

STERN REVIEW INTO THE ECONOMICS OF CLIMATE CHANGE: EVIDENCE FROM THE ASSOCIATION OF BRITISH INSURERS

Summary

- The **worldwide impacts** of climate change on the severity and frequency of significant weather events **will have effects on the UK insurance market**, even if climate change impacts are well managed here in the UK. Insurers use international capital markets to manage the volatility of weather claims and as such access the same pool funding hurricanes in the US, typhoons in Japan, floods in Europe etc. The current capacity for catastrophe reinsurance is around US\$150bn. Reinsurers, who need to manage their exposures in any single market, effectively ration capital to each market. Heavy losses in one market could limit availability to other markets in subsequent years.
- The **poor are least likely to be protected** by insurance and the effect of **increased losses will be to exclude even more** as the risk price of capital rises. This is both true of developing countries and the poorer sections of developed economies.
- International action on mitigation is uncertain in its implementation and effect. Even if current international plans to reduce emissions are successful, climate change will continue for some decades so we **need to take action on adaptation as well as mitigation**. This means action needs to be taken now on planning, resilience and investment. Infrastructure, including housing, has a long legacy (around 1% of the housing stock turns over each year) so, for example, we need to build houses **now**, and protect them with flood defences in ways that meet the likely severe weather conditions of 2050 and beyond.
- In terms of insurers' interests, the **main costs and effects fall on property insurance, health insurance and investment** portfolios, either directly or via regulatory responses to climate change. Some of these impacts have been quantified, particularly on property damage, but many have not since the underpinning scientific analyses are not yet available. There needs to be **more investment in research to inform risk assessments and responses**.
- **Insurance acts a risk communicator** through risk premiums. But insurers can only respond as markets adjust to short term pressures – **today's premiums reflect today's risks**, not those in 2050. **Government must send clear and consistent signals on long term risk trends**, whether on energy policy and emissions or on adaptive responses such as flood defences, building regulations or land use policy. Market mechanisms will then allocate capital efficiently within these clear boundaries.

Introduction

The Association of British Insurers (ABI) is the trade association for insurance companies operating in the UK. It represents over 400 members who, between them, account for over 94% of the general insurance business of UK insurance companies and hold 17% of equities on the Stock Market.

The ABI welcomes the establishment of the Stern review to look at the economic costs of climate change in the UK and internationally. This builds on the important role the UK government has played in leading the international debate on climate change and the necessary action to tackle climate change and its impacts during its Presidencies of the EU and G8 in 2005. The Government's reviews of Climate Change Programme and energy policy will also be important in defining how the UK responds to preventing and reacting to climate change.

The financial services sector has been described as "a unique qualitative indicator of the potential socio-economic impacts of climate change because the sector is sensitive to climate change and offers an integrator of effects on other sectors".¹ This paper sets out the UK insurance industry's view of these impacts and the extent to which adequate action has been taken to manage them. It focuses on the UK but refers to studies elsewhere and global assessments. Insurers data and assessments concern financial and insured costs, excluding costs not insurable through current mechanisms. As such they offer only partial assessments of economic costs but may include some transfer costs.

ABI is aware of a number of ongoing studies which should contribute to the assessments being undertaken in this review of the consequences of climate change. We therefore propose to offer additional evidence as new data becomes available, but submit this paper as summarising information that could be brought together in the brief period during which evidence has been invited. We would be happy to provide further details and discuss issues that arise from this submission.

Insurance and weather

Much of the debate to date has concentrated on the need for mitigation (reduction of greenhouse gas emissions) and the costs of taking measures to reduce emissions, including the impacts on the competitiveness of UK and EU businesses. To date there is little objective analysis of the economic and social consequences of failing to act, including failures to address society's vulnerability to climate change. Almost one fifth of the world's gross domestic product is generated in the world's ten most economically active cities, suggesting that the impact of significant climate change at a few key locations could have appreciable consequences, in the medium term, for the world's economy. A recent assessment of the world's largest 50 cities suggests that many are

¹ Third assessment report. Inter-governmental Panel on Climate Change, 2001.

exposed to significant natural hazards. Nineteen of these cities produce more than 30% of their countries' GDP².

Megacities facing natural hazard risks (50 most important global cities)

Natural Hazard	High hazard risk	Medium hazard risk	Low hazard risk
Tropical storm	6	2	9
Winter storm	3	6	8
Thunderstorm, hailstorm or tornado	0	36	14
Flood	2	21	26
Storm surge	2	9	12

Source: Megacities – Megarisk. Munich Re, 2004.

Note: cities assessed as having no hazard are not counted, eg 33 cities face no risk of tropical storms.

UK insurers, who compete for capital in global capital markets, are acutely aware of the need for UK business to remain competitive and note that UK plc will be best placed to invest in measures to manage climate change impacts in a high growth economic environment³. The ABI approach therefore seeks to maximise the UK's competitiveness and growth potential through taking a prudent and risk-based approach to managing climate costs.

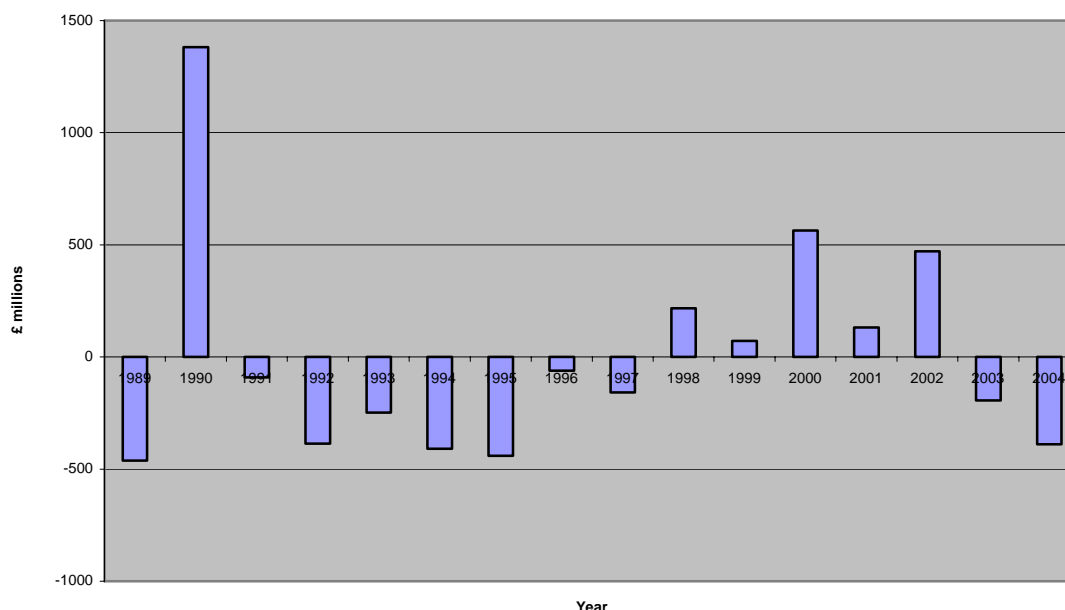
Weather damage is by its very nature a volatile peril to cover. Over the last 15 years total annual property claims in the UK have ranged from £360m to £2.1bn. The period 1998-2004 saw a series of high loss years, with total losses being double those in the previous six year period. It is estimated that losses in the UK could treble by 2050 if nothing is done to control risk⁴. Socio-economic changes could combine with climate effects so that actual claims rise even more sharply. In order to deal with the threat of climate change, this sustained increase in claims (which will drive inevitable rises in future insurance costs) should be addressed through cost-effective measures which enable markets to respond more effectively to future, as well as present, risk.

² Megacities – megarisks. Munich Re, 2004.

³ Future flooding. Office of Science and Technology, 2004.

⁴ A changing climate for insurance. Association of British Insurers, 2004.

Variation in UK weather claims compared with 1989-2004 average of £813m



Source: ABI

The ABI considers that in future the debate needs to be framed in terms of the costs of not taking action to avoid climate change impacts, whether in increased social, economic or environmental costs or through the need to take additional measures to reduce vulnerability to the damages giving rise to these costs.

Percentage of years experiencing extreme seasonal anomalies across the UK, based on medium-high emissions scenario⁵

Extreme event [^]	Likelihood of years experiencing an extreme event (%)		
	2020s	2050s	2080s
A hot August (average temperature >3.4°C above average)	1	20	63
A warm year (average temperature >1.2°C above average)	28	73	100
Drier summers (rainfall 37% below average)	10	29	50
Wetter winters (rainfall 66% above average)	1	3	7
Increase in number of depressions per season in winter (baseline of 5 per winter season)	*	*	63

[^] Compared with the 1961-1990 average

* Information not yet modelled by UKCIP

It should be noted that insurance for weather disasters, whilst widely available in most OECD countries, is largely confined to wealthy individuals and large state owned enterprises in many developing countries. While more than half of direct

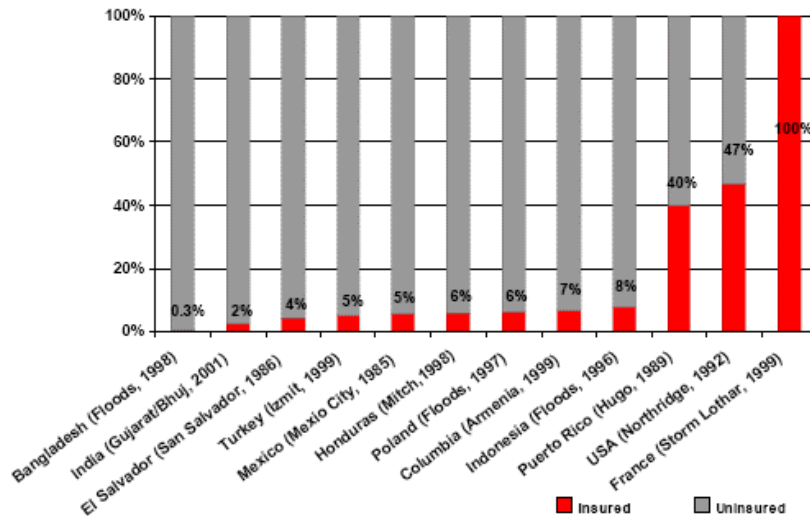
⁵ Climate change risks in building: an introduction. CIRIA and dti, 2005.

losses from catastrophes in the USA is insured, insurance coverage drops to less than 10 per cent in countries with annual per capita income of US\$10,000 and to 1 per cent where annual per capita income is under US\$760⁶. This largely accounts for the skewed distribution of impacts of weather catastrophes between wealthy and poor nations.

Virtually all (92 per cent) of insured weather losses and 57 per cent of economic losses occurred in wealthy countries between 1985-99, whereas two thirds of deaths and a quarter of economic losses occurred in the poorest countries over the same period⁷.

SOURCE: World Bank (2003)

Insured versus Economic Losses: Major Natural Disasters



Note: data for Storm Lothar, causing US\$7bn damage⁸, should be treated with caution since 100% of losses can never be insured. Even fully insurable risks fall short of this due to e.g. deductibles, underinsurance and uninsured properties.

The above chart contrasts the small proportion of insured losses found in recent natural catastrophes in developing countries with the much higher proportions typically found in developed economies.

Even in wealthy countries uptake is unlikely to be universal, especially for non-compulsory classes of insurance. For example, Household buildings insurance

⁶ Being prepared. P Freeman, M Keen and M Muthukumara, Finance and Development, Vol 43, September 2003.

⁷ Enhancing security, reducing vulnerabilities: climate change and financial innovation. J Park, at Human security and climate change workshop, Oslo, June 2005

⁸ Combined figure with storm Martin. Weather Catastrophes and Climate Change. Munich Re, 2005.

has an uptake of 93% in the UK despite lenders requiring anyone with a mortgage to take out cover. One reason is variable uptake amongst different income groups: in the UK 4 out of 5 of all households purchase Home contents cover⁹, a basic insurance, but only half of the poorest decile of households purchase this cover.

The availability of insurance also varies between developed markets, reflecting the maturity and availability of capital in that market, the nature of weather risks affecting the market and the nature of any public/private partnerships operating in the market. The following table summarises the covers offered in a number of EU member states. A wide range of weather perils are available as standard on a packaged basis in the UK and achieve more than 75% coverage. Similar cover and market penetration is achieved in France, but on a statutory basis for storms and floods, with the state providing catastrophe funding when necessary and being involved in decisions as to whether an insured event has happened. Compulsory inclusion of flood cover in Spain is also state backed, although uptake is only 25-75%.

Property insurance: coverage of weather perils in European markets¹⁰

Coverage:	UK	FR	D	I	E	P	AUT	B	NL	S	FIN	DK	PL	CZ	GR
Storm	Y	C	Y	N	Y	Y	Y	C	Y	Y	Y	Y	Y	Y	Y (1)
Cyclone/ Hurricane	Y	C	Y	N	C (2)	Y	Y	C	Y	Y	Y	Y	N	N	Y (1)
Floods	Y	C	Y (1)	Y	C (2)	Y	Y	Y (1)	N	Y	Y	N	Y	Y	Y (1)
Hail	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y (1)
Lightning	Y	Y	Y	Y	Y		Y		Y		Y			Y	Y
Water damage	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y	Y
Landslips	Y	C	Y (1)	Y	Y (1)	Y	Y	Y (1)	Y (1)	Y	Y	Y	Y	Y	Y (1)
Snow	Y	Y	Y (1)	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y (1)
Frost	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y (1)
Subsidence	Y	C	Y (1)	N	Y (1)	Y	Y	N	N	Y	N	N	Y	Y	Y (1)
Avalanche	N	C	Y (1)	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	N
Drought	N	C	N	N	Y (1)	N	Y	N	N	Y	N	N	N	Y (1)	N
Forest fires	N	Y (1)	Y	N	Y (1)	Y	Y (1)	N	Y	Y	Y	Y	Y	N	Y (1)

Key

Y =	Optional Cover	UK	United Kingdom	P	Portugal	FIN	Finland
N =	Cover not available	FR	France	AUT	Austria	DK	Denmark
C =	Compulsory cover	D	Germany	B	Belgium	PL	Poland
(1)	Cover available as option at extra cost	I	Italy	NL	Netherlands	CZ	Czech Republic
(2)	Compulsory pool	E	Spain	S	Sweden	GR	Greece
■	Cover automatically included	■	Cover not offered or additional premium required				

⁹ Expenditure and food survey. Office of National Statistics, 2005.

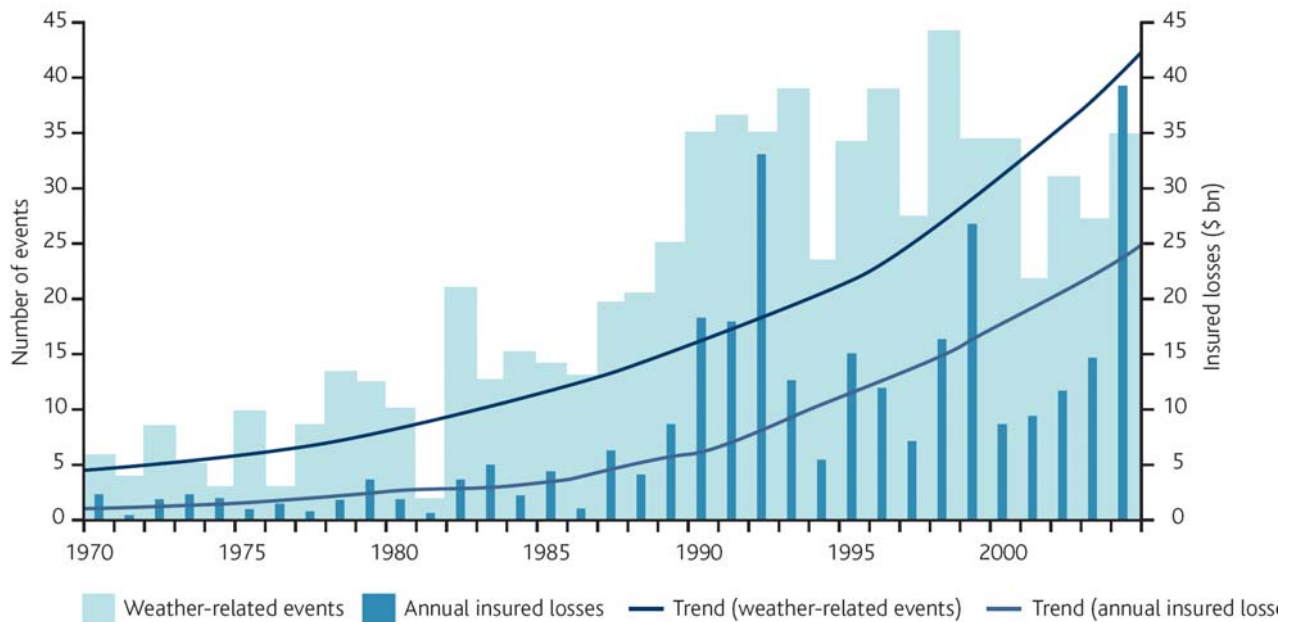
¹⁰ Climate change and the European insurance market. Comité Européen des Assurances, forthcoming.

In Germany, Austria and Greece, for example, flood cover is provided separately from the standard property insurance and achieves much lower levels of penetration – 10-25% in Austria and less than 10% in Germany. This also suggests that adverse selection occurs here, with only those who think they have a high probability of claiming purchasing cover. In Greece, where home ownership is high, less than 10% of households have Home insurance.

Key impacts of climate change on the UK insurance industry

Most insurance protection products indemnify the policyholder for defined damages or costs. A change in either the probability of an insured event happening or the cost¹¹ of restoring the policyholder to the original state therefore impacts on the price, and perhaps availability, of insurance. Investment and long term savings products, however, are affected by any factor influencing the medium to long term returns on investments, whether equities, bonds or property.

Climate change will have some impact on virtually all insurance products. But these effects will be tempered, exacerbated or disguised by socio-economic changes. For example, the significant rise in financial and insured damages globally arising from weather events since the 1950s is driven in large part by increasing numbers and values of assets in flood-prone areas as well as the increased penetration of insurance in certain markets¹². Globally, economic costs due to natural catastrophes have increased seven-fold in the last 40 years, while insured losses have increased 14-fold.¹³



Source: Sigma Database, Swiss Re.

¹⁴ Swiss Re Sigma report

¹³ Annual review of natural catastrophes 2003. Munich Re Topics 2004

It has been estimated that a repetition of Hurricane Andrew, the costliest ever weather-related insurance claim at US\$22bn until Hurricane Katrina in 2005, would have resulted in double the value of damage if it had occurred a decade after the original due to the increased settlement and asset values in the Miami Dade area in the intervening years¹⁴. In the UK, planned developments in the Government's growth areas could result in an increase in average annual damages of £55m with an addition £19-27m annual damages associated with the transport and other infrastructure associated with the development. In an extreme event damages of £4-5bn would arise from these developments¹⁵. The increased costs arising from climate change would further increase these figures by a factor of 8-12 times.

The UK enjoys a relatively benign climate, without risk of hurricanes or severe snowstorms. Nevertheless, London has been identified as the 28th most at risk megacity, globally, in view of the high asset accumulation and level of economic activity combined with low-medium level natural hazards¹⁶. For comparison, Paris stands at 23rd and Frankfurt at 50th. The threats affecting London were identified as medium risk of winter storms and low risks of storm surge, thunder and hail storms, tornados and flooding. This assessment took account of the existing resilience of building codes, flood and coastal defences, emergency planning systems etc as well as the total assets at risk. Not only could climate change affect the severity and frequency of extreme weather, it could also render ineffective these measures designed to reduce vulnerability.

Property (domestic, commercial and related business interruption) and Health insurance have been identified as the classes of insurance most likely to be affected significantly by climate change in the UK¹⁷. Other General Insurance products that could also be affected include motor, travel, construction and engineering, directors and officers liability and employers' liability. For example, winter weather-related road accidents increased from 8% of all accidents in 1998-99 to 12% in 2001-02, and 25% in the first half of 2003-04¹⁸.

¹⁴ Financial costs of climate change. Association of British Insurers, 2005.

¹⁵ Making communities sustainable. Association of British Insurers, 2005.

¹⁶ Megacities – megarisks. Munich Re, 2004.

¹⁷ A changing climate for insurance, Association of British Insurers, 2004.

¹⁸ Rain-related winter accidents on the increase – survey, Town and Country Assistance, Press Notice, 27 January 2004.

The impact of climate change on losses in individual classes of insurance¹⁹

Product lines	Flood, storm surge		Storm, flash flood		Heat, drought		Cold weather, frost	
	ST	LT	ST	LT	ST	LT	ST	LT
Property (personal)	-	--	--	---	-	--	+	++
Property (commercial)	-	--	--	---	-	--	+	++
Engineering	--	---	--	---	-	--	+	++
Marine	-	--	--	---	-	--	+	++
Agriculture (crops + stock)	-	--	--	---	--	---	+	++
Motor own damage	-	--	--	---	-	-	+	++
Contingency risks*	--	---	--	---	-	--	--	---
Health	-	-	-	-	-	--	+	++
Life	-	-	-	-	-	--	+	++

Key: ST = short term; LT = long term; +++ High positive effects ie cost reduction; --- High negative effects, ie cost escalation.

* Event cancellation etc.

Agriculture (crops and livestock) is a relatively undeveloped insurance market in the UK, as evidenced by the low uptake of livestock insurance during and after the Foot and Mouth outbreak of 2001. Penetration levels of animal disease insurance are estimated as remaining around 10%²⁰. It is difficult to assess the potential impacts of climate change on this market but it may add to the difficulties in establishing a private insurance market greater demand for insurance develop in future. Elsewhere in Europe and globally this market is already more developed.

The evidence base is most developed for Property insurance risks, where some quantification has already been made. However qualitative assessments have also been included for Health insurance and Investment affairs.

Property

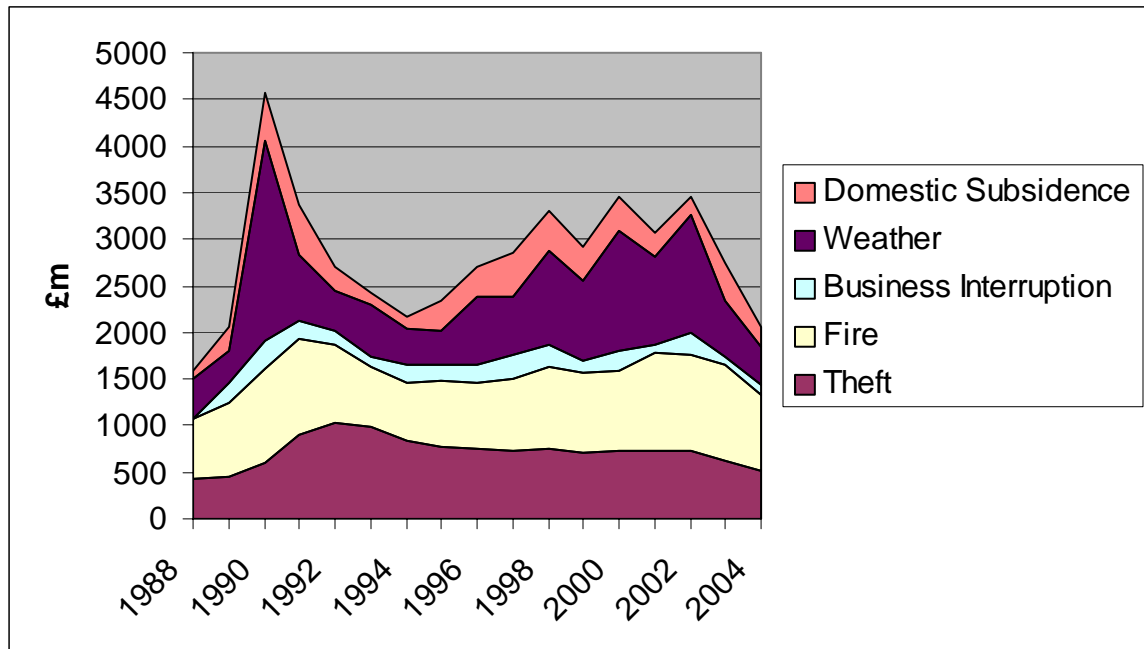
As noted previously, weather related losses are volatile which in itself poses additional challenges in offering insurance. Greater volatility due to climate change is as relevant to the provision of insurance as the total quantum of damages occurring. Early estimates of the impacts of climate change on property claims suggest that windstorm and coastal flooding pose the two greatest threats in the UK.²¹ Either scenario could give rise to losses more than three times the largest loss experienced to date in the UK.

¹⁹ Weather catastrophes and climate change. 2005 Munich Re,

²⁰ Personal communication from NFU Mutual.

²¹ A changing climate for insurance, Association of British Insurers, 2004.

UK property claims (domestic and commercial)



Source: ABI

It is difficult to assess the likely costs of future UK windstorm claims since there is little consensus between climate models on the effects on European windstorm severity and frequency.²² The two most costly claim years in the last two decades were due to windstorm damage, at £2.1bn (1990) and £1.4bn (1987). These events led to millions of claims within a few weeks. By comparison, in an average year there are around 200,000 wind damage claims²³.

Preliminary estimates of future costs of weather insurance claims (£million, in 2004 prices).

	Today		2050	
	Annual average	Extreme year	Annual average	Extreme year
Subsidence	300	600	600	1,200
Storm	400	2,500	800	7,500
Inland flood	400	1,500	800	4,500
Coastal flood	-	5,000	-	40,000 (London affected)

Source: ABI

Wind damage is both a function of wind speed (especially peak or gusting wind speeds) and construction standards: significant shifts in cost occur once the standard design threshold is exceeded, whereas limited additional damage

²² The financial costs of climate change. Association of British Insurers, 2005.

²³ The vulnerability of UK property to windstorm damage. Association of British Insurers, 2003.

occurs up to this point. Historically windstorms have accounted for around three quarters of UK weather related claims, although in the last decade flooding has become much more important.

Recent work on European windstorms suggested that a 20% increase in frequency of the current most intense storms would result in annual average insured losses increasing by just €0.5bn across Europe, or €2.0-2.5bn in the most severe years²⁴. This is because building codes already largely allow for the majority of conditions likely to occur in these events. However, modelling also suggests that a repeat of the 1703 windstorm (the worst recorded to date) would result in insured losses in the UK of around £10bn²⁵.

Modern UK building codes are designed to withstand winds up to 65-70 mph²⁶. The storms in October 2002, which led to £150m insured damage and significant transport and power supply disruption, had winds gusting 70 mph and average sustained wind speeds of 50-60 mph. The Birmingham tornado of July 2005 caused modest damage to new roofs on the margins of the affected area, although any roof in the direct path suffered spectacular damage. However, older properties that had not undergone recent renovation suffered considerable damage, even on the margins of the affected area.

The thresholds of current regional design requirements are likely to be exceeded as climate change takes effect. Damage levels can increase substantially once this occurs. It has been assessed that roof design requirements in south east England will need to be strengthened by 10% to deal with increased wind speeds later this century, using the High UKCIP02 scenario²⁷.

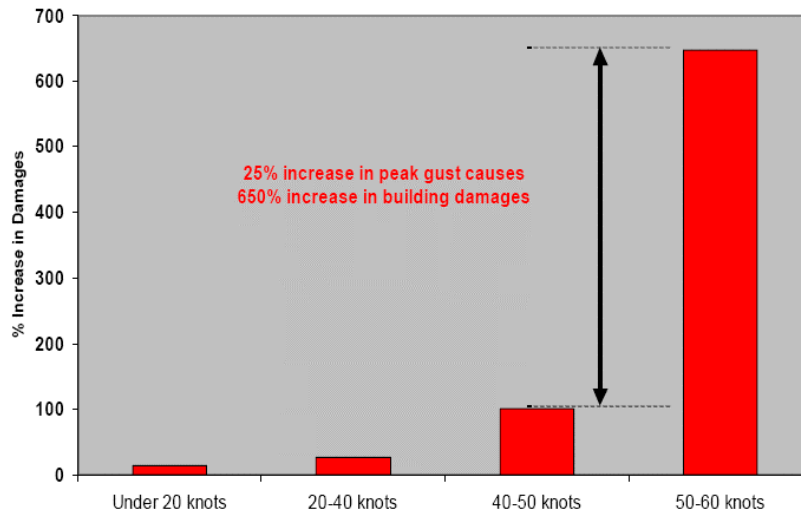
²⁴ The financial risks of climate change. Association of British Insurers, 2005.

²⁵ World@risk 2005: London, Europe and beyond. International Underwriting Association, 2005.

²⁶ Open country, inland, below 500ft. CP4 1944.

²⁷ The vulnerability of UK property to windstorm damage. Association of British Insurers, 2003.

Increase in building claims versus peak gust speeds²⁸



Source: Australia Insurance Group data

Flooding losses in the UK have become significantly more pronounced over the last decade. Prior to the 1960s, insurance largely provided protection against fire and theft, so the serious flooding of 1947 (river) and 1953 (coastal), for example, did not give rise to the high level of claims that would be associated with similar events now. Climate studies suggest a high likelihood of increased inland flooding and coastal surges in future and have a high level of confidence in making these projections. The actual cost of future events will depend on both changes in climate and socio-economic trends. Even the most conservative estimates of both suggest flooding costs will double to over £2bn p.a. by 2080 whereas worst case scenarios suggest this could rise to in excess of £20bn p.a. if nothing is done to manage risk²⁹.

The overall cost of flood claims is linked to the number and severity of specific flood events. However, unlike windstorm the costs are normally contained in that usually only one or two catchments are affected at any one time (Autumn 2000 being exceptional in this respect). Most affected properties are in areas either in or adjacent to the floodplain. Coastal surge events have much wider potential effects. Whilst many UK coastal towns are protected to withstand 1:200 year events, projections of significant increases in coastal surges combined with rising sea levels, particularly along the east and south east coasts, could lead to high probabilities (1:5-10 years) of storm surge damage in these communities later this century. An additional 2 million people could be at high risk of river and coastal flooding by 2080, many in the Thames and Humber estuaries, the Bristol channel, the south and east coasts and the Mersey to Lancashire coast³⁰.

²⁸ The impact of climate change on insurance against catastrophes. Tony Coleman, Insurance Australia Group, 2003.

²⁹ Future flooding. Office of Science and Technology, 2004.

³⁰ England and Wales only. From: Future flooding. Office of Science and Technology, 2004.

The cost of a severe storm surge affecting London has been calculated at £30bn³¹ with an estimated £80bn valuation of assets at risk in 2002³². This represents around 75% of the national property valuation at risk from tidal flooding³³ concentrated in a single relatively small area (150km²)³⁴. A London storm surge overwhelming the Thames Barrier defence system would be in excess of 1:1000 year probability, under present conditions. However, if the 20-fold increases in coastal flooding risks are realised, such a hazard would become 1:50 frequency. The solvency regime applied by the insurance regulator, the Financial Services Authority, requires insurers to take account of the impact of 1:200 year loss scenarios.

Preliminary work on future protection needs suggest that storm surges could be several metres higher than current³⁵. Unless Thames estuary defences are significantly improved in advance of these changes, the aggregation of risk and sheer size of potential losses make it likely that reinsurance (and hence insurance) cover would be withdrawn. Insurers are currently signalling that they are extremely reluctant to insure new properties in flood risk areas facing greater than 1:200 year probability³⁶.

Urban flooding, arising from severe rainstorms, are also likely to become more frequent and severe as a result of climate change, affecting 500,000-700,000 additional people. Estimates on the possible level of damages in future range from £1bn-£15bn each year³⁷.

More studies are needed to separate socio-economic and climate effects in modelling future flood risks. The ABI plans to undertake work into coastal and urban flooding risks during 2006.

Lower order hazards include subsidence and freeze damage. Climate models predict drier and hotter summers with a high degree of certainty. This could give rise to increased subsidence although the replenishment of water tables during wetter winters could limit the incidence of subsidence. Subsidence “event years” are most likely to follow dry winters resulting in higher than usual soil moisture deficits and currently are anticipated around once in seven years by insurers. It is not clear how often such rainfall patterns will arise in future, or whether the combination of hotter and drier summers will in itself be sufficient to give rise to more frequent claim years.

³¹ Environment Agency. www.environment-agency.gov.uk

³² Flooding risk in London. London Assembly. November 2002.

³³ Flooding risk in London. London Assembly. October 2005.

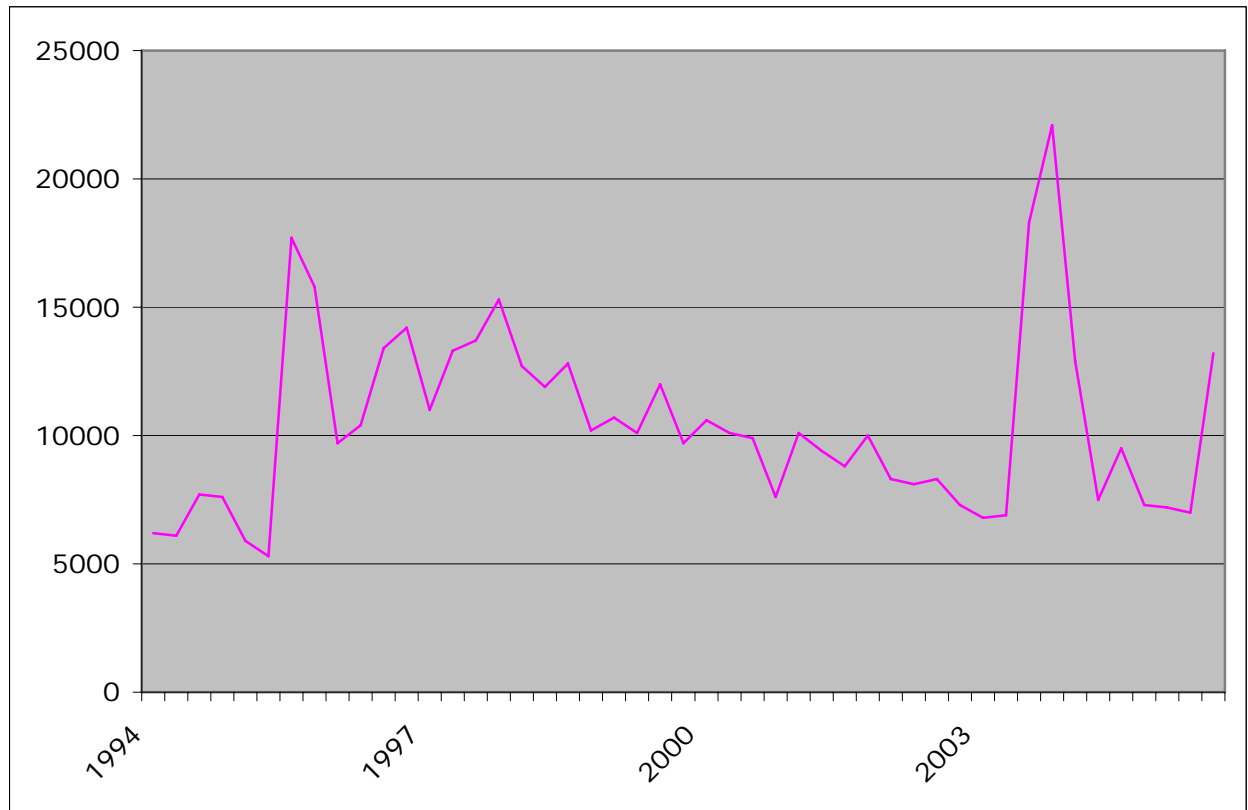
³⁴ www.nbu.ac.uk

³⁵ Personal communication. Environment Agency, 2005.

³⁶ Development Planning and Flood Risk (PPG25) Association of British Insurers' Guidance on Insurance Issues. ABI, 2003.

³⁷ Future Flooding. Foresight Programme, Office of Science and Technology, 2004.

Number of subsidence claims notified each quarter, 1994-2005



Source: ABI

The incidence of subsidence is also affected by the construction of the property, most notably foundation depth, and the effect of vegetation in removing soil moisture through evapo-transpiration. Around three quarters of subsidence claims involve trees or large shrubs and could be avoided through better choice and management of vegetation. Modern building standards largely avoid subsidence and heave problems in current conditions except where existing large trees are removed on sites with shrinkable clay soils, or similar, shortly prior to construction. Here re-wetting of the sub-soil following construction can lead to difficulties. It has been estimated that foundation depths on clay soils will need to be increased to 0.5m by 2050, costing an additional £32m in construction costs³⁸. However it is difficult to take pro-active measures to limit damage in existing housing stock. Increases in insured damage therefore appear inevitable.

³⁸ Potential implications of climate change on the built environment. HM Graves and MC Phillipson, Foundation for the Built Environment, 2000.

Correlation between property age and subsidence claims³⁹

Date of building	Claims in 1976 (%)	% Housing stock	Risk factor
Pre 1920	32	32	1
1920s	9	30	1.2
1930s	25		
1940s	3		
1950s	9	18	0.7
1960s	17	20	0.3
1970s	6		

Freeze damage costs and frost heave claims are likely to reduce with climate change since fewer very cold winters are expected. However, if this leads to fewer precautions such as lagging of pipes and water tanks, unexpected cold snaps could lead to higher levels of claims. Recently reported work suggesting that the dilution and slowing of the Gulf Stream could lead to colder winters in future⁴⁰, opens up the possibility that the reverse effect could be seen, particularly if increased energy efficiency in homes does not incorporate protection of water supply equipment.

Health

The 2003 heatwave in Europe and south east England, with temperatures up to 6°C hotter than the 20th century average, contributed to many hospital admissions and the premature deaths of over 27,000 people⁴¹. The potential impacts on the health insurance industry were much bigger than previously expected. Climate change has already doubled the chance of a very hot summer in Europe such as 2003. It is projected that by 2040 the conditions prevailing in 2003 will represent the average. Similar effects have been reported in previous heatwaves in the UK, Portugal, Italy and Greece⁴². Those with pre-existing heart and respiratory conditions are affected disproportionately as well as the overweight, and given health inequalities, might be expected to impact on the poor most heavily.

The net effect of climate change on health insurance is currently unclear, as the potential impacts are mixed. Some factors affecting health or “wellness” may have beneficial effects on health policy claims. However, increased health interventions driven by heat waves, skin cancer and injuries caused in extreme weather events could offset these. In the UK, climate-related diseases are not thought to be a major health risk, but food poisoning could become more prevalent and malaria could become endemic in parts of SE England⁴³.

³⁹ *Based on* Property damage by foundation failure. Atlas of drought in Britain, 1975-76. MJ Clark, Institute of Geographers, 1980.

⁴⁰ Restricted circulation. The Economist, pp 95-96, December 3rd 2005.

⁴¹ Annual review: of natural catastrophes 2003. Munich Re Topics, 2004

⁴² Kovats and Koppe (forthcoming), reported in Financial risks of climate change. Association of British Insurers, 2005.

⁴³ Health effects of climate change in the UK. Department of Health, August 2002.

Globally, vector-borne diseases may become more or less prevalent in specific regions as they are closely associated with certain ecosystems which may increase their range, may act over a longer season or undergo accelerated maturation. In some parts of the EU such diseases may decrease as hotter, drier conditions lead to significant reductions in vector populations.⁴⁴ These changes will add complexity to the health impacts seen in the UK, given likely impacts on migration resulting from water shortages in Mediterranean areas and eastern Europe.

Potential impacts of climate change for health in the UK⁴⁵

New Challenge	New Opportunity
Greater heat stress and summer mortality	Greatly reduced winter illness and mortality
Increased incidence of skin cancer, due to more outdoor lifestyle	More active lifestyle with warmer summers encourages less obesity
Greater incidence of food poisoning due to longer, hotter summers	Greater availability of a range of fresh food
Increased occurrence of endemic malaria due to warmer climate	
Increased exotic diseases through greater global migration from drought stricken areas	

Over the longer term increased life expectancies may be combined with poorer health later in life and this would increase burdens on healthcare resources, as would greater requirements for public health surveillance. This may drive a change in the relationship between the state and private sector providers. New technologies could mitigate health effects, including new treatments and changes to the design and management of buildings to manage temperature. These would also impact on costs through taxes, health insurance premiums and building costs.

⁴⁴ Financial risks of climate change. Association of British Insurers, 2005.

⁴⁵ A changing climate for insurance. Association of British Insurers, 2004

Investment

For some time environmental impacts, including those from climate change, have been incorporated into the investment strategies of socially responsible investment (SRI) funds. Here fund managers offer investors ethical and “green” investment opportunities when choosing where to channel funds.

Estimates of funds invested under SRI are highly variable. Retail investment in SRI funds in the UK is generally accepted to be of the order of £5bn. However, this is a misleading figure since the institutional market offers clients a corporate responsibility approach in their investment strategies which may include climate change as one of their criteria. Indeed whilst originally climate change may have been restricted to environmental SRI funds, the financial impact of environmental issues is a key factor for mainstream investors. This is reflected in the number of fund managers who have signed up to the Carbon Disclosure Project in 2005⁴⁶ and in the UK, those who belong to the Institutional Investors Group on Climate Change (IIGCC⁴⁷).

Investors managing US\$21 trillion engaged in the Carbon Disclosure Project in 2005, evaluation global companies’ responses to a questionnaire and identifying sector leaders. Current studies on the potential impacts of climate change on investment values are underway⁴⁸ and methodologies are being developed to assess better the impacts.

One of the most concrete examples of the financial impact of environmental factors has arisen from the introduction of the EU Emissions Trading Scheme (EU ETS). Analysts’ views on the effects on profitability of firms, especially electricity generation companies⁴⁹ will inform investment strategies. Other public policy developments such as green procurement strategies could have similar effects if these are extended⁵⁰.

The impact of climate change is perhaps most apparent in areas affected by regulations dealing with climate change issues, such as the impact of land use policy and building control on property investment. Studies are underway⁵¹ and methodologies are being developed to assess the impact on investment value. Some early signs that customers may attach higher value to the environmental

⁴⁶ Carbon Disclosure Project, 2005.

⁴⁷ A climate for change: a trustee’s guide to understanding and addressing climate risk. Institutional Investors Group on Climate Change, 2005.

⁴⁸ For example, the Institute of Actuaries.

⁴⁹ Climate Change Credit Survey: a study of emissions trading, nuclear power and renewable energy. Standard & Poor’s, November 2005.

⁵⁰ Greening Government: the 2004 sustainable development in government report. House of Commons Environmental Audit Committee, First Report of Session 2005-06.

⁵¹ For example, the Kingston University project.

performance of homes include one study suggesting 84% of home buyers would pay a price 2% higher than standard purchase prices⁵².

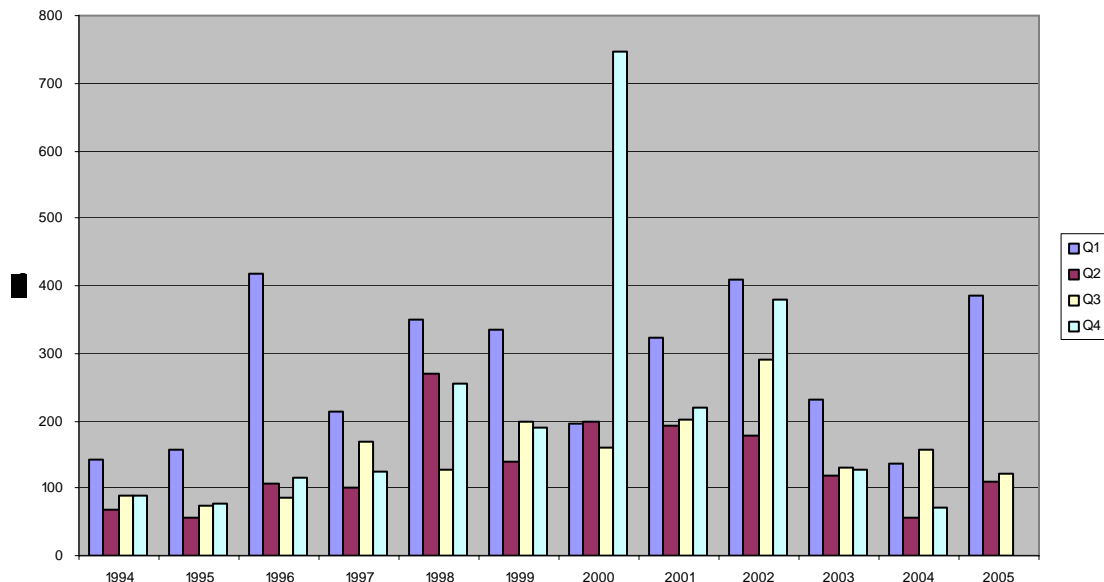
Climate change also offers new opportunities for investment in innovative technologies and services responding to mitigation and adaptation strategies and regulatory measures which influence them.

Insurance in a global market

Insurance responds most easily to steady state claims where costs and hence pricing are relatively straightforward to predict. In the UK fire and crime-related claims fall most readily into these categories, with total claims lying within a fairly predictable band each year. The main uncertainty is who will be affected and whether several large industrial risks will suffer fires at any one time.

However weather claims are much less predictable in the short to medium term, with major claims costs being associated with particular “catastrophic” events. This close association shows through in quarterly claims returns, with winter periods generally showing higher activity, but year-on-year variation remaining high. Summer claims in some years exceed winter claims in others. “Ordinary” weather gives rise to a low level of background claims from localised events but these represent a small proportion of total weather costs.

Volatility of weather claims, UK Property account 1994 to 2005

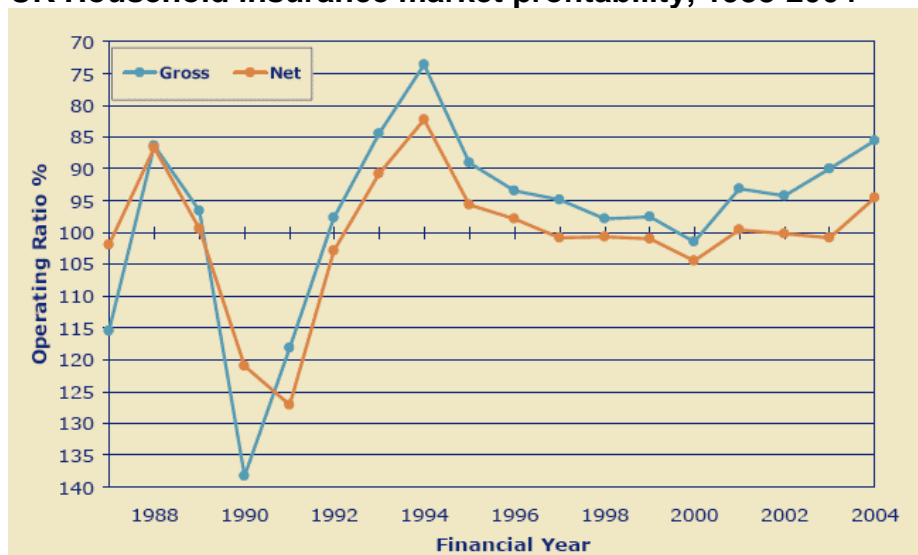


Source: ABI

⁵² www.cabe.org.uk/news/press/showPRelease.asp?id=647. CABE, WWF and Halifax, 2004.

As a result insurers either need to hold capital to deal with sudden and unexpected surges in claims costs or need to utilise financial products to smooth these peaks and troughs. Current fiscal regimes discourage reserving of capital and most insurers rely to a large degree on reinsurance arrangements, drawing on international capital markets. Even so, since insurers retain a significant proportion of claims costs, profitability can be influenced to a large degree by catastrophic weather events. The chart below shows operating ratios soared in the storm years of 1987 and 1990.

UK Household insurance market profitability, 1988-2004

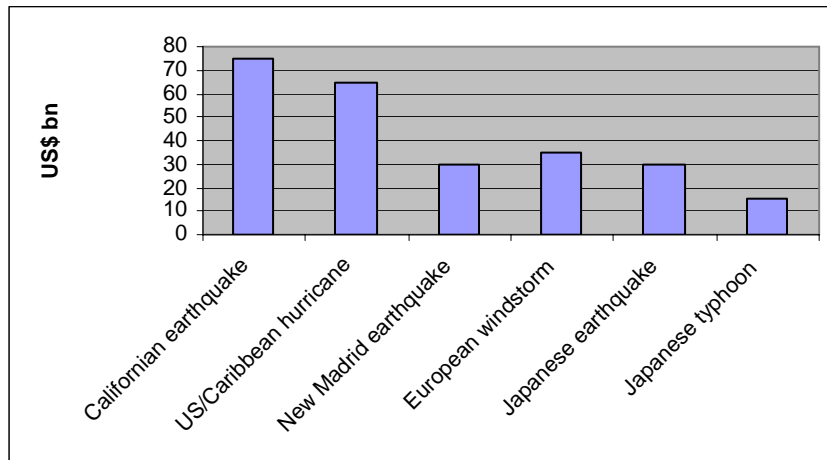


Source: Deloitte

Note: 100% operating ratio marks the break even point. Ratios above 100% represent losses.

Reinsurers manage this volatility by operating across insurance markets globally, offsetting high loss years in one market against benign results in another. In effect, reinsurers “gamble” on not all contracts being called on at any one time, a gamble based on careful study of the likelihood of each, uncorrelated event. Increasing severe events globally could potentially result in this approach coming under strain.

Maximum loss potentials for events with return periods of between 100 and 500 years⁵³



Average global windstorm costs could increase by two thirds to US\$27bn annually by 2080. These projections are principally driven by hurricane losses in the US and typhoon costs in Japan as a result of relatively small increases in wind speeds (6%) and no increase in storm frequency. In extreme event years, costs could rise by three quarters to US\$100-150bn in the US and by two thirds to US\$25-34bn⁵⁴. The rapidly developing economy on the Chinese coast together with projected population increases in hurricane-prone areas of the US such as Florida would add further to these costs, which assume no socio-economic change. European flood losses could increase to around 100-120bn euros annually by 2080⁵⁵.

Reinsurance catastrophe contracts in the UK market typically come into play once weather losses reach a certain level within a defined length of time, for example 72 hours. The storms of 1987 and 1990, which resulted in one million claims in a single day and three million claims in a four week period, respectively⁵⁶, triggered reinsurance contracts and the viability of UK insurers was not in question. However the timing of claims payments, which totalled £1.2bn, and reinsurance reimbursements following the 1990 storms were such that liquidity issues arose and forced selling of equities⁵⁷.

Large scale insured catastrophes around the world can affect reinsurance rates in the UK in certain circumstances. The four major hurricanes affecting the US in 2004 US, costing US\$21bn in total⁵⁸, and record Japanese typhoon season

⁵³ Natural catastrophes and reinsurance. Swiss Re, 2003.

⁵⁴ Financial risks of climate change. Association of British Insurers, 2005.

⁵⁵ Financial risks of climate change. Association of British Insurers, 2005.

⁵⁶ A changing climate for insurance. Association of British Insurers, 2004.

⁵⁷ London's warming. London Climate Change Partnership, 2002.

⁵⁸ US and European approaches to insure natural catastrophe and terrorism risks. US Government Accountability Office, 2005.

costing around US\$7bn⁵⁹, accounted for the major part of global natural catastrophe losses that year. Whilst the reinsurance rates and attachment points were affected in the US market, these losses had little effect on reinsurance rates in Europe. In part this is due to the mobility of capital and increases in capacity in Bermuda and Lloyd's of London due to anticipated increases in returns.

In 2005, whilst Hurricanes Katrina, Rita and Wilma have led to total losses totalling US\$79bn of which US\$60bn will be met by the global insurance industry⁶⁰, US\$5bn at Lloyd's, the anticipated reaction of the Lloyd's market is to draw in an additional 7% capital in 2006, instead of previous plans to reduce capital availability by 7%⁶¹. However this is against a background of generally softening capital markets. In 2001 the US\$66bn losses arising from the terrorist attack on the World Trade Center led to a more general increase in rates, due to a combination of higher losses affecting a broader range of insurance products, continuing fears of a sustained campaign and tighter capital markets.

Similar reactions have been seen following previous natural catastrophes. For example, global reinsurance rates rose from 1.0% rate on line in 1989 to around 4.5% in 1994, falling back to around 4% for the period 1995-97 and finally dropping to 2.0% in 1998⁶². Significant events in the period included Hurricane Andrew in 1992 and the Northridge Earthquake in 1994.

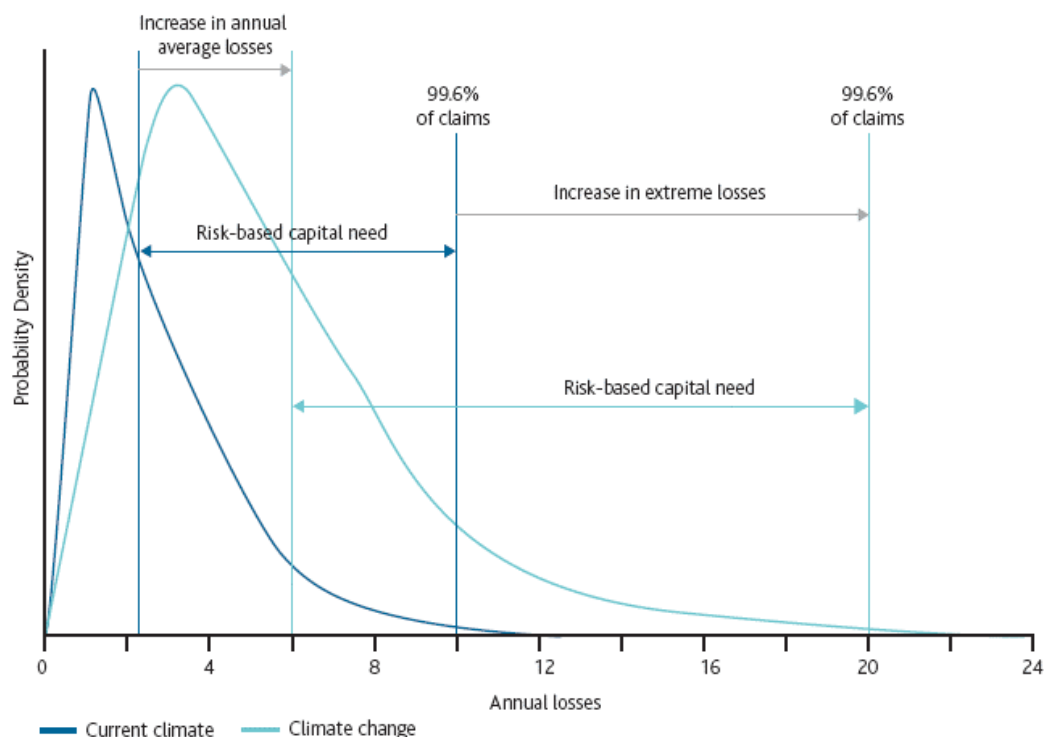
⁵⁹ Financial risks of climate change. Association of British Insurers, 2005.

⁶⁰ Swiss Re

⁶¹ Lloyd's

⁶² Managing catastrophic disaster risks using alternative risk financing and pooled insurance structures. JD Pollner, World Bank Technical Paper 495, 2001.

Impact of climate change on probability of loss distribution and implications for risk⁶³



The global reinsurance capacity is estimated at US\$150bn⁶⁴. It has been suggested that natural catastrophes could double within a decade⁶⁵. Increased windstorm losses due to climate change effects only (ie excluding socio-economic effects) in the US and Japan could increase global insurers capital requirements by 90% and 80%, respectively by 2080. In total, an additional US\$76bn would be needed to cover the gap between extreme and average losses resulting from tropical cyclones alone⁶⁶. Risk premiums would need to increase by a similar amount, although this would in part be determined by market dynamics, in view of the marked price cycles that are a significant feature of the insurance and reinsurance markets.

One response to this is to access emerging financial instruments which access capital not normally available to the reinsurance market to finance capital needs. Catastrophe bonds, developed in response to losses caused by Hurricane Andrew in 1992, have remained fairly constant at around 7-10 bond issues per year, and drew in only an additional US\$1.7bn in 2003⁶⁷.

⁶³ Financial risks of climate change. Association of British Insurers, 2005.

⁶⁴ Munich Re

⁶⁵ Chief executive briefing. UN Environmental Programme Finance Initiative, 2002.

⁶⁶ Financial costs of climate change. Association of British Insurers, 2005.

⁶⁷ Storm chasing Wall Street. Jeremy Khan, New York Times, 19 September 2004

New Financial Instruments to Hedge Against Climate and Weather Disaster Risks

Catastrophe bonds are subject to default if a defined catastrophe occurs during the life of the bond but are attractive to investors because of their correspondingly high yields

Contingent surplus note are essentially “put” rights that allow the notes’ owners to issue debt to pre-specified buyers in the event of a catastrophic event

Exchange-traded catastrophe option allow purchasers to demand payment under an option contract if the index of property claims service options traded on the Chicago Board of Trade surpasses a pre-specified level

Catastrophe equity puts are a type of option that permits the insurer to sell equity shares on demand after a major disaster

Catastrophe swaps are derivatives that use capital market players as counterparties. An insurance portfolio with potential payment liability is swapped for a security and its associated cash flow payment obligations

Weather derivatives are contracts that provide payouts in the event of a specified number of days with temperatures or rainfall above or below a specified trigger point

SOURCE: Pollner (2001)

The investment community constantly reviews the impacts of short term weather events on insurers’ financial performance⁶⁸. At its most extreme this is driven by insurance company failures driven by severe weather events, such as the 11 insurers which failed following Hurricane Andrew in 1992⁶⁹. Global investment flows into and out of (increasingly) global insurance groups are influenced both by exposure to losses and the management of those catastrophe risks.

Insurance as a risk communicator

Insurers provide signals on risk to customers and wider society through risk-based premiums. In the UK this increasingly results in significant differentials in commercial property and household premiums in high flood risk areas, for example. Risk is defined as the product of probability of an event occurring and the consequential costs of that event. So property construction can also be a driver of insurance costs, with those particularly vulnerable to damage or costly to repair resulting in the highest premiums. Pricing will of course reflect current, rather than future risks.

⁶⁸ For example, US Insurance/Non-Life – Market Underweight. Notice for catastrophe modelling conference call – uses and trends following Katrina, Rita and Wilma. Bear Stearns, 14 November 2005

⁶⁹ Catastrophe risk: US and European approaches to insure natural catastrophe and terrorism risks. US Government Accountability Office report, 2005.

Terms and conditions may also be used to convey messages about risk to policyholders. For example, the usual £50-100 excess on Household policies is specifically raised to £1000 for subsidence. A similar approach is now being adopted in high flood risk areas where excesses of £1000 or even £5000 are applied in extreme situations. Commercial property policies often contain conditions that certain risk control measures should be in place for the policy to be operative. It is possible that similar provisions could apply to Household policies in the future where insurance is available only due to the adoption of, for example, flood warnings from the Environment Agency and responses such as the use of flood protection products.

ABI members have made clear their intention to remain on cover wherever possible for existing customers in high flood risk areas⁷⁰, under current climatic conditions. Equally they have given notice⁷¹ that insurance will not normally be available to new properties developed without adequate flood protection in high risk areas. As a result the ABI, on behalf of its members and in conjunction with the Council of Mortgage Lenders, writes to local planning authorities in England and Wales where the Environment Agency has raised and sustained objections to proposals for development. This enables the insurance and lending attitudes to local risks to be fully reflected in planning decisions.

An example of government and insurance communicating consistent and mutually supporting messages on risk can be found in the collaborative work on flood risk communication undertaken by the Environment Agency (EA) in England and Wales and ABI members. Over the last 5 years the EA has improved the quality and resolution of its flood risk maps, available via the EA website⁷². Information is now available on the extreme flood outline (1:1000 years) as well as the inland (1:100 years) and tidal (1:200 years) floodplain delineations. The effect of local flood defences is also clear, with additional information on flood probability (low, medium or significant) provided by clicking on the relevant location. These probability bands relate to detailed mapping information shared with ABI members which in turn underpins the operation of the ABI Statement of Principles on the provision of flood insurance⁷³. Under this agreement, ABI members offer flood cover on a fully competitive basis in low and medium risk areas, although pricing reflects risk levels.

In high risk areas, insurers have committed to staying on cover for existing customers wherever Government is committed to investing in improved flood defences within five years, provided these defences will reduce flood risk to an annual probability of less than 1.3% (1:75 years). Pricing and conditions will

⁷⁰ Statement of Principles on the provision of flood insurance. Association of British Insurers, 2002 and 2005

⁷¹ Development Planning and Flood Risk (PPG25) Association of British Insurers' Guidance on Insurance Issues. ABI, 2003.

⁷² www.environment-agency.gov.uk, What's in My Backyard.

⁷³ Statement of Principles on the provision of flood insurance. Association of British Insurers, 2005.

reflect risk levels, with the expectation that premiums will fall once improved defences are delivered⁷⁴.

This joint and joined up approach has enabled a much clearer understanding of flood risk, although the EA estimates that 40% of people living in the floodplain do not understand the risk affecting their property. A third approach is therefore necessary. Both EA and ABI are keen to see flood risk included as a mandatory field in Home Information Packs so that in future anyone buying property in the floodplain is made aware of the risk at the outset.

Insurance as a driver for risk management

Insurance has a long history of driving risk management through providing pricing incentives and imposing terms and conditions requiring action⁷⁵. Insurance is often the messenger of change through adjusting pricing and conditions applied to policies⁷⁶. Insurance can be an effective market mechanism for signalling risk and changes in risk or understanding of risk but has most impact when coupled with other signals.

In the example of risk communication given above, insurers are working with the EA to communicate flood risk and to deliver competitive insurance where risk is being controlled. Around 350,000 or so properties in England and Wales are largely unprotected from flooding: flood risk is not controlled by taxpayer funded defences. Where there are no plans to improve management of flood risk, insurers have agreed to use best efforts to stay on cover by discussing measures the householder can take to reduce future flood damage costs or modest flooding. Insurance can continue if the customer takes responsibility for risk management. Insurers have underpinned this work by researching the impacts of various building designs and materials on the cost of flood claims⁷⁷ and have produced information leaflets in conjunction with a consumer group representing flood victims⁷⁸. For customers in these areas availability, terms and conditions and pricing will reflect the probability and nature of flooding in the area and their efforts to reduce risk.

Insurers are also working to reduce weather damage to property through influencing building design and choice of construction materials. Modern

⁷⁴ Many insurers adjust pricing gradually for existing customers so actual changes may not reflect the full change in risk since some discounting may have applied. Premiums also include provision for all other perils included under the policy and movements in these risks together with cost of repairs and reinstatements will also contribute to post-completion pricing.

⁷⁵ The Social Value of General Insurance, Association of British Insurers, 2005.

⁷⁶ A Changing climate for insurance. Association of British Insurers, 2004.

⁷⁷ Assessment of the Cost and Effect on Future Claims of Installing Flood Damage Resistant Measures. Association of British Insurers, May 2003.

⁷⁸ Flood resilience homes: What homeowners can do to reduce flood damage. Association of British Insurers and National Flood Forum, 2004.

materials such as chipboard and plasterboard are more vulnerable to damage than traditional solid or seasoned timber floors or traditional plasters. The ABI is researching⁷⁹ the vulnerability of the more innovative construction methods currently being encouraged by Government, so that pricing and conditions can reflect the risk profiles associated with those building types. However most customers will not seek insurance until a building is about to be occupied rather than choosing building type informed by insurance and other “running” costs. Ultimately this may affect rental and market values if there are pronounced differences in vulnerability.

Dealing with inter-generational costs

Climate change impacts will assume increasing importance over the next half century or so. Climate scientists advise that even if successful mitigation strategies were adopted now, lags in the climate system will result in continued climate change over the next 30 years. The differences between alternative scenarios offered are small at this point. So although there remains considerable uncertainty over some climate change effects over the longer term, there is a strong signal of likely changes over the next three decades. On this basis it should be easy to make decisions today that take account of these changes.

However, dealing with climate change impacts often (although not invariably) results in higher up-front costs, whilst benefits may not flow for some years to come. To the extent that severe weather events will continue to occur, at least at present frequencies, throughout this period, some benefits will be fairly immediate. But there is no additional incentive to invest to avoid future losses. This is the classic inter-generational dilemma which markets fail to price effectively. Developers have no financial interest in the resilience of the houses or offices they build beyond, at best, the warranty period offered at the time of sale, typically ten years. Even here the interest only extends as far as defects. Most insurance contracts are annual or can be annually adjusted, with only a small proportion of property insurance contracts extending to three or five years. Insurers can signal current risk levels very effectively, but not those applying in ten, twenty or fifty years' time.

Businesses such as property developers, operating in highly competitive markets, need strong and clear external signals before they can internalise climate change externalities⁸⁰. Whilst investors and financial institutions can incentivise adaptation to a changing climate once cost-drivers are operating in the short term, these pricing signals are not usually apparent well in advance of losses. Yet the long term nature of housing means that decisions need to be made well in advance, particularly as many adaptations are difficult to adopt in

⁷⁹ Due to report mid 2006.

⁸⁰ Climate change, insurance and the building sector: synergisms, conflicts and adaptive capacity. Jane Milne, Building Research and Information, 2004, Vol 32(1), pages 48-54.

retrospect. Anticipatory adaptation cannot be driven by market mechanisms alone, although these mechanisms can be encouraged and supported through innovative regulation. Regulatory intervention of some sort is required to protect the interests of future property owners and occupiers.

Government levers for action work most effectively at design and build stage – revisions to building regulations may apply to significant refurbishments but these are difficult to police or even define. Better regulation principles encourage the use of voluntary codes rather than statutory regulation. Regulation-based market mechanisms may provide the best compromise. The EU ETS has developed a market-based solution to a regulatory need. Similarly the energy coding of some electrical appliances has driven consumer response through more clearly signalling energy usage and future running costs and congestion charging in London has left open the choice of transport whilst subjecting car users to “polluter pays” charging. The proposed inclusion of energy efficiency information in Home Information Packs will reward home owners for investment in thermal insulation if it stimulates pricing differentials. A “connection charge” for developments in the floodplain, benefiting from established tax-payer funded flood defences, could recover externalities already borne by wider society.

Successful adaptation to climate change, leading to reduced damage or claims costs, will be dependent on clear signals provided through regulation. This could be either direct, through tighter land use planning or building regulation, or via secondary markets developed in response to regulations seeking to influence broad societal behaviours but leaving individuals to choose the most appropriate response for their own circumstances. It is likely that a combination of both approaches will be needed.

Key actions required from government

Insurers would like to see urgent action to reduce the UK’s vulnerability to climate change. We need to start taking action now to manage future costs and keep business and the economy running after a severe storm or during a heatwave. ABI’s studies and other research suggest that the following measures could be effective in improving resilience:

- Future flood losses arising from new housing and regeneration projects in three of the Government’s Growth Areas could be reduced by over 90% by applying existing planning guidance (PPG25) properly – but at present around a fifth of Environment Agency objections to development on flood grounds are ignored by planning authorities. Ensuring that strategic structural plans avoid high risk areas would reduce nugatory developer costs pursuing sites which would be considered unacceptable on closer analysis.

- In Thames Gateway there is less scope to avoid the floodplain, but even here the additional flood damage arising from new development could be halved by focussing development in the lowest risk areas. High risk areas could be used as urban green space, providing amenity and biodiversity opportunities in inner city areas and flood storage when needed. Economic costs arising from lost development opportunities could be offset by significant social and environmental benefits, as well as the gains from avoided damages.
- Existing properties will require better protection from river and coastal flooding – the Thames Barrier replacement alone could cost around 10 years of current national flood and coastal defence spending. Elsewhere communities on the south and east coasts will need enhanced defences in anticipation of current 1:100 year events moving towards 1 in 5 year frequencies⁸¹.
- Universal adoption of the strongest building codes (currently applied in some counties but not others) in Florida would reduce property damage in hurricanes by 45%. Here in the UK we start from a relatively strong position but upgrading design codes could have similarly beneficial impacts, particularly in south east England where standards are lower than northern and western parts of the UK. The Code for Sustainable Buildings must address climate impacts as well as energy efficiency and use of renewable materials.
- Heat stress will increase. By 2040 the summer of 2003 will be the norm. By 2050 around a quarter of working hours will be hotter than “comfort levels” in London but air conditioning adds to heat island problems⁸². Building design must tackle better temperature modulation without resorting to energy dependent systems. People with ill health in housing with poor temperature regulation are most likely to die when night time temperatures stay high – in other words, the poorest pensioners and young children living in the poorest households.

Although many impacts will not be fully realised until much later in the century early action on climate change is necessary since infrastructure leaves a long legacy. The housing stock turns over at a rate of about 1% a year, commercial property at about 2% so decisions today will still have an effect in the latter part of the century. Transport patterns tend to persist long beyond the original asset life.

Planners and designers face significant and challenging changes to the risks likely to be experienced by the property within its lifetime. Past practices are not a good guide to the future and land use planning and building design concerns interact in responding to these challenges. Solutions which are acceptable in one situation are quite inadequate in another. There is a need to integrate the myriad codes, statutory and voluntary, so that a single authoritative reference is produced, providing clarity to

⁸¹ UKCIP Climate Change Scenarios 2002.

⁸² London’s warming. London Climate Change Partnership, 2002.

decision makers. The recently launched Developers' checklist⁸³ attempts to pull together many of the factors that should be considered, drawing on a wide range of stakeholder views. It is a significant step towards a coherent guide to tackling climate change in the built environment by flagging up the issues to be addressed and suggesting solutions.

Developers need to be offered a tool which identifies solutions for specific problems, particularly if linked to geographic risk ratings of weather perils affected by climate change. This would cut through uncertainties, enhance technology transfer, ensuring the UK's housing and commercial property stock is adapted appropriately. Replacement and refurbishment of the public sector estate need to take account of the same concerns and this should be reflected in PPP/PFI contract terms.

Other Government investment and services that need to be climate-proofed include flood and coastal defences and transport links. Similarly public services should be responsive to changing needs such as increased heat stress on public transport, food poisoning outbreaks, avoiding the sun at school playtime. Regeneration and critical infrastructure planning should avoid high risk areas and encourage housing patterns which adapt to changing climate risks.

Government needs to deliver additional research where climate impacts or their effective management are not fully understood. In particular, more research is needed on future windstorms affecting the UK and Europe, probabilistic modelling of climate impacts, risk mapping of urban flooding and non-flooding weather perils, higher definition mapping of inland flooding and coastal storm surge risks, and detailed evaluations of the costs and benefits (including non-financial factors) of different interventions to reduce or avoid damage.

Government will also need to stimulate action by wider society. In doing so it will be important to ensure that measures do not fall exclusively on business, but are shared proportionately across transport, housing, construction and business sectors. These measures should be market-based wherever possible to achieve the greatest gains in the most economically effective way. Government will need to provide incentives for positive behaviours as well as disincentives for damaging activity and these should encompass both mitigation and adaptation.

In order to stimulate voluntary action by businesses and individuals Government needs to give coherent and consistent messages, providing regulatory certainty to business so that investment in innovation is encouraged.

⁸³ Adapting to climate change: a checklist for development. South East Climate Change Partnership, Sustainable Development Roundtable for the East of England, London Climate Change Partnership, 2005.