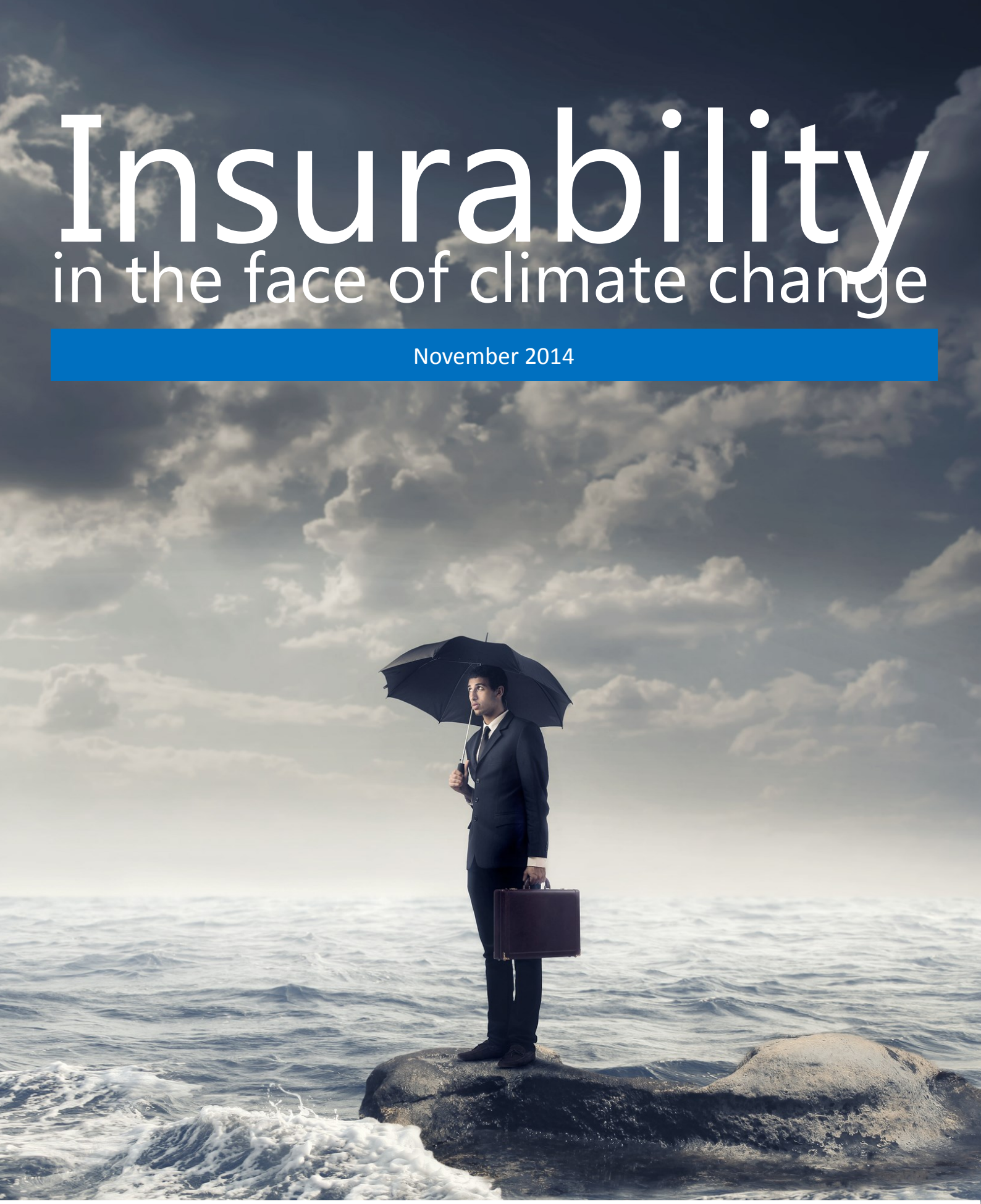
Insurability
in the face of climate change

November 2014



ClimateWise
REDUCING THE RISK FOR TOMORROW

Facilitated by

UNIVERSITY OF CAMBRIDGE
INSTITUTE FOR SUSTAINABILITY LEADERSHIP

Author

CALLUND CONSULTING

Contents

This publication has been developed by Callund Consulting Ltd, 154 Victoria Road, Wargrave, Berkshire RG10 8AJ, United Kingdom, T. +44 7711 566425, Email: nsilver@callund.com, www.callund.com

About this report

This report is intended to explore the interaction between climate change and insurability in order to support an informed debate that helps to avoid maladaptive practices and promote risk reduction activity. It was commissioned from Callund by ClimateWise and the Cambridge Institute for Sustainability and prepared by Callund Consulting Limited.

About ClimateWise

ClimateWise leverages the insurance industry's expertise to better understand, communicate and act on climate change risk.

Members commit to action following six key principles and are independently reviewed against these annually. ClimateWise's membership includes non-life and life insurers, reinsurers, intermediaries, risk modellers and professional bodies from around the world covering Asia, Europe, North America and Southern Africa. Membership is led from the Company Board level and supported by senior practitioners from across the organisation.

ClimateWise is a voluntary initiative, driven by its members and facilitated on a not-for-profit basis by the University of Cambridge Institute for Sustainability Leadership (CISL), which provides the Secretariat for the group.

Connect with us via our LinkedIn Group (Search 'ClimateWise'), Twitter (@ClimateWise) or contact the ClimateWise Secretariat:

1 Trumpington Street, Cambridge, CB2 1QA,
United Kingdom
T: +44 (0)1223 768850
E: info@climatewise.org.uk
www.climatewise.org.uk

The project was undertaken by an interdisciplinary team:

- Nick Silver, an actuary, is a Director of Callund consulting, a Director of the Climate Bonds Initiative, and a member of the Institute and Faculty of Actuaries' Resource and Environment Board
- Louise Pryor, an actuary and risk modelling specialist, is a member of the Institute and Faculty of Actuaries' Resource and Environment Board
- David Cook, an environmental economist and sustainability consultant, is based at the University of Iceland

Many thanks to all those involved in the industry who were interviewed for this report, and those who have commented on earlier drafts.

Please refer to this report as: 'Insurability in the face of climate change', University of Cambridge Institute for Sustainability Leadership and ClimateWise 2014.

Executive Summary

There is now widespread acceptance that the world's climate is changing. This report considers the potential impact of climate change on insurability drawing on information from three case studies: property insurance in Florida, agricultural insurance in India and supply chain risks and insurance. Each case study includes a description of the geographical and commercial environments and the insurance market followed by a discussion of whether there is evidence of uninsurability or other problems in the insurance market, and, if so, the role played by climate change.

All three insurance markets exhibit evidence of uninsurability. In Florida, many insurers exited the market or stopped writing new policies in the aftermath of Hurricane Andrew and the 2004 and 2005 storm seasons. In India only around 20% of farmers are covered by crop insurance. Worldwide, there is low uptake of insurance covering supply chain risks. In all three cases, while it is not the only factor, climate change intensifies other market problems by introducing uncertainty or by increasing risk.

A major factor influencing insurability is the extent of uncertainty: greater levels of uncertainty mean that acceptable premium levels are more difficult to achieve. In a market in which there is a great deal of uncertainty, a single event can change perceptions of the underlying risk and so have a disproportionate effect on premium levels. This can render risks uninsurable because of a mismatch between policyholders' and insurers' pricing of risk. There are several courses of action that could assist insurers in mitigating the adverse effects of climate change on insurability.

They focus on increasing the joint understanding of risk and uncertainty by insurers, policyholders and other stakeholders through communication and research: by broadening the pool of those who share existing knowledge, and by deepening the knowledge that can be shared. There are three main areas that should be addressed:

- achieving a shared understanding of climate related risk among stakeholders,
- working with regulators to avoid unintended consequences, and
- working to understand and reduce levels of uncertainty.

The insurance industry benefits from, and is a vital part of, a healthy economy. The availability of insurance is an important prerequisite for many types of commercial activity, and a thriving commercial sector provides a large and potentially profitable insurance market. It is therefore in insurers' interests that they act in a way that supports the development of a healthy and resilient economy, and they are well placed to have significant influence. Acting now in order to affect the future is a strategic choice: the alternative is to wait until severe problems have emerged, by which time there may be no practical solutions to them. There may therefore be longer-term payoffs for persisting in insurance markets that are currently weak, or for developing new types of cover.

1. Insurability and climate change

The Intergovernmental Panel on Climate Change (IPCC) published its *Fifth Assessment Report* (AR5) in 2014. The overall conclusion is that warming of the climate system is unequivocal and is caused by human activity. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen. Changes in climate have affected natural and human systems across the globe. It is likely that the frequency of extreme weather events is increasing. It is very likely that in the future heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. In 2012 the IPCC report *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (SREX) concluded that climate risks are expected to rise in the future as a result of climate change. SREX identifies the following changes as being likely in some or all regions, with varying confidence levels:

- An increase in warm temperature extremes and a decrease in cold extremes, with longer, more frequent and stronger heat waves
- Rising coastal high water levels
- Higher frequency of heavy precipitation
- Intensification of droughts
- An increase in the frequency of the most intense tropical cyclones (although not necessarily the overall frequency)

These changes imply changes in related phenomena, such as flood frequencies and levels, and high mountain phenomena such as landslides and glacial lake outburst floods.

Overall, there is widespread agreement that change is occurring and will continue into the future, but there are high levels of uncertainty surrounding the likely future impacts. In particular, it is often difficult to assess the impacts on a local scale, even when global patterns appear clear. The details will not emerge until the changes have actually occurred.

This report considers how these changes, and the uncertainty surrounding them, might affect insurers, and what actions could be taken now in order to prepare for them.

This report does not present new research into climate change or its effects. Instead, it brings together existing information (much of which may already be known to individual insurers) in a form that clarifies the long-term effects and some of the barriers to the maintenance of active and healthy insurance markets.

Insurability

For the purposes of this report, a risk is described as insurable if it is practicable to write insurance on it. In order for a risk to be insurable, the following conditions must be met:

- It is possible to define the risk in such a way that it can be reasonably and unambiguously determined whether there is a genuine claim under an insurance policy, and how much that claim amounts to
- An insurer is prepared to write the insurance at a price that can be offered in the market
- There are potential policyholders who are prepared to buy the insurance at the price offered by the insurer

The price of the insurance includes the premium that is paid for a specified level of cover, and the terms and conditions attached to the insurance, including the excess borne by the insured.

In practice, there are a number of factors that contribute to insurability, including:

- Whether the potential policyholders perceive that there is a risk that they would like protection against
- Whether the risk aversion of the potential policyholders is high enough to justify the cost of insurance
- Whether the insurers have enough information to be able to judge the price at which they can write the insurance profitably
- The attitude of regulators towards the proposed price

Effects of climate change on insurability

Climate change can affect insurability in several ways.

- It can increase the level of risk, leading to higher premiums, higher policyholder excesses or more restrictive terms and conditions. In turn, these effects may lead to a lack of demand for insurance (if potential policyholders perceive it as poor value for money), or an inability to write the insurance profitably (for example, if regulators limit the prices that can be charged to a level below that which the insurers consider profitable).

- Climate change can increase the uncertainty involved in insurance. It may become less feasible to extrapolate from past experience to project the frequencies and levels of claims that might be expected in the future, thus making it more difficult for insurers to price the risk. In this case they may become unwilling to write insurance in a particular area, or may add a large margin to the premium to allow for the uncertainty, which makes the insurance unaffordable or perceived as poor value for money.

- An increased level of risk can lead to more demand for insurance, creating a potential market where there was none before, such as drought insurance for hydroelectricity.

- Climate change can act as a threat multiplier, giving rise to second order impacts. For example, a drought or flood could lead to political instability, giving rise to increased political risk which may affect insurers directly, or indirectly through lower economic activity.

- Climate change may decrease the level of risk, leading to reduced demand for insurance in a previously thriving market. For instance, rainfall patterns are likely to change, and some areas will have much less rain than hitherto, leading to less flooding.

Climate change can affect risk both directly, through changing weather and environmental conditions, and indirectly, through the effects of mitigating measures.

For instance, new techniques or materials are developed to reduce the carbon footprint of construction or industrial processes: these new ways of doing things can change the resulting product's vulnerability to other risks, such as fire or water damage. Moreover, whole new industries are developing in response to climate change: the renewable energy industry, for example, and carbon capture and storage. These new industries will have limited past claims experience with which to price risk. Climate change can also make new types of operations viable, either by changing the conditions under which they are performed, or by affecting the demand for the products they produce: some of the drilling and recent shipping activities in the Arctic region are examples of this type of effect.

Climate change can thus lead to a reduction in insurability on one hand, and opportunities in the shape of new markets for insurance on the other.

Real or perceived increases in levels of risk often go hand in hand with increased uncertainty. For example, there is a growing body of scientific evidence that climate change will lead to an increased number of flood events on a global scale. Although it is known that certain regions are more vulnerable than others, the exact location of floods remains relatively uncertain. Similarly, there is currently a perception that climate change is leading to increased or more severe hurricane activity, but the extent or location of any change in risk is not known with any reliability.

Both types of effect appear in the case studies described in section 2. Increased premiums and market withdrawals in homeowner's insurance appear to be driven primarily by increased risk, while much of the difficulty in the area of supply chain insurance is a direct result of a high level of uncertainty. It should also be noted that the effects of climate change increase with time, so the impact on insurability (and the insurance market in general) is likely to be more significant in the future.

Types of insurance affected by climate change

Most of the press coverage around climate change and insurance focuses on just two types of cover: homeowner and crop insurance although they are by no means the only lines that could be affected.

Property insurance in general can be affected in many ways, including through changes in weather patterns, increased storms and flooding, higher water tables etc. Much of the public information is concentrated on homeowner's insurance, presumably because of its newsworthiness. Other forms of insurance such as commercial property and infrastructure are subject to similar perils.

Crop insurance is clearly highly dependent on the weather. The availability of crop insurance (and the form it takes) is highly variable across jurisdictions and geographic areas.

Liability claims can arise if dangerous substances or other pollutants escape into the environment from industrial or other premises. Such leakages may become more common if weather patterns worsen (they were seen in the aftermath of Hurricane Katrina, for example). Climate change may also lead to changes in the legal environment affecting Directors & Officers Liability (D&O) insurance. For instance, there is the possibility of law suits being brought against fossil fuel companies and their executives for opposing policies to fight climate change. It is also possible that structures (such as bridges or dams) could become unsound in the face of climate change impacts (for example, increased flooding), leading to more potential law suits.

Business continuity cover will be affected if there are increases in disruption due to changing weather patterns, and the same applies to **supply chains**.

Particular industry sectors will be affected if their operations are significantly dependent on weather-related risks. For instance, oil and gas explorers are entering the Arctic, a fragile and hostile environment that is very sensitive to the influences of climate change. The construction industry may be sensitive to local effects caused by its own activity: developments built in flood plains or regions liable to drought can lead to local changes such as changing water tables and the urban heat island effect. Large water users, such as power and mining companies, may cease to have access to the water they need.

The offshore and onshore wind industries are sensitive to changing wind patterns. Offshore drilling is also affected by storms. Farming and forestry are affected by changing growing conditions. Fish farming is affected by the acidification of the ocean and the accumulation of pollutants, changes that are linked to increased levels of carbon dioxide in the atmosphere. The tourism and leisure industry is notably sensitive to weather conditions.

Finally, the possible effects of climate change are often ignored in the areas of life and health insurance. There may be changing risks of life threatening diseases, as well as loss of life from catastrophic events. The bulk of this risk is considered to be uninsured.

2. Case studies

Three case studies were selected for analysis:

- Property insurance in Florida
- Agricultural insurance in India
- Supply chain risks and insurance

Descriptions and analysis are primarily based on publically available information, supplemented by interviews with some of those involved in the industry, including members of ClimateWise.

Property insurance in Florida

Florida is the fourth most populous state and the eighth most densely populated state in the USA, with a population of 19m. Its annual GDP was $800bn in 2013 and it is home to about 2 million firms. A total of 110,000 new homes are expected to be built in Florida in 2014, around 10% of the total for the USA as a whole.

Geographically, it is in the south east of the USA, with most of the state forming a peninsula between the Gulf of Mexico and the Atlantic Ocean: its coastline is just over 2000km long. The state is generally quite low-lying, with a highest point of just 105m above sea level.

Florida's location means that many hurricanes and tropical storms hit the state, and its topography means that they tend to cause significant damage. In fact, more hurricanes hit Florida than any other state in the USA. The number of recorded storms affecting Florida appears to have risen over the past century, although no major hurricane has hit the state since 2005.

The state suffered major damage from Hurricane Andrew in 1992, and again in the hurricane seasons of 2004 and 2005. At the time, Hurricane Andrew was the costliest hurricane in United States history, causing about $52bn in damages in Florida (in 2005 dollars). Most of the damage in Florida was caused by high winds. The 2004 and 2005 hurricane seasons were two of the most costly seasons on record. Three of the top ten costliest Florida hurricanes occurred in 2004 and 2005 (Hurricanes Wilma, Charlie and Ivan).

It is not certain that the apparent increase in frequency of hurricanes is due to climate change. However, it is likely that over the next century warmer oceans will cause hurricanes to become more intense, that numbers of very intense storms will increase in some regions (though not necessarily the overall number of storms), and that hurricanes will have substantially higher rainfall rates than present day hurricanes.[1]

Insurance market

The property insurance market in Florida was significantly affected by Hurricane Andrew in 1992 and the storm seasons of 2004 and 2005. The market is now dominated by a public insurer, Citizens Insurance Corporation (Citizens), which is the successor of arrangements established after Hurricane Andrew in 1992. It was originally intended that Citizens would write insurance only for applicants who could not obtain cover elsewhere, but since 2007 there have been few restrictions.

There are two other unusual features of the market: the presence of significant numbers of Florida-domiciled insurers who write primarily Florida property insurance ("domestics") and Florida-domiciled subsidiaries of national insurers who write only Florida property insurance ("pups"). Domestics are essentially monoline insurers, and reinsure about 60% of their liabilities. A number of them appear to be financially weak, with low levels of capital compared to the premiums they write. The use of pups allows national insurers to protect their non-Florida assets in the event of catastrophes in the Florida property insurance market. This unusual structure arose after many insurers exited the Florida market or stopped writing new policies after Hurricane Andrew and the storm season of 2004-5.

[1] See http://www.gfdl.noaa.gov/global-warming-and-hurricanes and http://www.c2es.org/science-impacts/extreme-weather/hurricanes

Citizens' premium rates are effectively set by Florida's Office of Insurance Regulation (OIR). Premium increases on any individual Citizens policy are limited to 10% per year. Citizens has three insurance accounts, covering personal lines, commercial lines and coastal properties, and may levy post-loss assessments when any of the three has a deficit. These financial levies are imposed on nearly all policyholders of property casualty insurance in Florida, regardless of insurer.

There is also a public reinsurer, the Florida Hurricane Catastrophe Fund (FHCF). It provides reinsurance for a portion of an insurer's hurricane losses above the insurer's required FHCF retention. Insurers that write covered policies must enter into a contract with the FHCF and pay an annual premium for the coverage. If the FHCF's losses exceed its surplus, it may levy assessments on nearly all policyholders of property casualty insurance in Florida.

Insurers are required to apply mitigation credits to property insurance premiums on properties that meet certain conditions. The basis on which these must be applied was changed in 2003 and 2006-7, resulting in a rate structure that applies no surcharges to risks that are worse than average, although the base rates were originally computed for average risks. An adverse effect is that in order to reduce underwriting losses, it makes more sense to underwrite properties that have not been inspected or are unreinforced.

The Florida Catastrophic Storm Risk Management Center, in the College of Business at The Florida State University, prepared two Annual Reports on the State of Florida's Property Insurance Market for the Florida Legislature in 2011 and January 2013. The two reports identified a number of problems in the Florida property insurance market that meant that the aim of a "healthy, competitive private residential insurance market" had not been achieved. The contributory factors cited in the reports included:

- The market dominance of Citizens, which may be a cause or effect or both
- An emphasis in public policy on the affordability of premiums, rather than their adequacy
- The system of assessments for Citizens and FHCF meaning that poor risks are subsidized by good ones
- The system of mitigation credits not working effectively

It is notable that the structural changes to the market occurred in the aftermath of Hurricane Andrew in 1992 and the 2004-5 storm seasons. For instance, in 2005 Allstate stopped writing commercial property insurance in Florida, and decided not to renew 15% of its residential policies, citing the 2004 storm season as a reason. In the early to mid 1990s insurers revised their estimates of the probable maximum loss (PML) from $10-20 billion before Hurricane Andrew to $50-100 billion after it. This caused an increase in catastrophe reinsurance rates and a reduction in reinsurance capital available. Large insurers could not obtain the catastrophe reinsurance that they needed.

Analysis

Evidence for uninsurability

There is evidence for uninsurability in the Florida property insurance market, and it is possibly at least partially caused by climate change. The Annual Reports on the State of Florida's Property Insurance Market conclude that there is not a healthy, competitive private residential insurance market: there are few national insurers in the market, which is dominated by Citizens and has an unusual structure. Many insurers exited the market or stopped writing new policies in the aftermath of Hurricane Andrew or after the 2004-5 storm seasons. There are concerns about the capital strength of some sectors of the private market (although despite these issues, over 75% of homeowners in Florida still get their windstorm insurance from private insurers).

Causes of uninsurability

On the face of it, the proximate cause of uninsurability is that premium rates are lower than insurers would like, because of price regulation and the presence of Citizens in the market. However, we suggest that there are three underlying causes of this situation:

- The sharp increase in PML estimates after Hurricane Andrew indicates high levels of insurer uncertainty regarding hurricane risk in Florida. If there had been low levels of uncertainty, a single event would not have changed those estimates by a significant amount. The presence of uncertainty tends to increase prices, as insurers try to protect themselves against the worst outcomes. It seems likely that Hurricane Andrew prompted insurers to reconsider their views on the levels of uncertainty.

- Insurability implies that the parties to the insurance transaction – policyholder, insurer and reinsurer – have a shared view of the risk. In this case, it appears that the policyholders and their proxies (who may include regulators, brokers or even insurers' marketing or sales teams) do not consider the risk as severe as do the reinsurers. This may be an example of anchoring – policyholders have an expectation of insurance premium levels based on past experience, and do not accept that a large increase in premiums is due to an underlying change in the risk premium.
- Poor construction quality and rapid coastal developments with highly vulnerable buildings increase the exposure and hence the risk premiums. Planning policy, building codes and the actions of developers thus affect the insurance market, as well as having wider economic impacts.

Market adaptation

The market has adapted to the lack of insurability in several ways. Citizens and FHCF are public insurers and do not have to rely on existing capital to pay losses, but through the assessment mechanism can raise extra funds from, effectively, the general public. The pups have been set up in such a way that the assets of their parent groups are not at risk in the event of poor experience in Florida. These market participants have thus isolated themselves to a certain extent from the full effects of the risk.

More generally, risk assessment underwent significant changes after Hurricane Andrew, prompted by the realisation that risk levels had previously been underestimated. At that time, probabilistic catastrophe models were estimating higher PMLs than were generally accepted in the market. The effects of Hurricane Andrew supported the higher estimates, and probabilistic catastrophe modelling became widely accepted. Since then, risk estimates among insurers and reinsurers have converged and stabilised.

Ultimately, part of the adaptation is that either the policyholders or taxpayers are taking some catastrophe risk, if the private or public insurers were to fail in the event of a severe hurricane season.

Impacts

The overall effect of the problems in the market is difficult to assess. The main impact is a large concentration of risk borne by policyholders and tax payers, the extent of which they may not fully appreciate. In a bad season the following effects could occur:

- Private insurers (especially poorly capitalised domestics or pups) could fail, meaning that claims would not be paid
- If Citizens' losses exceed its surplus, all policyholders (regardless of insurer) could be subject to a levy
- If FHCF's losses exceed its surplus, it too could raise a levy from policyholders

Policyholders thus face a triple risk (if they are not insured with Citizens; double if they are), when they are probably assuming that they are fully covered. In this situation the Florida government could feel compelled to support aggrieved policyholders, leading to support being required from taxpayers.

Other possible impacts include:

- The damage that is suffered as a result of a severe hurricane might be worse than it could have been if the insurance market incentivised effective mitigation measures (and in fact it may even be disincentivising them). Coastal development is one of the major economic drivers in Florida, so encouraging effective building techniques and less risky choice of locations would probably have a significant impact on the level of damage.

- Insurers who have withdrawn from the market may suffer reputation damage.

- If premiums had been allowed to rise in the aftermath of major events, it is possible that they would have fallen in the intervening period. Premiums might now be higher than they actually are.

- A widespread failure of the current system could mean that the insurance industry faced even more political pressure or a maladaptive policy environment.

It is certainly true that Florida is particularly vulnerable to hurricanes. However, it seems likely that the private sector could provide competitive insurance rates, given sensible regulation, building codes and zoning, and appropriate terms and conditions in insurance policies in a country with a sophisticated and highly developed insurance industry.

Agricultural insurance in India

Agriculture accounted for nearly 14% of Indian GDP in 2013 and is India's largest economic sector, although its share of total GDP is declining. In world terms, India's agricultural output is second only to that of China. Two thirds of the Indian population depend on agriculture for their livelihood, and 70% of the farming community could be described as small and marginal farmers.

Agriculture in India relies heavily on the South Asian monsoon, an annual wind-driven weather pattern that typically provides 85% of annual precipitation during the three months from June to September. There are two principal cropping seasons. *Kharif* crops such as rice, millet and oilseeds are sown at the beginning of the monsoon season and harvested four to five months later. *Rabi* crops such as wheat, barley and sesame are sown after the end of the monsoon and harvested in spring, before the monsoon starts. The vagaries of the monsoon impact crops in several ways: too much rain can result in flooding, too little in drought and crops can be ruined if the monsoon arrives earlier or later than expected. The distribution of rainfall during the season is also important. More dry days during crop growth can reduce yields, while very intense bursts of rainfall can lead to flooding. The current variation in rainfall from year to year is typically around 10%, a level which has significant effects on crop yields

For many years Indian farmers have claimed that the monsoon is becoming less reliable. Recent scientific assessments have supported this view. It appears that there is less rain overall, more intense rainfall bursts and more frequent dry spells during the monsoon season.[2]However, simulations of future climate change generally suggest that the total monsoon rainfall will increase by 5% - 10%, so the impact is likely to be significant. It has also been suggested that short term variation in rainfall within the monsoon season is likely to increase, producing more floods and disruption of the growing season. Overall, the projections are that climate change is likely to make the monsoon less stable.

Insurance market

Agricultural insurance has been available in India since the 1970s. Historically, insurance has been provided by the government. Several schemes have been in operation over the last forty years, some lasting for only a few years before being replaced or updated in the hope of reducing problems in their operation.

The National Crop Insurance Programme (NCIP), launched in November 2013, includes the Modified National Agricultural Insurance Scheme (MNAIS), and the Weather Based Crop Insurance Scheme (WBCIS). Premiums are subsidised on a sliding scale, and premium rates are capped at levels depending on the crop and season. If the cap applies, the sum insured is reduced proportionately.

All states and provinces in India have the option of implementing MNAIS. All farmers growing specified crops in areas that are covered are eligible to buy insurance, which is compulsory for all those who take out crop loans. The insurance covers the value of the loan, and can be extended to cover 150% of the average yield of the crop in question in the local area (which may be anything from a single village upwards). Each year the actual yield for the local area is measured and compared to the threshold yield (which is based on historical yields). Claims are paid if the actual yield is less than the threshold yield multiplied by the indemnity level – 90%, 80% or 60% for low, medium and high risk areas. All farmers in the same area are deemed to have suffered the same shortfall in yield. Although the farmers are the beneficiaries of the insurance policies, the actual policyholders for the compulsory insurance are the banks, who also administer the premium collection and claims payments.

[2] See Singh, D, Tsiang, M, Rajaratnam B & Diffenbaugh NS (2014), Observed changes in extreme wet and dry spells during the South Asian summer monsoon season, *Nature Climate Change* **4**, doi:10.1038/nclimate2208 and Turner, A. G. and H. Annamalai (2012) Climate Change and the South Asian Monsoon, *Nature Climate Change* **2**: 587-595, doi:10.1038/nclimate1495.

MNAIS is a modified version of the National Agricultural Insurance Scheme (NAIS) which operated from 1999 to 2013. The principal change is the introduction of actuarially based premiums in MNAIS: the premium rates for NAIS were set by the government. NAIS covered an average of 15.7 million farmers each year, with a claims ratio of 331%. MNAIS has operated since 2010, in parallel with NAIS until 2013. It has so far covered an average of 1.8 million farmers each year, with a claims ratio of 80%.

WBCIS was first piloted in 2007, and uses the same area approach as MNAIS. Each area has a Reference Weather Station, and claims are paid on the basis of adverse weather events defined in terms of various triggers. The sum insured for each farmer is based on the area they have sown or planted with the crop in question. WBCIS has covered an average of 7.2 million farmers each year, with a claims ratio of 70%.

Since 2003, private insurance companies have been increasingly involved in the agricultural insurance sector. They are involved in two ways: first, they may bid to run the MNAIS or WBCIS in individual districts, and second, they also produce their own agricultural insurance products. Weather-based index insurance was introduced in the private sector before being proposed as a national government scheme. In general, private schemes are less attractive to farmers than government schemes because the government does not subsidise the premiums, which are therefore higher. However, some schemes have premiums subsidised by private companies: for example, Pepsico sources potatoes from contract farmers in India, who are incentivised to buy index insurance by a slight increase in payment from Pepsico if they do so, which 95% do.

Fisher and Surminski (2012) identified a number of barriers to private sector involvement in the agricultural insurance market in India, including:

- Limited demand for insurance
- Difficulties of distribution
- Difficulty of incorporating risk reduction measures because of complex regulation and lack of expertise within state governments

In 2014 a government report identified a number of problems that have consistently affected crop insurance schemes over the last forty years. They include:

- Double counting: farmers often take loans from more than one bank, so the same acreage is insured several times over
- The loan documentation may not specify which crop is being insured
- Adverse selection: farmers at higher risk (or in years when monsoon failure appears more likely) may be more likely to take out insurance
- There are continual problems with the method of measuring yields, and therefore with determining the amounts of any claims payments

Other problems that have been noted, particularly by the DHAN Foundation, include:

- Moral hazard: once insured, farmers may be less likely to apply fertilizer and other inputs
- Distribution and administration costs: contracts are generally for small amounts
- Asymmetric information

The DHAN Foundation has noted that some of these problems are much less severe for weather-based insurance than for yield-based insurance.

Analysis

Evidence for uninsurability

There is some evidence for uninsurability in the Indian crop insurance market. There are few private companies in the market, although this is at least partly because the market was only opened to them in 2003. The latest census, in 2011, put the number of farmers in India at just under 120 million. An estimate for the average number of farmers per year covered by crop insurance is between 20 and 30 million, or around 20% of all farmers. This means that 80% of farmers are uninsured. The claims ratios of the current schemes (MNAIS and WBCIS) are viable, at 70—80%, but the previous schemes (including NAIS) had unviable claims ratios of 330% —575%, primarily because of the way in which premiums were determined. Few farmers voluntarily take out crop insurance: most of those who are covered have taken out bank loans for which insurance is compulsory.

Causes of uninsurability

The low penetration rate may indicate that that the price of insurance is higher than farmers are prepared to pay (even when the premiums are subsidised). However, both a government report from 2014 and a DHAN Foundation report from 2006/7 identified a lack of understanding of how insurance works as a barrier to uptake. This may be partly because most farmers who benefit from it not only did not choose to take out insurance, but do not receive the claims payments themselves – the claims are paid directly to the bank that advanced the loan to which the insurance is attached. Because insurance is a mandatory accompaniment of a loan (and the lending banks make their profits from the loans rather than the insurance), there is often little or no communication regarding the insurance mechanism and its benefits to the farmers.

It is also possible that there is substantial basis risk – in other words, the insurance available does not meet the perceived needs of the farmers, because it does not compensate them for their actual losses, but rather for losses that they would have sustained had they had the average outcome for their area (for crop-based insurance) or at a level related to the weather at their local weather station (for weather-based insurance) that might bear little relation to their losses. Moreover, distribution costs are high in comparison with premiums, and farmers are poor and unable to afford insurance.

Climate change is related to emissions in the atmosphere with a time lag; the effects of climate change will be more severe in the future than in the past. If the monsoon becomes more variable (as is projected), the need for crop insurance among farmers will grow and the problems caused by uninsurability will intensify.

Market adaptation

There are two major aspects of the market that reflect the lack of insurability. First, most insurance is provided by a public insurer, the Agriculture Insurance Company of India. Second, insurance is mandatory for farmers who take out loans for specified purposes, thus giving them no choice about participation, and few other farmers opt to buy it.

The ultimate adaptation is that farmers take the risks themselves. This means they are vulnerable to crop failure; increasingly so as climate change has an impact on the monsoon and other weather patterns. A secondary adaption is that farmers tend to be more risk-averse, i.e. they will plant a range of crops rather than specialising, which makes it harder for them to increase their income and escape poverty.

Impacts

The poor penetration of agricultural insurance undoubtedly leads to more economic hardship in years with poor yields and affects the livelihood of farmers. Without crop insurance, poor harvests can lead to higher levels of indebtedness and abandonment of farms. The suicide rate for farmers in India is nearly 50% higher than for other professions. Given the connection between loans and agricultural insurance in India, the low level of take up may also indicate a low level of access to finance, with knock-on effects on investment and productivity. The premium subsidies that are provided constitute a burden on the public purse.

Insurance of loans lowers the credit risk of farmers and therefore makes finance cheaper for them. Crop insurance also allows farmers to increase their risk appetite and therefore generate potentially higher returns. The combined effect of a lack of insurance is that it makes it much more difficult for farmers to escape poverty. This is in addition to the direct impacts suffered from uninsured losses which can be devastating for poor farmers.

Supply chain risks and insurance

World imports doubled between 1995 and 2005, and although they declined in 2008 they were back to their pre-crisis level by 2010, and have continued to grow by about 10% a year. Globalisation has continued to spread through nearly all industries, with some reaching very high levels indeed: between 2000 and 2012, 94% of the IT equipment that was manufactured worldwide was exported. The World Bank has estimated that intermediate goods account for about 75% of the international trade in goods – about $8.5 trillion out of a total of $11.5 trillion – reflecting the globalisation of supply chains. Supply chains are also increasingly complex, looking less like chains than impossibly complicated spiders' webs, as one commentator has noted. For example, as a result of the 2011 floods in Thailand, Toyota slowed down production in its factories in Indonesia, Japan, Malaysia, Pakistan, the Philippines, South Africa, Vietnam and North America.

Supply chains are also increasingly vulnerable, for at least three reasons. First, trends in manufacturing such as just in time production, more automation and increased vertical integration lead to lower stocks, more vulnerability to the failure of automatic processes, and greater interdependencies between business partners. Second, many industries have been through phases of consolidation, so there are fewer alternatives in case of disruption. For instance, in the automotive industry there were 23 major companies in 1988 but only 12 in 2008, and 600 major suppliers in 2001 but only 22 in 2008. Third, there is increasing geographic concentration. For example, 50% of the world's semiconductor production takes place in a narrow belt of eastern Asia, from Japan down to Singapore, and it is estimated that from 25% to 40% of hard disk drives are produced in Thailand.

A major area of vulnerability for supply chains are weather related events, which can cause crop failures, physical damage to plant, factories and warehouses as well as disrupting transport and communication links, affecting both the movement of goods and the ability of workers to turn up. An increase in the frequency of extreme weather events is one of the likely effects of climate change. For some types of event, the severity is likely to increase too. In addition, rising sea levels and changing weather patterns could change the incidence of floods, and in general, weather events including storms and droughts (which can lead to fires) could occur in new locations.

Insurance market

The principal insurance coverage used for supply chain risks is Contingent Business Interruption (CBI). CBI is an extension of Business Interruption insurance that reimburses a company for losses (or necessary continuing expenses) caused by an insurable loss suffered by a supplier or customer. There are several aspects of this coverage that make it somewhat complex.

First, there is the question of what counts as a supplier or customer. As noted, supply chains are often widespread and complex. Policies may cover only named suppliers or customers, or may include unnamed suppliers that meet specified criteria. Second, there's the difficulty caused by the insurable loss being sustained by a party that is neither the insured nor the policyholder. There may be only limited information available to the insurer when the policy is taken out, and information may also be in short supply in the event of a claim. Third, there may be problems in determining whether a particular loss is covered by the policy. This difficulty is by no means unique to CBI cover, but can occur with any property cover.

An Airmic survey in 2012 reported that there was still only limited insurance market appetite for supply chain insurance, probably because of the difficulty of quantifying the scope of potential losses. A Swiss Re report in 2012 also observed that although CBI was a growing market, worldwide coverage remained low.

However, CBI is not the only type of insurance coverage that is affected by supply chain risk. Because supply chains are so large and complex, the effects of their disruption can emerge in unexpected places.

In addition, insurers have their own supply chains, both for distribution and general administration and for claims handling. These supply chains are themselves subject to the same risks as those of their policyholders.

An example of the effects that severe weather events can have on supply chains is provided by the 2011 Thai floods. According to the World Bank the total economic cost was $45.7bn. Estimates of insured losses vary between $12-20bn, but it is agreed that much of the total was from business interruption and contingent business interruption. The two major industries that were affected were the manufacture of hard disk drives (HDD) and car manufacturing. As a result of the floods, there were global price increases in HDD and the electronic equipment dependent on them. There were local and international disruptions to car manufactures, and some companies postponed the launch of new car models. Ironically, some Japanese organisations had located their plants in Thailand partly in order to avoid some of the catastrophe exposures in Japan. As the floods occurred only seven months after the Tohoku earthquake and Tsunami many businesses were affected twice within a year. In the aftermath of the Thai floods a number of insurers reduced their levels of coverage for CBI by reducing limits. In some cases they reduced limits for natural catastrophes even further.

Analysis

The low worldwide coverage for CBI provides some evidence for uninsurability. There are significant challenges to overcome in providing effective insurance for large, complex supply chains, many of them arising out of the difficulty of defining the risk and, in particular, the supply chain. It is possible that the low penetration is at least partly due to one or more of:

- A low level of awareness of the potential worst outcomes of supply chain disruption
- A low level of awareness of the complexity and possible areas of concentration in the policyholder's own supply chain
- A perception that CBI excludes some of the significant risks
- A low level of awareness among smaller companies of the existence of CBI cover
- An assessment that the supply chain risks have been adequately managed and mitigated without the use of insurance

The hypothesis that there is a low level of understanding of supply chain risk is supported by the tone of the commentary on the Thai floods. The overall impression was one of surprise that the ramifications were so broad and that there was such a concentration of risk. However, there are other areas in which risk is concentrated, for instance in the manufacturing clusters in Shanghai and other Chinese and Asian cities, and in the principal global ports and shipping lanes.

This concentration of risk makes some supply chains particularly vulnerable to severe weather events, and hence to the effects of climate change. There is a concern that there may be hidden accumulations of risk, through geographical proximity or because a single supplier may feature in the supply chains of many different policyholders.

From the insurers' point of view, the principal challenge is that of uncertainty: information on the extent and composition of the supply chain, and its vulnerability to risks. Climate change can only increase that uncertainty, as it results in less predictable severe weather events.

Another way in which a possibly unexpected concentration of risk can arise is through the interaction of the risks insured and the insurer's own supply chain. A supplier used in the claims handling process could be affected by the same risk as the insured. Again, the impact of severe weather events provide clear examples: a flood affecting the premises of a policyholder could also affect the premises of the building contractors who might be able to perform repairs. If those building contractors themselves are insured with the same insurer, we can start to see a potential aggregation of risk across the insurer's book of business, even if they are not writing CBI. Some insurers may be able to take considerations such as these into account when deciding on what business they are able to write insurance, and the terms under which it is written.

3. Recommendations

The three case studies we have looked at are very different in terms of factors such as geographic scope, types of policyholder, extent of regulation in the market and levels of market penetration. However, some common themes have emerged, and in this section we discuss those themes, along with potential approaches to them. The approaches we recommend are not specific to the case studies. Their inclusion here does not imply that they have not been adopted in whole or in part in the markets discussed in the case studies, and their adoption would not necessarily have avoided the specific problems highlighted in the case studies. Not all the approaches are likely to be possible in all markets; in particular, some may be precluded by anti-competition or other regulation.

Common themes in our case studies are the different expectations and levels of understanding of risk between insurers, policyholders and other stakeholders, exacerbated by the increased uncertainty introduced by climate change. Whether insurance is available or purchased depends on complex social phenomena: it depends on policyholders being prepared to pay a level of premiums which is acceptable to insurers or, equivalently, on insurers being prepared to charge premiums at a level which is acceptable to policyholders. Social attitudes to insurance depend on the perceptions of risk and whether the premiums reflect this risk.

A major factor influencing insurability is the extent of uncertainty: greater levels of uncertainty mean that acceptable premium levels are more difficult to achieve. In a market where there is a great deal of uncertainty, a single event can change perceptions of the underlying risk and hence have a disproportional effect on premium levels. This can render risks uninsurable because of a mismatch between policyholders' and insurers' pricing of risk.

Our recommendations therefore focus on ways of managing the social risk to insurers by increasing the understanding of risk and uncertainty by insurers, policyholders and other stakeholders. This can be done through both communication and research: by broadening the pool of those who share existing knowledge, and by deepening the knowledge that can be shared. There are three main areas that should be addressed:

- achieving a shared understanding of climate -related risk,
- working with regulators to avoid unintended consequences, and
- working to understand and reduce levels of uncertainty.

Many of the recommended actions are long-term in nature, for example, supporting research, developing communication programmes with policyholders, regulators and other stakeholders, and supporting initiatives to share information more widely. Some of these actions may be effective if undertaken by individual insurers: most of them may well be more effective if undertaken in conjunction with other organisations: either other insurers, or organisations in other industries that are affected, such as banks and finance providers, logistics operators, construction companies and others.

In some cases, industry-wide collaboration might be both effective and possible, although of course it is important not to support anti-competitive activities. However, given the general nature of much of the research and communication that is needed, it is likely that relevant activities can take place in the pre-competitive space.

Shared understanding of climate-related risk

An important prerequisite for insurability is that all parties concerned in the insurance transaction have a shared understanding of the risk and the role of insurance. If there is no shared understanding, it is unlikely that there will be a demand for insurance at a viable price. In Florida, it appears that policyholders, regulators and taxpayers do not assess the risk posed by major storms at the same level as do insurers and reinsurers. In India, many farmers have a limited understanding of the role of insurance and of the trade-off between premium payments now and possible claims payments in the future. In both markets, climate change is affecting the risks and hence cost of insurance by increasing the likely frequency and severity of severe weather events. Insurers and policyholders have access to different information about these effects, and are therefore likely to hold differing views. Policyholders may not have a detailed understanding of the underlying cost of insurance, and therefore assess the price heuristically based on what it has been in the past.

One of the principal characteristics of supply chain risk is that it is often exceptionally difficult to identify the risk. Companies may not have a clear view of the participants in their supply chains, and even less idea of the risks those participants face, or of the interactions and mutual dependencies between the participants. Insurers, on the other hand, while having less information about the details of a specific company's supply chain, may have more information about likely risks and aggregations.

In all three case studies, the fact that weather based risks are changing makes achieving a shared understanding more difficult. The uncertainty about the extent and effects of climate change means that there is more scope for misunderstanding and disagreement.

However, a disagreement about the likelihood of a change, its possible extent or its cause is not the same as disagreeing about the possibility of any change occurring.

Insurers can work towards sharing an understanding of risks in a number of ways.

- Support research into the effects that climate change is likely to have on their policyholders and share the results across the industry and with stakeholders.
- Support research into the public understanding of climate change and climate risks
- Support initiatives that will increase risk awareness among policyholders and the public in general
- Develop programmes to communicate with policyholders, regulators and others about climate change and about risk in general

Insurers often have much more information about risks, including climate change risk, than do their policyholders, so a shared understanding of risk might require more sharing of that information. As well as general initiatives, such as those listed above, it might be possible to develop targeted communications to policyholders: for instance, giving concrete examples of how climate change might affect the property being insured. Where regulations permit, being able to adjust the premium that is charged to allow for mitigating actions on the part of the policyholder might also be an effective communication mechanism.

Working to reduce political risk

Unfortunately, it is often the case that the well-intentioned actions of regulators or politicians can have undesirable or unforeseen consequences. For example, in both Florida and Thailand, as in many other areas throughout the world, there is a heavy emphasis on economic growth, which has led to rapid development of coastal and other regions that are especially vulnerable to extreme weather events. Such developments are often not subject to building codes that would provide some mitigation of the risk.

The effects of climate change increase the risk of damage to such developments, and the concentration of development in hazardous areas, together with poor construction quality, can increase the PML estimates to levels that affect insurability.

As is the case with many industries, the insurance industry as a whole has access to more information and expertise than many regulators. If regulation is to protect policyholders, taxpayers and other stakeholders effectively, insurers should work with regulators to help them understand the possible medium and long term effects of their interventions. The regulators whose actions might affect insurability include those involved with planning and infrastructure, and environmental regulators, as well as insurance and financial regulators. This is particularly important with an issue such as climate change where there are such high levels of uncertainty.

If regulation is to be fair to policyholders, taxpayers and other stakeholders, the regulators must understand the extent of the uncertainty and the implications for all parties. Proactive and ongoing engagement with regulators, and an understanding of their priorities and constraints, could help avoid knee-jerk reactions with unintended consequences for policyholders and taxpayers.

Actions insurers can take include:

- Supporting industry wide initiatives for strategic dialogue with regulators
- Supporting initiatives to share information with regulators
- Supporting research into the long term effects of policies
- Supporting research into effective construction techniques and infrastructure work such as flood defences

This last point represents an area in which collaboration with other organisations across industry boundaries is likely to be particularly effective, as it could provide better and more varied inputs into possible consequences of regulatory action and make any messages more acceptable to regulators.

A good example of the type of initiative that is possible is the Australian Business Roundtable for Disaster Resilience & Safer Communities, which notes that “It’s impossible to stop natural disasters from happening. But it is possible to do more to make our communities safer.” The Roundtable has six members, two of which are insurers, and sponsors research and communication programmes as well as other activities that promote its overall goals of working collaboratively with governments to effect change in public policy and increase investment aimed at building safer and more resilient communities, and actively improving the capacity of people and businesses to better withstand future natural disasters. The Roundtable members consider Australia’s investment in recovery following natural disasters to far outweigh its investment in building resilience to make communities safer. if national investment in resilience continues to be short of what is required to seriously tackle the issue, the social and economic cost of future disasters will keep escalating, with part of the burden possibly falling on insurers.

Addressing uncertainty

There is undoubtedly a high level of uncertainty in any projections of future climate change and its effects. It may be difficult to understand the extent of this uncertainty and the impact it has on insurance. For example, if a single event has a large influence on estimates of possible future losses, as occurred in Florida, that may be a signal that there is more uncertainty in those estimate than had hitherto been thought. There may well be implicit assumptions that particular risks are fairly stable, and not subject to change, because they do not at first glance appear to be directly influenced by climate change. In general, the uncertainty due to climate change can intensify uncertainty from other causes, as is the case with supply chains.

High levels of uncertainty may contribute to uninsurability if insurers consider that the uncertainty makes the risk poorly defined. In supply chain insurance, for instance, there is uncertainty around both the extent and composition of supply chains, and the risks to which they are exposed, while in property insurance the PML may be difficult to estimate if there is uncertainty around the severity of severe weather events.

There are two approaches that can be taken towards uncertainty: either accepting and allowing for it, or trying to reduce the levels of uncertainty. It might be beneficial to act on the basis of the presence of uncertainty, rather than waiting until further information reduces the level of uncertainty. Delayed action might be too late to have any useful effect. Paying more attention to early, possibly poorly understood concerns could in some cases allow less drastic changes to premiums that would be more acceptable in the market. Actions that can be taken to reduce uncertainty include research into the underlying causes, or changing terms and conditions.

In order to address uncertainty, insurers can take the following actions:

- Support initiatives that contribute to the wider sharing of information about the possible sources or extent of uncertainty
- Support research that is intended to reduce levels of uncertainty

4. References

Intergovernmental Panel on Climate Change (2014), *Fifth Assessment Report (AR5).* http://www.ipcc.ch/report/ar5/

Intergovernmental Panel on Climate Change (2012), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX).* http://www.ipcc.ch/report/srex/

Florida Catastrophic Storm Risk Management Center (2011), *The State of Florida's Property Insurance Market 2011.* http://www.stormrisk.org/research/state-of-the-market

Florida Catastrophic Storm Risk Management Center (2013), *Property Insurance Market 2nd Annual Report for the Florida Legislature.* http://www.stormrisk.org/research/state-of-the-market

Evan Mills, Richard J Roth Jr, Eugene Lecomte (2005). *Availability and Affordability of Insurance Under Climate Change: A Growing Challenge for the U.S. Ceres.* http://insurance.lbl.gov/availability-affordability.html

Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India (2014). *Report of the Committee to Review the Implementation of Crop Insurance Schemes in India.* http://www.indiaenvironmentportal.org.in/files/file/Report_Crop%20Insurance%20Schemes%20in%20India.pdf

Centre for Policy and Planning, DHAN Foundation. *Policy Brief 5: Crop Insurance for Sustaining Agricultural Production.* http://dhan.org/cpp/pdf/policybrief5.pdf

Gurdev Singh (2010). *Crop Insurance in India.* WP 2010-06-01, Indian Institute of Management, Ahmedabad, India. http://www.iimahd.ernet.in/publications/data/2010-06-01Singh.pdf

Susannah Fisher and Swenja Surminski (2012). *The roles of public and private actors in the governance of adaptation: the case of agricultural insurance in India.* Centre for Climate Change Economics and Policy Working Paper No 102. http://www.cccep.ac.uk/Publications/Working-papers/Papers/100-109/WP102-public-private-actors-governance-adaptation-agricultural-insurance-in-india.pdf

World Economic Forum (2014). *Climate Adaptation: Seizing the Challenge.* http://www.weforum.org/reports/climate-adaptation-seizing-challenge

Supply Chain Risk Leadership Council (2013). *SCRLC Emerging Risks in the Supply Chain 2013.* http://www.scrlc.com/articles/Emerging_Risks_2013_feb_v10.pdf

SCOR (2013). Supply Chain and Contingent Business Interruption (CBI): A *perspective on Property and Casualty.* http://www.scor.com/images/focus_cbi.pdf

Swiss Re (2012). *Insuring ever-evolving commercial risks.* Sigma No 5/2012. http://media.swissre.com/documents/sigma5_2012_en.pdf

Airmic (2012). *Review of recent developments in the supply chain insurance market.* http://www.airmic.com/sites/default/files/Supply%20Chain%20insurance_1.pdf

Cambridge insight, policy influence, business impact

The University of Cambridge Institute for Sustainability Leadership (CISL) brings together business, government and academia to find solutions to critical sustainability challenges.

Capitalising on the world-class, multidisciplinary strengths of the University of Cambridge, CISL deepens leaders' insight and understanding through its executive programmes, builds deep, strategic engagement with leadership companies, and creates opportunities for collaborative enquiry and action through its business platforms.

Over 25 years, we have developed a leadership network with more than 5,000 alumni from leading global organisations and an expert team of Fellows, Senior Associates and staff.

HRH The Prince of Wales is the patron of CISL and has inspired and supported many of our initiatives.

UNIVERSITY OF CAMBRIDGE
INSTITUTE FOR SUSTAINABILITY LEADERSHIP

Head Office
1 Trumpington Street
Cambridge, CB2 1QA, UK
T: +44 (0)1223 768850
E: info@cisl.cam.ac.uk

Brussels
The Periclès Building
Rue de la Science 23
B-1040 Brussels, Belgium
T: +32 (0)2 894 93 20
E: info.eu@cisl.cam.ac.uk

South Africa
PO Box 313
Cape Town 8000, South Africa
T: +27 (0)21 469 4765
E: info.sa@cisl.cam.ac.uk

www.cisl.cam.ac.uk