).

*9.4.1.1 Increasing capacity to insure the carbon market*

"Providing structured insurance and financial products for [carbon trading] risk is significant because it validates the market-based approach to reducing GHG emissions and in tackling climate change".

Ben Lashkari, Head of Emissions Swiss Re Environmental and Commodity Markets.

Some insurers are already building their capacity to realise opportunities in the fast-growing carbon market. These firms are going beyond obvious steps, such as purchasing offsets to cover their own emissions, and are instead creating innovative products, some of which are described below.

- Carbon emission credit delivery guarantees (CDGs): These products aim to reduce the risk for companies and investors participating in carbon emission trading markets (Chemarin 2007; Mills 2007a). They provide coverage for the non-delivery of

credits due to un-projected hazards, such as operational problems, project insolvency, currency incontrovertibility and host-country political and investment risk (Marsh 2006a). As such, these products will facilitate the market's growth by addressing a major hurdle faced in the financing of such carbon projects. According to Marsh (2006a), "The [CDG] insurance will help monetise the future value of carbon credits and allow them to be incorporated into project-financing decisions. This should, in turn, reduce the project cost of capital and improve the overall project economics".

- Property and liability insurance for carbon-reduction capital projects (Mills 2007a).
- Consultative services to design, manage and maximise the potential of such projects or to manage carbon risk generally (Mills 2007a).


Figure 30. Combined carbon and climate impact risk reduction: Starting in 1999, Tokio Marine & Nishido responded to the challenge of global warming through a program that saw 3444 ha of mangroves planted in Indonesia, Thailand, Myanmar, the Philippines and Vietnam as of 2006. The carbon dioxide absorbed by the growing mangroves is sufficient to offset the GHG emissions of the company's business activities. Importantly, mangroves also protect communities from natural hazards, such as storm surge and coastal erosion. The company aims to plant a further 5000 ha by 2009 (Millea Group 2007).

### Box 22. Pioneering novel products to reduce carbon risk

In 2006, insurer Swiss Re and RNK Capital LLC, a New York-based private investment firm, created the carbon market's first insurance product for managing Kyoto Protocol-related risk in carbon credit transactions carried out by RNK (Swiss Re 2006b).

The product provides coverage for risks RNK encounters in carbon-credit transactions under Kyoto Protocol mechanisms, such as the Clean Development Mechanism (CDM, under which proponents obtain revenue from the sale of carbon credits for clean energy and emission abatement projects in developing countries). For example, some projects may experience delayed approval for their validity to participate under this mechanism; others may fail to receive the required certification for their emissions reductions.

According to RNK portfolio manager Robert Koltun, "Kyoto-related risk is the only part of the risk equation we were previously unable to mitigate or manage. This insurance policy allows RNK to invest in carbon emissions reduction projects at an even earlier stage of the process, and to commit a greater share of fund resources" (Swiss Re 2006b; Mills 2007a).

Additional products include a 'Kyoto Multi-Risk Cover' offered by Munich Re that compensates investors in CDM and JI (joint implementation) projects against failure to deliver the stipulated number of emission rights (Mills 2007b), as well as an AIG marketing program through HSB Solomon to identify efficiency improvements that can be translated into carbon reductions (Mills 2007b). AIG is also developing a range of insurance products for carbon market investments, including coverage for the delivery of up to 80% of the carbon credits under contracts companies enter into to meet their emissions reductions targets (AIG 2007).

*9.4.1.2 Increasing capacity in the clean tech market:*

> "The insurance sector has a key role to play in helping to mitigate the effects of climate change … developing new products and solutions that can support emerging greenhouse-gas and renewable energy markets".
>
> Marsh, 2004[36]

As previously discussed, rapid expansion of energy efficiency and

36 From Mills (2007a).

renewable energy technologies is providing opportunities for new markets and innovative new products. Here we provide some concrete examples of such products.

**Increasing capacity for energy efficiency products:**

As discussed in 'Opportunities', energy services companies (ESCOs) often lack appropriate insurance coverage. Some insurers are stepping in to fill this void with new products. One example is a package by Lockton Risk Services in partnership with RESNET (the US energy services network) to provide liability and property insurance for home energy auditors who meet professional criteria (RESNET undated).

New insurance products are also providing coverage against the underachievement of energy-savings projects. Mills (2003b) identified 12 such providers in the UK, US and Canada. These insurance products include energy savings insurance, surety bonds and savings guarantees, as well as hybrids of these three.

In Japan, Sompo Japan Insurance has since the year 2000 offered order-made insurance for ESCO proprietors. It provides comprehensive energy-saving packages for projects on buildings and factories (Sompo 2006). And in Canada, the province of British Columbia's retrofit program uses insurance as one way to transfer the risk of underachievement for energy and water efficiency upgrades performed on its public buildings. This risk is transferred from the participating educational or healthcare institutions to the energy services provider or a third-party insurer, through an agent representing several insurers identified during a competitive bid process (Mills 2003a).

**Increasing capacity in renewable energy:**

"Insurance for renewable energy projects goes well beyond the coverage for construction and machinery… Products need to have the scope to include business interruption and downtime for weather-related operational problems".

Ron Berler, Global Energy Coordinator, XL Insurance, 2007

We have discussed how the fast-growing renewable energy sector is an area of considerable opportunity for insurers to engage in new markets. Here we show how insurers in North America and Europe are already using their capacity to tap this market by providing coverage for alternative energy projects including wind, solar, geothermal and agri-fuels. According to Marsh (2006b), surveyed reinsurance firms had an aggregate US$2.2 billion capacity for renewable energy projects, indicating they have "more than adequate capacity to cater for the insurance requirements for any one of the largest projects in the renewable energy industry".

Despite industry concerns (discussed

in the 'Vulnerability' section and largely relating to these technologies' prototypical nature), some insurers are already adapting traditional insurance products for the more uncomplicated and well-commercialised renewable energy developments, including onshore wind, small-scale hydro and energy from waste (Marsh 2006b). This includes coverage for business interruption, machinery breakdown, property damage and construction. However, insurers are finding offshore wind to be a more challenging market. Marsh (2006b) notes that while premium income from such projects is attractive, the increased marine hazards and requirement for specialist marine reinsurance protection constitute a barrier for many insurers. This represents a new area of marine cover, similar to the expansion of the oil industry to off-shore platforms.

In addition to the above comprehensive project insurance, derivatives[37] are also being offered to cover policyholders in the event that solar and wind power production revenues fail to meet expectations.

Looking at the full range of insurance products available for renewable energy, Mills (2007a) found many insurers offering at least one type of eight existing forms of coverage. Here are some illustrative examples of how insurers are building capacity in this market:

- Since the year 2000, Sompo Japan Insurance has provided weather derivatives for wind power producers, which "contributes to the stabilization of revenues for wind power producers by paying a predetermined amount to the producer in the event that wind speeds do not meet forecasts." In 2005, Sompo introduced a similar weather derivative for solar power systems (Sompo 2006).
- In 2007, Royal & SunAlliance became the first insurer to launch a global renewable energy

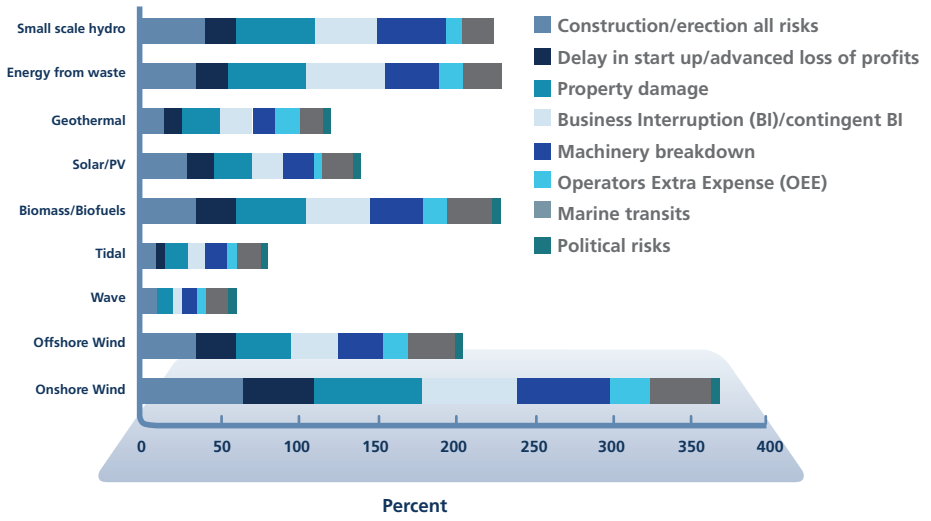



Figure 31. Marsh's (2006b) survey details the availability of insurance products for various renewable energy technologies. The percentages refer to total aggregated response for each product type.

37 A wind-power derivative reduces financial volatility for wind producers by transferring the risk of below-average energy production to a third party. Based on estimate of a normal production, the derivative's payment will trigger to the purchaser according to a pre-determined structure (eg a 10% reduction triggers a payment of the proportional value of the foregone power to the derivative's purchaser).

business. The insurer has over 25 years of specific wind energy experience, and provides coverage for manufacturers, developers, contractors, operators and finance companies, including off-shore coverage. It also has solar, water to energy, biomass and hydro expertise (RSA 2007).

- In Australia, IAG is partnering with Renewable Devices Swift Turbines Ltd (RDST) and aiAutomotive (aiA) to develop a license to distribute the SWIFT™ Rooftop Wind Energy System throughout Australia. The venture is called Micro Wind Turbines Australia (MWTA), and IAG views it as a component in its carbon-neutral strategy (Renewable Devices 2008).

- Lloyd's (2006b) has a unique approach to wind power coverage, through its WindPro consortium that covers both onshore and offshore wind power projects, worldwide. This allows an integrated approach to types of projects that usually sit in different markets.

### 9.4.2 Increasing capacity for climate risk advisory services

Insurers are society's risk experts. Building on insurers' existing risk management capacity to provide climate-risk management services is another growing area touched on briefly in the 'Opportunities' section. Looking at concrete examples, Aon has increased its capacity in this regard by establishing a Climate Change Solutions group to provide risk management services on carbon trading. Aon was approached by the global energy company BG Group to assess risks and opportunities in relation to climate change legislation, particularly the EU ETS (Mills 2007a). According to Margaret Mogford of BG, "We recognised that any energy company and particularly a fossil fuel company has opportunities and threats arising out of climate change. We knew them in principle, but we didn't know how they applied across our businesses and this is where Aon came in" (Aon 2005).

### Box 23. AXA pioneers wind project insurance

Germany is a wind power giant, with more than 17,000 wind farms generating around 5% of the country's power as of the end of 2005. The sector employs 60,000 people there, and generates more than US$6 billion a year in revenue. Europe's favourable policy environment for renewable energy promises continued rapid growth of wind power.

According to its website, AXA's comprehensive insurance coverage for wind farms generated 9.5 million Euros (US$15 million) in premium revenue for the company in 2006. One of the leading insurers for wind farms and other renewable energy facilities in Germany, AXA Konzern, the Group's German subsidiary, offers insurance lines for the set-up phase, machine breakage and loss of business and civil liability.

In explaining its decision to provide wind-project coverage, AXA cites favourable tax incentives, the technology's reliability, ongoing maintenance systems, a favourable loss experience (few cases of damages) and the ability to transfer risk to reinsurers, as well as AXA's recognised expertise in prevention and underwriting for construction, machine breakage and loss of business.

However, AXA Konzern notes that effective management of cumulative risk is essential for providers of wind farm insurance. This includes assessing the risk of climate change impacts, such as increasing wind speeds - a particular risk factor for older wind power facilities. AXA also requires mandatory fitting of lightning protection.

See: www.axa.com/en/responsibility/protection/property/environment/

## 9.5 Policy, partnerships and stakeholders

"It is in the business interest of insurers to support public policies that reduce and make risks more predictable. Insurers are now beginning to add their voices to the national and international discussion regarding climate change".

Mills 2007b

As experts in risk, insurers are uniquely placed to advise governments on policy. Although the responsibility for setting goals to reduce society's vulnerability lies with government, private insurance firms have unique insight into hazards and vulnerabilities. Here we discuss how leading companies are increasingly engaging and assisting governing bodies in developing policy as another way to increase their capacity to manage their climate risk and position themselves to benefit (Reo Research 2007).

### 9.5.1 Global initiatives

"Insurers have a unique capacity to speak out in this area… The tactics of negotiating near-term targets can be left to the political process. What we need are a long-term, 'safe' goal and an allocation method that is easily understood and will guide near-term policies and actions".

Dlugolecki, 2008

This section outlines specific examples of how insurers are increasing their capacity to engage in the policy debate at the global level. As noted previously, some reinsurers and large insurers have been active in the climate-change policy debate at the global level for more than a decade. In addition to the aforementioned ClimateWise program, insurers are participating at the global policy level through the United Nations Environment Programme, which examines the industry's vulnerabilities, recommends solutions, and provides information to international policymakers and the financial services sector (Mills 2007a). It counts three Australian companies among the 36 insurers participating as of September 2007.

Although the responsibility for setting goals to reduce society's vulnerability lies with government, private insurance firms have unique insight into hazards and vulnerabilities.

The UNFCCC (2007a) recently underlined the need to promote insurance approaches within UN frameworks, International Financial Institutions (eg the World Bank), international donors and the private sector. One proposal is to pool intergovernmental funding to align the insurance sector with climate-related risk in order to address global risk sharing and equity.

One interesting initiative by Munich Re is the Climate Insurance Initiative. Begun in 2005, it shares analysis and develops insurance solutions in developing countries (Reo Research 2007). Insurers have also endorsed a number of declarations and initiatives to move climate change policy forward (see Mills 2007a).

### 9.5.2 National and regional efforts

A growing number of insurance companies are using their capacity as experts on climate-related risk in efforts to convince their governments to implement stringent emissions reduction policy. In Europe, such efforts include the UK Corporate Leaders Group on Climate Change and the EU Corporate Leaders Group (Reo Research 2007).

There are also numerous examples of insurers working in Europe and North America to effect policies that support increased funding for public transportation, vehicle fuel efficiency and telecommuting (Mills 2007a). In the UK, the Association of British Insurers engages regularly with government on detailed policy discussions, and one result is that flood insurance cover has been maintained in exchange for a firm commitment by the government to invest in flood defence (Reo Research 2007).

### 9.5.3 Local governments

"Improving building codes so that they make maximal use of hazard resistant technologies and practices while minimizing energy use is an example of a strategy that requires the leadership of local government".

Mills, 2007a

Some insurers have recognised the value in maintaining strong links with - and lending capacity to - local governments. In New Zealand, for example, IAG used its capacity in rainfall modelling to help the local government formulate local council flood strategies based on likely changes to future flood levels, such as increasing their planned height for levee banks. Thus, IAG was able to influence local government planning responses to flooding and ultimately reduce the company's risks in those areas (Stagnitta and Forster 2004).

And, although the public sector is responsible for integrating climate change into land use planning, insurers can also play a role in this aspect of planning (Mills 2007a). A key area of policy activity for insurers is lobbying for improved building codes, which can produce a win-win situation: reduced vulnerability to hazards, reduced energy use, reduced insurance losses and the possibility of discounted premiums (Mills 2007b). Importantly, these partnerships can also promote policy to discourage building in high risk areas (Lloyd's 2006a).

### 9.5.4 Stakeholder partnerships

There are numerous examples of insurers engaging in a variety of partnerships with other stakeholders both inside and outside their sector that aim to reduce climate risk. These can take a number of forms.

For example, Reo Research (2007) notes that "Joint industry initiatives can also be highly effective in establishing

norms and best practice standards, and in providing a forum for co-operation". According to Dowlatabadi and Cook (2007), "Many insurance initiatives are looking toward public–private partnerships and new risk-management instruments to provide a cushion for climate change-related effects…" Mills (2007a) points out the potential for insurers to make alliances with energy utilities to provide incentive programs that reward hazard resilience and reduce energy use, such as an effort by FM Global Insurance and Boston Edison to promote fire-safe, energy-efficient light fixtures.

# 10 Conclusion

"The insurance sector has been an important sector when they want to be. The reality is that the power and leverage of the insurance industry is extraordinary".

Mindy Lubber, President, CERES[38]

Climate change is the most serious threat to the insurance industry. Although the number of insurer responses to climate change is increasing rapidly, those taking substantive action still represent a minority. Yet the responses of this proactive minority provide a concrete demonstration that insurers can help society adapt to and mitigate climate change, whilst sustaining profitability.

## 10.1 Climate change hazards and vulnerability are escalating

A signal of climate change (of about two per cent of losses per year) is measurable in global annual economic losses from weather-related catastrophes. These physical climate change hazards are locked-in and increasing; regulatory responses are growing; and the associated complex social changes and feedbacks are underway. Meanwhile, (to paraphrase Munich Re), when it comes to actuarial analysis, the industry essentially continues to drive forward into a perfect storm of escalating or shifting hazards with its vision fixed on the rear-view mirror.

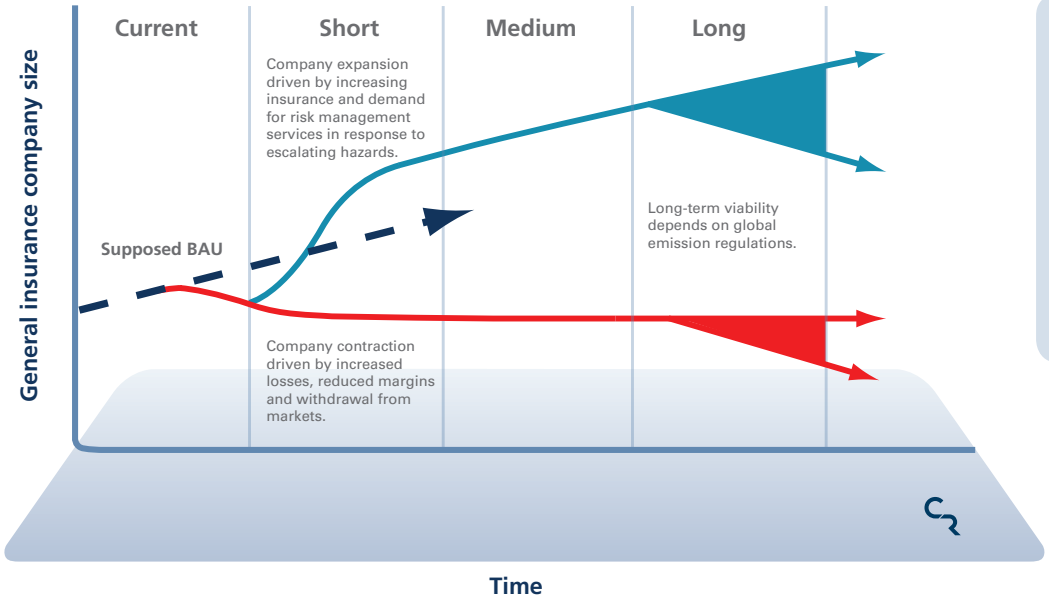



Figure 32. A climate-change driven contraction for companies in the global general insurance industry is foreseeable; conversely a major expansion is also foreseeable. Unfortunately, business as usual is no longer in the frame.

38 As quoted in National Journal (2007).

## 10.2 Exposures are far from optimal

There appears to be an inadequate response to the need to address escalating climate change hazards in current market exposures. Exacerbating this risk is intensifying urban and non-urban development in zones of escalating climate and weather hazards; development which is often built to standards that fail to account for climate change. Insurer responses, when they do come, typically take the form of flight from the affected market. However, this is a race to the bottom; it carries many risks of its own, not least of which is contraction or loss of market share, diminishing returns and a missed opportunity to meet a society-wide increase in demand for greater insurance cover.

## 10.3 Many opportunities remain untapped

In terms of opportunities, the industry clearly recognises the potential of some fast-growing new markets for insurance, such as renewable energy, as well as the potential to capitalise on shifting consumer preferences toward "green" products. These opportunities focus on mitigation — that is, a long-term approach to hazard reduction through cuts to greenhouse gas emissions. However, there is less evidence that the industry appears to recognise the opportunity to help clients adapt to unavoidable and escalating climate change hazards through proactive risk reduction.

## 10.4 Climate risk capacity far from sufficient

Some insurers are seizing the early-mover opportunity to create new insurance products for renewable energy projects, as well as products which transfer the risk associated with carbon trading and related carbon-reduction projects. A smaller number of insurers are using their capacity for products which promote risk-reduction. Yet insurers such as FM Global provide strong evidence of the manifold benefits of these products, in terms of loss avoidance and hazard reduction.

Thus it is our view that the current thrust of insurers' response to climate change appears to be somewhat more focussed on new markets and their associated benefit of long-term risk reduction through mitigation. Meanwhile, existing markets which represent insurers' core business remain vulnerable to escalating losses given the shortfall of concrete action to manage these emerging primary climate change hazards (eg sea-level rise, drought and cyclones).

## 10.5 A wicked problem requires a unifying framework for dialogue

Climate change presents to insurers a 'wicked problem', one for which there is no 'silver bullet'; rather, management of this issue requires an ongoing and dynamic approach. This highly complex and rapidly-evolving issue interfaces with the insurance industry at diverse touchpoints, and readily jumps companies' divisional silos. Yet

as society's primary shock absorber for risk, the insurance industry's continued profitability is vital to underpin the health of the global economy in the face of climate change. Thus it is crucial for the industry, government and other stakeholders to see these issues though the same prism, to understand what insurers can and cannot do about climate change in the short and longer term, and to establish an ongoing dialogue to develop solutions. We propose that there are five critical levers (set out in the Climate Risk Diamond) that clearly define the range of insurer actions available to minimise risk and build resilience. These require a balanced and comprehensive response from the each of the stakeholders.

The five key 'levers' available to insurers to respond to climate change are:

1. To reduce the hazard(s)
2. To reduce their vulnerability
3. To optimise their exposure
4. To recognise new opportunities
5. To develop capacity to manage new risks and deliver opportunities.

### 10.5.1 Scale of response must match enormity of the challenge

As society's risk managers, insurers are paid US$4 trillion a year[39] to provide a buffer against losses due to hazards. The industry is now presented with what is emerging as the biggest future risk to the global economy: climate change. While large uncertainties remain, an already large body of climate science indicates that these risks are not unknown entities. Furthermore, insurers' lengthy history of risk remediation suggests unavoidable climate change hazards could be proactively and profitably managed, while accruing considerable reputation gains for the industry. Yet a vast amount of preparation remains to be done if insurers are to fulfil their intrinsic role as leaders of society's response to climate change.

If this is not accomplished, the public and private sectors face the prospect of unaffordable insurance; insurers face the possibility of onerous regulatory responses; and the wider industry faces a race to the bottom, if insurers respond to weather-related losses by withdrawing from the very markets that most urgently require their risk management services.

It is true that some in the industry, most notably a number of reinsurers, have taken the climate change issue very seriously. However, the scale of response, which sees only a fraction of insurers responding, is still a long way from meeting the enormity of the challenge. This is of concern given that climate change impacts may be more severe and arrive sooner than projected. This will remain the case until insurers fulfil their natural leadership role as key agents of climate change adaptation and ultimately mitigation.

39 This figure includes both life as well as non-life premiums.

# 11 References


AIG (2007) Carbon Credit Delivery Insurance. AIG Brochure.

ABC (2007a) Coastal areas face environmental threats. 7:30 Report. By Matt Peacock, 12 March. See: www.abc.net.au/7.30/content/2007/s1869888.htm.

ABC (2007b) Climate change raising insurance premiums. By Ashley Hall, 21 December. See: www.abc.net.au/news/stories/2007/12/21/2125181.htm.

ABI (2005) Financial Risks of Climate Change. Available at: http://www.abi.org.uk

ABI (2007) Influential Insurance: A guide to communicating climate change for insurers. September.

AFR (2008) How Cars Drive Property Prices. By Dierdre Macken, 24 May, p. 19.

Allianz & WWF (2006) Climate Change and Insurance: An Agenda for Action in the United States.

AMA and ACF (2005) Climate Change and Health Impacts in Australia.

Andreae, M.O., Jones, C.D. and Cox, P.M. (2005) Strong Present-Day Aerosol Cooling Implies a Hot Future. Nature 435: 1187-1190.

ANZ (undated) New Building. ANZ website. Available at: www.anz.com/aus/About-ANZ/Corporate-Responsibility/Environment/Reducing-Our-Environmental-Footprint/New-Building.asp.

Aon (2005) Aon Provides Strategic Climate Change Review to BG Group. Alternative Views 43, July.

ASIC (2000) Consumer Understanding of Flood Insurance. Report 7.

Australian Climate Group (2008) Climate Change Solutions for Australia.

Australian Government (undated) Emissions Trading Scheme. Department of Climate Change. Webpage available at: www.greenhouse.gov.au/emissionstrading/index.html.

AusWind (2006) Wind Energy Projects in Australia. AusWind. Webpage available at: www.auswea.com.au/auswea/projects/proposed.asp. Last accessed 23 May 2008.

BBC (2007) Insurers Pushed on Flood Claims. BBC Website, 10 July. Available at: news.bbc.co.uk/2/hi/business/6286492.stm.

BCSE (2004) Australian Photovoltaic Industry Roadmap. Available at: www.efa.com.au/Library/David/Published%20Reports/2004/PVRoadmap.pdf.

Benoist, G. (2007) Climate Change Impacts on Personal Insurance. The Geneva Papers 32: 16-21.

Best P., Stone R. and Sosenko O. (2007) Climate Risk Management Based on Climate Modes and Indices – the Potential for Australian Agribusinesses. Paper presented to the 101st EAAE seminar on Management of Cimate Risks in Agriculture, Berlin, Germany, July5-6, 2007. Available at http://purl.umn.edu/9257.

Best's Review (2006) Insurers Reward Eco-Friendly Clients. Best's Review. December.

Best's Insurance News (2008) Climate Change Concerns Will Stay at the Forefront for Insurers. 14 April.

Blanchet, D. (2007) Changing Life Cycles and their Impact on Insurance. The Geneva Papers 32: 1-10.

Bligh, A. (2008) Bligh fast-tracks Regional Plan Review. Ministerial Media Statement, 5 May. Available at: www.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=57869

Brooks, N. (2003) Vulnerability, Risk and Adaptation: A Conceptual Framework, Tyndall Centre for Climate Change Research and Centre for Social and Economic Research on the Global Environment (CSERGE) School of Environmental Sciences, University of East Anglia.

BTE (2001) Economic Costs of Natural Disasters in Australia. Bureau of Transport Economics Report 103, Canberra.

Burton, D. and Dredge, D. (2007) Framing Climate: Implications for Local Government Policy Response Capacity. State of Australian Cities. Adelaide.

Canadell, J.G., Le Quere, C., Raupach, M.R. *et al.* (2007) Contributions to Accelerating Atmospheric $CO_2$ Growth from Economic Activity, Carbon Intensity, and Efficiency of Natural Sinks. Proceedings of the National Academy of Sciences. Available at: www.pnas.org_cgi_doi_10.1073_pnas.0702737104.

Canadian Chamber of Commerce (2006) A Guide to Climate Change for Small- to Medium-sized Enterprises.

Canadian Underwriter (2005) Homeowners and Natural Hazards. By Paul Kovacs. January.

Candel, F. (2007) Climate Change and the Global Insurance Industry: Impacts and Problems in Latin America. The Geneva Papers 32: 29-34.

Chemarin, S. and Bourgeon, J.-M. (2007) Insurance and Adaptation to Climate Change, Report for the French Environment and Energy Management Agency (ADEME), March 2007.

Chemarin, S. (2008) Personal communication. July 4 (by email).

Church, J., Hunter, J. *et al.* (2006). Sea-level Rise Around the Australian Coastline and the Changing Frequency of Extreme Sea-level Events. Australian Meteorological Magazine 55: 253-260.

CEC (2007) Clean Energy Sector Welcomes Target. Media Release. 24 September. (Formerly AusWind and the Business Council for Sustainable Energy).

CEC (undated) Wind Energy in Australia. Fact Sheet. Available at: www.auswind.org/downloads/factsheets/WindEnergyInAustralia.pdf Last accessed 23 May 2008.

Charpentier, A. (2008) Insurability of Climate Risks. The Geneva Papers 33: 91-109.

Clean Edge (2008) Clean-Energy Trends 2008. Available at: www.cleanedge.com/reports/reports-trends2008.php

Climate and Insurance (2007) Take Five Interview: By Lindene Patton. 12 May. Available at: www.climateandinsurance.org/takefive/bio_Patton.html.

Climate Group (2007) In the Black: The Growth of the Low Carbon Economy.

Climate Group (2008) Climate Change Solutions for Australia.

Climate Risk (2008a) An Introduction to Climate Change Hazards for Zurich Financial Services Australia Limited. ISBN: 978-0-9804343-3-0.

Climate Risk (2008b) A "Fit-for-Use" Approach to Assessing Greenhouse Gas Offsets: Supplementary Submission to the Australian Competition and Consumer Commission. 26 February.

ClimateWise (2007). Reducing the Risk for Tomorrow.

Coleman, T. (2003) The Impact of Climate Change on Insurance against Catastrophes. By Tony Coleman, Insurance Australia Group. Presentation to the Institute of Actuaries of Australia.

Coughlin, K. (2007) Hurricanes and Climate Change. Florida Commission on Hurricane Loss Projection Methodologies.

Crichton, D. (1999) The Risk Triangle. In: Ingleton, J. (Ed.), Natural Disaster Management. Tudor Rose, London.

Crichton D. (2005) Insurance and Climate Change. Conference on Climate Change, Extreme Events, and Coastal Cities: Houston & London. Houston, Texas.

CSIRO (2007a) Climate Change in Australia. Technical Report.

CSIRO (2007b) Australian Climate Change Impacts, Adaptation and Vulnerability. By Kevin Hennessy and Blair Fitzharris, October. Presentation available at: www.greenhouse2007.com/downloads/keynotes/071002_Hennessy.pdf.

Datamonitor (2006) Insurance in Australia: An Industry Profile.

Derocher, A.E., Lunn, N.J. and Stirling, I. (2004) Polar Bears in a Warming Climate. Integrative Comparative Biology 44: 163-176.

Deutsche Gesellschaft für Technische Zusammenarbeit (2004) Risk Analysis - A Basis for Disaster Risk Management, Commissioned by the German Federal Ministry for Economic Cooperation and Development.

DITR (2004) Department of Industry Tourism and Resources Communiqué. See: www.industry.gov.au/assets/documents/itrinternet/MCMPR4_COMMUNIQUE20060110103010.pdf. Last accessed 23 May 2008.Dlugolecki, A. (2008) Climate Change and the Insurance Sector. The Geneva Papers 33: 71–90.

Donald, J. and Kurdian, G. (2007) Insurance Coverage for Climate Change Disclosures: Are You in Good Hands? The Corporate Governance Advisor 15(5): 5-24.

Dowlatabadi, H. and Cook, C. (2007) Climate Risk Management and Institutional Learning. Resources for the Future Discussion Paper.

Epstein, P. and Mills, E. (2006) Climate Change Futures Health, Ecological and Economic Dimensions. The Center for Health and the Global Environment Harvard Medical School.

Ernst & Young (2008a) Strategic Business Risk: Insurance 2008. In collaboration with Oxford Analytica.

Ernst & Young (2008b) 2008 – The Top 10 Risks for Business. In collaboration with Oxford Analytica.

Firth, J. and Colley, M. (2006) The Adaptation Tipping Point: Are UK Businesses Climate Proof? A report by Acclimatise, the UKCIP and the CDP.

Flannery, T. (2005) The Weather Makers: The History and Future Impact of Climate Change. Text Publishing, Melbourne, Australia.

Flavin, C. (1994) Storm Warnings: Climate Change Hits the Insurance Industry. World Watch 7:6 United States, p 10-20.

Florida Insurance Council (2007) Hurricane Andrew Led to Higher Deductables. 18 July. Available at: www.flains.org/content/view/349. Accessed 25 May 2008.

Forbes.com (2006) Good Hands, Iron Fist. By Carrie Coolidge, 27 November.

Forum, W. E. (2007) Global Risks 2007: A Global Risk Network Report. A World Economic Forum Report in collaboration with Citigroup, Marsh & McLennan Companies (MMC), Swiss Re and Wharton School Risk Center.

Freeman, P.K. and Kunreuther, H.C (2003) Managing Environmental Risk Through Insurance. Folmer and Tietenberg (Eds.) International Yearbook of Environmental and Resource Economics. pp 159-189. Edward Elgar Publishing Ltd.

Friedman, S. (2007) Be Practical On Climate Risk, Insurers Told. National Underwriter Property & Casualty. 12 November 2007.

Garnaut Climate Change Review (2008) Garnaut Climate Change Review Interim Report. February. Available at: www.garnautreview.org.au.

Garnaut R. (2008) The Garnaut Climate Change Review. Cambridge University Press Australia. Available at: www.garnautreport.org.au/

Green, M. (2006) Insurers Reward Eco-Friendly Clients. Best's Review, 1 December.

Guardian (2007) Global Carbon Trading Market Triples to £15bn. By Mark Milner, 3 May. Available at: www.guardian.co.uk/environment/2007/may/03/business.climatechange/print.

Hansen, J., Sato, M., Ruedy, R. *et al.* (2006) Global Temperature Change. Proceedings of the National Academy of Sciences 103: 14288.

Hansen, J. (2007) Scientific Reticence and Sea Level Rise. Environmental Research Letters 2: 1-6.

Hansen, J. (2008) National Press Club address and briefing to the House Select Committee on Energy Independence & Global Warming, 23 June.

Harvey, N. and Woodroffe, C.D. (2008). Australian Approaches to Coastal Vulnerability Assessment. Sustainability Science 3: 67-87.

Hawker, M. (2007) Climate Change and the Global Insurance Industry. The Geneva Papers 32: 22-28.

Hempel, G. and Sherman, K. (2003) Large Marine Ecosystems of the World: Trends in Exploitation, Protection, and Research. Amsterdam: Elsevier Science.

Hoeppe, P. (2007). Scientific Evidence for Influences of Global Warming on Extreme Weather Events – Consequences for Cat Modelling, Munich Reinsurance Company.

Hoff, H., Bouwer, L. *et al.* (2003). Risk Management in Water and Climate - the Role of Insurance and Other Financial Services, Joint Report by Dialogue on Water and Climate and Munich Re.

Hogg, M. (2005) Intangible Assets, Risk Management and Insurance: Bringing All Minds Together. Risk Management and Innovation in Japan, Britain and the United States. R. Taplin (Ed.) Oxon, Routledge.

IAG/DEC (2006) Sustainability Compact Between IAG and the Department of Environment and Conservation NSW.

IAG (2007) A Shared Future. IAG Sustainability Report.

IAG (2005) IAG Sustainability Report 2005. Available at: www.iag.com.au/sustainable/reports/2005/understandingAndPricingRiskChallenge2.shtml.

IBHS (undated) Institute for Business and Home Safety Website. Available at: www.ibhs.org.

Ibuyeco (undated) Ibuyeco website. Available at: www.ibuyeco.com.au/index.jsp?LinkId=04262.

ICA (2008a) Improving Community Resilience to Extreme Weather Events.

ICA (2008b) Improving Community Resilience to Extreme Weather Events. Insurance Council of Australia Media Release, 16 April.

IEA (2007) Annual Report 2007. Available at: www.iea-pvps.org.

IFSL (2007) Fund Management 2007. Available at International Financial Services London website: www.ifsl.org.uk/upload/CBS_Fund_Management_2007.pdf

INTERCEP (2006) Low-Cost Preparedness Efforts Significantly Mitigate Loss: An InterCEP Mini-Case Study. October. New York University.

Insurance Journal (2007) New ‚GREEN' Captive Insurer Promises Savings for Eco-Friendly Businesses. 22 May.

IPCC (2001) Climate Change 2001: Impacts, Adaptation and Vulnerability. Cambridge University Press.

IPCC (2007a) Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (2007b) Climate Change 2007. The Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change.

IPCC (2007c) Climate Change 2007. Synthesis Report.

Johnson, M. E., and Watson, C., Jr. (2006) Fitting Statistical Distributions to Data in Hurricane Modeling. Department of Statistics, University of Central Florida.

Khalil A.F., Kwon H.-H. , Lall U., Miranda M.J. and Skees J. (2007) El-Nino-Southern Oscillation-based Index Insurance for Floods: Statistical Risk Analyses and Application in Peru. Water Resources Research 43:W10416. Doi.10.1029/2006WR005281.

Kovacs, P. (2005) Hope for the Best and Prepare for the Worst: How Canada's Insurers Stay a Step Ahead of Climate Change. Options Politiques.

Kunreuther, H.C. and Michel-Kerjan, E.O. (2006a) Climate Change, Insurability of Large-scale Disasters and the Emerging Liability Challenge. Paper Prepared for University of Pennsylvania Law Review, Conference on Climate Change, Philadelphia, PA. 16-17 November.

Kunreuther, H.C. and Michel-Kerjan, E.O. (2006b) Managing and Financing Extreme Events. A Research Program of Wharton Research Center.

Kunreuther, H. (2007) Catastrophe Insurance Challenges for the U.S. and Asia. Wharton Risk Management and Decision Processes Center.

Kronowitz, R. (2007) United States: Climate Change Exclusion. Mondaq. Available at: www.mondaq.com/article.asp?articleid=48264.

LaCroix, K. (2007) Climate Change: Directors' and Officers' Risk Ahead? Insurance Journal, West Addition. 4 June.

Larson, P. (2006) An Evaluation of the Sensitivity of US Economic Sectors to Weather. Cornell University.

Leigh, R. and Chen, K. (2006) A National Coastal Vulnerability Study. Report Prepared for the Insurance Council of Australia, February. Risk Frontiers, Macquarie University.

Lloyd's (2006a) 360 Risk Project: Climate Change: Adapt or Bust.

Lloyd's (2006b) 360 Risk Project: Catastrophe Trends: What Next on Climate Change?

Lloyd's (2007) 360 Risk Project: Rapid Climate Change.

Lloyd's (2008) 360 Risk Project: Directors in the Dock: Is Business Facing a Liability Crisis?

Lokey, E. (2007) Creative Renewable Energy Purchasing Options for Businesses. The Electricity Journal 20(1): 63-72.

Los Angeles Times (2007) Climate Change and the World Wine Map. By Corie Brown, 2 March.

Losey, J. and Vaughan, M. (2006) The Economic Value of Ecological Services Provided by Insects. BioScience 56(4): 311-323.

Mabey, N. (2007) The Engineering Response to Climate Change: The International Dimension.

MarketWatch (2007) Eco insurance: A Growing Market. MarketWatch Global Round-up. 6: 105-106.

Marsh (2006a) Climate Change: Business Risks and Solutions. A Report for Clients and Colleagues of Marsh on Risk-related Topics. Volume V(2).

Marsh (2006b) Survey of Insurance Availability for Renewable Energy Projects. A Report for the United Nations Environment Programme.

Maslowski, J., Kinney, C., *et al.* (2008). State of the Arctic Sea Ice. Geophysical Research Abstracts. 10: EGU2007-A-06425.

Mattson-Teig, B. (2007) Why Green Building Has Staying Power. National Real Estate Investor 49.

McAneney J., Crompton, R. *et al.* (2007a) Personal Lines Insurance: A Century of Damage. Australian and New Zealand Institute of Insurance and Finance Journal Volume 30(3): 16.

McAneney, J. K., Chen, K. *et al.* (2007b) Australian Bushfire Losses: Past, Present and Future. Conferencia Internacional sobre Incendios Forestales, Spain, 13-17 May.

McDonald, J. (2007) A Risky Climate for Decision-Making: The Liability of Development Authorities for Climate Change Impacts. Environmental and Planning Law Journal 24(6): 405-416.

McMichael, A., Woodruff, R. *et al.* (2006) Climate Change and Human Health: Present and Future Risks. The Lancet 367(9513): 859-869.

Meinke, H., Nelson R. *et al.* (2007) Rural Sector Adapting to Climate Change – Effects on Future Production. Prepared for ABARE, Outlook 2007, 6-7 March, Canberra.

Michel-Kerjan, E. and Morlaye, F. (2008) Extreme Events, Global Warming, and Insurance-Linked Securities: How to Trigger the "Tipping Point". The Geneva Papers, 2008, 33, (153–176).

Millea Group (2007) Corporate Social Responsibility Report 2007.

Mills, E., Torn, M.S. and Fried, J.S. (2002) Climate Change and Wildfire Severity in California. Environmental Energy Technologies Division Newsletter 3(1-2): 4.

Mills, E. (2003a) Climate Change, Insurance and the Buildings Sector: Technological Synergisms Between Adaptation and Mitigation. Building Research & Information 31(3-4): 257-277.

Mills, E. (2003b) Risk Transfer via Energy Savings Insurance. Energy Policy 31: 273-281.

Mills, E. (2005a) Insurance in a Climate of Change. Science 309(5737):1040-1044.

Mills (2005b) Availability and Affordability of Insurance Under Climate Change. Presented at the National Association of Insurance Commissioners Winter Meeting, Chicago, December.

Mills, E. and Lecomte, E. (2006a) From Risk to Opportunity: How Insurers Can Proactively and Profitably Manage Climate Change. A CERES Report.

Mills, E., Roth R., and Lecomte, E. (2006b). Availability and Affordability of Insurance under Climate Change: A Growing Challenge for the United States.

Mills, E. (2007a) From Risk to Opportunity: Insurer Responses to Climate Change. A CERES Report.

Mills, E. (2007b) Responding to Climate Change – The Insurance Industry Perspective. Climate Action, Sustainable Development International (in partnership with the United Nations Environment Programme) December: 100-103.

Mills, E. (2007c) Synergisms Between Climate Change Mitigation and Adaptation: An Insurance Perspective. Mitigation and Adaptation Strategies for Global Change (12): 809-842.

Mills, E. (2007d) Risk Assessment: Climate Change, Insurance, and Utilities. A Presentation for: Utility Executive Leadership Institute (UELI). Pinehurst Resort, North Carolina. 10 August.

Mother Jones (2005) Profits of Doom: Why the Insurance Industry is Putting its Money on Global Warming. By Dave Gilson, 18 April.

MMC Securities (2007) The Catastrophe Bond Market at Year-End 2006; Ripples Into Waves.

Muir-Wood, R., Miller, S. and Boissonade, A. (2006) The Search for Trends in a Global Catalogue of Normalized Weather-Related Losses. Workshop on Climate Change and Disaster Losses: Understanding and Attributing Trends and Projections. Hohenkammer, Munich, 188-194. Available at: sciencepolicy.colorado.edu/sparc/research/projects/extreme_events/munich_workshop/full_workshop_report.pdf.

Munich Re (1999) Topics 2000: Natural Catastrophes – The Current Position. Report 2895-M-e, Munich Re Group, Geoscience Research Group, Munich.

Munich Re (undated) The 1906 Earthquake and Hurricane Katrina: Similarities and Differences – Implications for the Insurance Industry. Web document, available at: www.munichre.com/en/corporate/history/san_francisco/the_1906_earthquake_and_hurricane_katrina/default.aspx. Accessed 22 May 2008.

NAIC (2007) Overview of the Potential Insurance-Related Impacts of Climate Change on Insurance Regulators. Climate Change and Global Warming (EX) Task Force, 11 January.

National Journal (2007) Feeling Storm Tossed. By Peter H. Stone, 7 July, p 30.

NFEE (2003) Towards a National Framework for Energy Efficiency: Issues and Challenges. Available at: www.nfee.gov.au.

Nicholls, R. J. *et al.* (2008) Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates. OECD Environment Working Papers, No. 1, OECD Publishing.

Norwich Union (2005) UK Householders Fear Flood Risk is Increasing; But Most Fail to Act to Reduce Damage. Media Release, 2 November. Available at: www.floodresilienthome.com/downloads/pressrelease.pdf.

NSFM (2008) Comment on OECD Guidelines for Pension Fund Governance. Network for Sustainable Financial Markets. www.sustainablefinancialmarkets.net

O'Connor, R. (2007) U.K. Insurers Establish Climate-Change Committee. Best's Review 108(6): 17.

OECD (2007) Insurance Statistics Yearbook 1996-2005.

Orr, J.C., Victoria, J. *et al.* (2005) Anthropogenic Ocean Acidification Over the Twenty-First Century and its Impact on Calcifying Organisms. Nature 437:681-686.

Phelan, L. and Taplin, R. (2007) A Powerful Agent of Change? The Global Insurance Industry as a Driver for Greenhouse Mitigation and Adaptation. A Presentation. Graduate School of the Environment, Macquarie University.

Point Carbon (2008a) Carbon Market Transactions in 2020: Dominated by Financials?" Carbon Market Analyst.

Point Carbon (2008b) To the Point: Carbon 2008, Post-2012 is Now. 11 March. Available at: www.pointcarbon.com/polopoly_fs/1.912721!Carbon_2008_dfgrt.pdf.

Pittock, B. (2005) Climate Change: Turning up the Heat. Earthscan, London.

Pollard, J. S., Oldfield, J. *et al.* (2008) Firm Finances, Weather Derivatives and Geography. Geoforum 39(2): 616-624.

Preston, B.L., Smith, T., Brooke, C., Gorddard, R., Measham, T., Withycombe, G., McInnes, K., Abbs, D., Beveridge, B. and Morrison, C. (2008) Mapping Climate Change Vulnerability in the Sydney Coastal Councils Group. Prepared for the Sydney Coastal Councils Group by the CSIRO Climate Adaptation Flagship, Canberra.

QFF (2006) Adaptation to Climate Change & Variability. Web article available at: www.qff.org.au/hot.asp?dbid=36. Accessed 23 May 2008.

Queensland Government (2007) ClimateSmart Buildings: Carbon Reduction Strategy for Government Buildings. Queensland Department of Public Works.

Rahmstorf, S. (2007) A Semi-Empirical Approach to Projecting Future Sea-Level Rise. Science 315: 368-370.

Renewable Devices (2008) New Partnership in 2008: Micro Wind Turbines Australia. 28 January. Available at: www.renewabledevices.com/news/company/new-partnership-announcement-renewable-devices-swift-turbines-ltd-and-micro-wind-turbines-australia.html.

Reo Research (2007) In the Front line: The Insurance Industry's Response to Climate Change, F&C Investments.

RESNET (undated). RESNET Insurance Program website. Available at: www.locktonaffinity.com/resnet/.

RMS (2005) Hurricane Katrina: Profile of a Super Cat Lessons and Implications for Catastrophe Risk Management.

RICS (2004) The Impact of Flooding on Residential Property Value. Prepared by Liverpool John Moores University and University of Wolverhampton for the RICS foundation, September 2004.

Ross, C. and Mills, E. (2007) Limiting Liability in the Greenhouse: Insurance Risk-Management Strategies in the Context of Global Climate Change UCLA School of Law Public Law & Legal Theory Research Paper Series, Research Paper No. 07-18.

Ross, C., Mills, E. *et al*. (2007) Review of Liability Insurance Considerations in the Context of Global Climate Change. 24 February 2007 Symposium: Climate Change Liability and the Allocation of Risk, Stanford Law School.

RSA (2007) Royal & SunAlliance First Insurer to Launch Global Renewable Energy Business. Media release, 1 May.

Schymyck, N. (2005) Emerging Risk. Risk Management and Innovation in Japan, Britain and the United States. R. Taplin (Ed.) Oxon, Routledge: 21-44.

Smith, D.F. (2007) Near Term and Long Term Hurricane Risk. EQECAT, Inc.

Sompo (2006) Corporate Responsibility Report 2006. Sompo Japan Insurance. Available at: www.sompo-japan.co.jp/english/about/csr/report/download/CSRreport2006.pdf

Stagnitta, L. and Forster, K. (2004) Is Climate Change for Real and if So What is the Cause, Likely Impact and Remedy. Australian Building Codes Board National Conference.

Stern, N. (2006) The Economics of Climate Change: The Stern Review HM Treasury/Cabinet Office.

Stewart, W.F. and Fontaine, P.J. (2007) The Business of Global Warming: Managing the Risks and Opportunities of Climate Change. A Report for Cozen O'Connor.

Swiss Re (2006a) CRO briefing: Climate Change & Tropical Cyclones in the North Atlantic, Caribbean and Gulf of Mexico.

Swiss Re (2006b) RNK Capital and Swiss Re Structure First Insurance Product for CDM Carbon Credit Transactions.

Swiss Re (2007) World Insurance in 2006: Premiums Come Back to Life.

Swiss Re (2008a) World Insurance in 2007: Emerging Markets Leading the Way.

Swiss Re (2008b) Natural Catastrophes and Man-Made Disasters in 2007.

Taplin, R. and Schymyck, N. (2005) An Interdisciplinary and Cross-cultural Approach. Risk Management and Innovation in Japan, Britain and the United States. R. Taplin (Ed.) Oxon, Routledge.

TCB (2008) The 2008 Institutional Investment Report: Trends in Institutional Investor Assets and Equity Ownership of U.S. Corporations. Available via The Conference Board website: www.conference-board.org/publications/describe.cfm?id=1548.

The Age (2007) Insurers Embrace the Winds of Change. By Peter Weekes and Jacinta Hannaford, 12 August.

Times-Picayune (2007) Using loophole, Allstate Insurance Drops Longtime Customers. 24 April. Available at: blog.nola.com/times-picayune/2007/04/all.html.

Torn, M.S., Mills, E. and Fried, J.S. (1998) Will Climate Change Spark More Wildfire Damage? LBL Report #42592.

Trenton, A. (2005) Developments in Patent Enforcement Procedure in Japan and England. Risk Management and Innovation in Japan, Britain and the United States. R. Taplin (Ed.) Oxon, Routledge: 77-89.

UKCIP (2002) Change Scenarios for the United Kingdom. A report by Hulme, M., Jenkins, G.J. *et al*., for the United Kingdom Climate Impacts Programme: UKCIP02.

UN-Energy (2007) Sustainable Bioenergy: A Framework For Decision Makers.

UNFCCC (2007a) Consultation with Insurance Sector on Finance and Investment Flows to address Climate Change. London, 20 June 2007.

UNFCCC (2007b) Report on the Workshop on Climate-related Risks and Extreme Events, United Nations.

UNFCCC (2007c) Report on the Workshop on Climate-Related Risks and Extreme Events. Subsidiary Body for Scientific and Technological Advice, 27th session, Bali, 3–11 December. Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change.

UNEP-FI (2007) Insuring for Sustainability. Inaugural Report of the Insurance Working Group.

UNEP-FI (2006) Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector. CEO Briefing.

USA Today (2008) Katrina Victims Swamp Corps with Trillions in Claims. By Brad Heath, 1 July.

Valverde, L. (2006) Global Climate Change and Extreme Weather: An Exploration of Scientific Uncertainty and the Economics of Insurance. Insurance Information Institute Working Paper Series, New York.

Wall E. and Smit B. (2005) Climate Change Adaptation in Light of Sustainable Agriculture. Journal of Sustainable Agriculture 27:113-123.

Watson Wyatt (2008a) The World's 300 Largest Pension Funds. Available via: www.watsonwyatt.com/research/resrender.asp?id=PI_300_Analysis_2007_YE&page=1

Watson Wyatt (2008b) Top pension funds reach twelve trillion dollars. Media release, September 2. Available at: www.watsonwyatt.com/news/press.asp?ID=19678

Watt, M. and River, J. (2005) Feed-in Tarriff Options. Available at: www.ceem.unsw.edu.au/content/documents/Feed-inTariffOptionsv3.pdf.

Webster, P. J., Holland, G. J., Curry J. A. and Chang H.-R. (2005) Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment. Science 309 (5742): 1844-1846.

WEEA (1999) Briefing Paper on Energy Services Companies with Directory of Active Companies (Revised Edition).

Westerling, A. and Bryant, B. (2008) Climate Change and Wildfire in California. Climatic Change 87 (Suppl 1):S231-S249.

Wharton (2007) Extreme Events, Global Warming and Insurance-Linked Securities: How to Trigger the "Tipping Point".

Woods, P. (Undated) Climate Change and the Role of Insurance in Mitigating Natural Disasters. (Sustainability Research Manager, Insurance Australia Group).

World Economic Forum (2007) Global Risks 2007: A Global Risk Network Report.

XL Insurance (2007) Competition Hots up for New Fuel Sources. Insight. Available at: www.xlinsurance.com/INSight_EU/download/INsight07_EU_Energy_Competition.pdf.

Yeo, S.W. (2003) Effects of Disclosure of Flood-Liability on Residential Property Values. Australian Journal of Emergency Management 18(1): 35-44.

Zurich (2008a) Zurich Launches Market-Focused Climate Initiative. Media release, 21 January.

Zurich (2008b) BCM and Catastrophic Claims Process. Zurich Financial Services Australia Limited.

Zurich (2008c) Global Energy Unit Forms Dedicated Alternative Energy Team. Media release, 22 April.

## Appendix A: Definitions

General insurance: This term essentially refers to non-life insurance policies; in the US, general insurance is also referred to as property and casualty insurance. General insurance encompasses lines including, but not limited to: property, flood, vehicle/auto, crop, marine, public liability, business interruption (although the terminology for and makeup of these lines also vary across jurisdictions). Globally, approximately 40% of premiums are general insurance, with the remainder life-health.

Climate change hazard: A climate-change-related event, series of events/variation, (or an action resulting from these), which has the potential to result in a material loss for an insurer, its customers and/or reinsurers. An example of such a hazard would be a projected increase in the number of severe and damaging hail events in Johannesburg due to climate change.

- **Primary climate change hazards:** This refers to climate-change-related physical weather or climate impacts. Examples include individual weather events (eg windstorms, hailstorms or cyclones), changes in climate norms or means (eg reduced average annual precipitation) or shifts in climate-linked systems (eg El Niño Southern Oscillation effects or ocean acidification).

- **Secondary climate change hazards:** These describe regulatory interventions by government or industry to address climate change. Examples include GHG emissions trading schemes (ETS) or new building standards.

- **Tertiary climate change hazards:** This refers to societal reactions to climate change and regulation. This includes auto-adaptation, such as urban residents coping with increases in the number of very hot days by installing airconditioners.

Climate change vulnerability: The sensitivity of insurers' business activity to climate-change-related loss. This sensitivity encompasses policies, premium setting, internal capacity and loss/premium ratio. An example of this is an insurance policy that covers property damage due to hail, but has been priced at a level that fails to account for an increase in severe hail events due to climate change, thereby increasing an insurer's vulnerability.

Climate change exposure: The market, both geographical and sectoral, in which an insurer is active and the extent/value of that market. For example, an insurer who provides coverage for hail damage for public sector vehicle accumulations in Sydney is exposed to a market that is subject to this climate-change hazard.

Climate change opportunity: The term refers to the potential for an insurer to reduce climate-change-related risks, increase profitability and/or grow business by risk transfers, risk management, risk mitigation and provision of new products. For example, an insurer may recognise the increasing need for car retailers to deal with the risks of more severe hail storms.

Climate change capacity: This describes the actual policies, product lines, know-how, methods and measures used by insurers to tap new markets emerging in response to climate-change-related events or actions or, alternatively, to achieve resistance or resilience to climate change risks in current markets. For example, the insurer can not only provide increased levels of cover for hail storm damage but also a reduced excess for car yards that erect hail-proof roofs for their outdoor vehicle displays.

Climate change adaptation: The IPCC defines adaptation as an "Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects".

Climate change mitigation: The IPCC defines mitigation as "Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks".

## Appendix B: Glossary

ABC - Australian Broadcasting Corporation

ABI - Association of British Insurers

AFR - Australian Financial Review

AMA - Australian Medical Association

ACF - Australian Conservation Foundation

AETS - Australian Emissions Trading Scheme

ART - Alternative Risk Transfer

ASIC - Australia Securities and Investments Commission

BTE - Bureau of Transport Economics

BSCE - Business Council for Sustainable Energy

CDGs - Carbon emission credit delivery guarantees

CDM - Clean Development Mechanism

CDP - Carbon Disclosure Project

CEC - Clean Energy Council

CER - Certified Emissions Reduction

CERES - Coalition for Environmentally Responsible Economies

CSIRO - Commonwealth Scientific and Industrial Research Organisation

D&O - Directors and Officers (ie D&O insurance)

DITR - Department of Industry Tourism and Resources

ENSO - El Nino Southern Oscillation

ESCO - Energy Services Company

EUETS - European Union Emissions Trading Scheme

GHG - Greenhouse Gas

IBHS - Institute for Business and Home Safety

ICA - Insurance Council of Australia

IEA - International Energy Agency

IFSL – International Financial Services London

INTERCEP - International Center for Enterprise Preparedness

IPCC - Intergovernmental Panel on Climate Change

JI - Joint Implementation

NAIC - National Association of Insurance Commissioners

NFEE - National Framework for Energy Efficiency

NSFM – Network for Sustainable Financial Markets

QFF - Queensland Farmers' Federation

RMS - Risk Management Solutions

SAM - Southern Annular Mode

TCB - The Conference Board

UNEP - United Nations Environment Programme

UNEP-FI - United Nations Environment Programme Finance Initiative

UNFCCC - United Nations Framework Convention on Climate Change

UKCIP - United Kingdom Climate Impacts Programme

WEEA - World Energy Efficiency Association






**Climate Risk Pty Limited (Australia)**
Sydney: + 61 2 8243 5767
Brisbane: +61 7 3368 2902
www.climaterisk.net

**Climate Risk Europe Limited**
London: + 44 752 506 8331

Climate Risk