The Insurability of the Impacts of Climate Change

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Abstract

Insurance mechanisms have been proposed as tools that could aid the process of adaptation to climate change in developing countries. A number of useful proposals have been made in recent times, and striking innovations have been trialled in the field of indexed insurance, but they have generally accepted the usual criterion of 'insurability' - that risks have to be quantifiable, occur randomly, and be many in number, so that variations in claims are smoothed out. From the client's side, the premiums have to be affordable and the contract has to perform reliably.

This paper explores some of the 'uninsurable' aspects of the impacts of climate change to discover whether insurance could also be a tool for managing slow-onset chronic problems such as sea level rise and desertification, and also damage to ecosystems. This could substantially expand the scope of insurance as a mechanism in the field of adaptation, and open the door to a more comprehensive system of assistance for developing countries.

The paper also considers how best to position any innovative mechanism in regards to its justification. The notion of 'responsibility' is firmly rejected through a consideration of the processes that give rise to climate-related damage, and the political dynamics of the negotiating forum, in favour of 'solidarity': a neutral rationale that already applies in many risk-sharing systems.

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1 Introduction

Insurance is a method for transferring and sharing risk. This paper argues that there is a large risk that, because of the momentum in both the climate system and the human emissions generating system, climate change will give rise to potentially catastrophic consequences due to fundamental changes in geographical configuration and growing conditions. This paper examines how insurance-like mechanisms could be used to support mitigation[3] and adaptation[4] strategies, to manage these risks.

Insurance is not a replacement for mitigation or adaptation, but it can be a key part of the overall suite of measures to manage the risk of catastrophic climate change. The paper argues that insurance should not be viewed as a form of compensation for victims of climate change, but instead in the classical view, as a risk-sharing mechanism or form of solidarity. Indeed, since insurance can help to preserve the global financial and social system, it is a risk reduction tool, not simply a risk-sharing one.

Section 2 outlines the likely impacts of climate change, arguing that mitigation is unlikely to reduce the possibility of catastrophic impacts from climate change completely. This means that the impacts of climate change may be beyond existing climate risks. Section 3 outlines the role for insurance or an insurance- like risk transfer mechanism under this scenario – insurance becomes a tool for protecting the vulnerable and hence preserving global social and financial integrity in the event of severe impacts. Section 4 outlines the problems that will be faced by insurance mechanisms to deal with this; essentially traditional notions of insurability will break down. Section 5 draws implications for insurance type mechanisms in a world which faces severe climate change impacts. The conclusions of the analysis are employed in section 6 to compare three proposals to introduce insurance mechanisms made under the UNFCCC process, and appraise their fitness for purpose. Section 7 discusses two innovative concepts to extend insurability for natural forests and slow-onset events, and Section 8 draws some conclusions on the role of insurance in managing the risk of climate change.

2. The challenge of climate change

The United Nations Framework Convention on Climate Change (UNFCCC) was signed by 154 nations in 1992. The objective of the treaty is (UN (1992)):

“to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.”

Section 2.1 argues that in practice mitigation strategies will, at best have limited success. This therefore means that there is likely to be ‘dangerous interference’, and the possibilities are discussed in section 2.2.

2.1 Increasing risk of catastrophic climate change

The atmospheric concentration of CO_2 (carbon dioxide) in 2008 stood at 385 ppmv[5] (parts per million by volume), the highest for at least two million years[6]. Allowing for the effect of five other greenhouse gases regulated by the Kyoto Protocol takes this to around 435 ppmv CO_2 equivalent.

The overall goal for the COP 15 UNFCCC conference in December 2009 is to establish an ambitious global climate agreement for the period after 2012 when the first commitment period under the Kyoto Protocol expires. The EU has, after due consideration, decided that this means holding the global increase in temperature to no more than 2C above the preindustrial level, and this is now a common yardstick.. However, even highly ambitious emissions targets may not be enough to reduce the probability of dangerous climate change below this level, given the inherent uncertainty in the link between CO_2 and climate.

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[3] In this context, the reduction of greenhouse gas emissions and their atmospheric concentration to lessen climate change
[4] In the context of climate change, the process of coping with the effects of climate change
[5] ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_gl.txt
[6] *Science* 19 June 2009: Vol. 324. no. 5934, pp. 1551 – 1554 DOI: 10.1126/science.1171477. ***Atmospheric Carbon Dioxide Concentration Across the Mid-Pleistocene Transition.*** B. Hoenisch et al.[1]

Figure 1 shows that despite the good intentions of the Rio Summit in 1990, and the subsequent Kyoto Protocol, drafted in 1997 and ratified in 2005, atmospheric levels of the main anthropogenic greenhouse gas carbon dioxide (CO_2) continue to rise inexorably. In fact, there are several other major greenhouse gases which add about thirteen percent additional warming on to the basic 'radiative forcing' of carbon dioxide. They are generally converted into 'carbon dioxide equivalent' units (CO_2e) to give the total warming.[7]

Figure 1 Recent global levels of atmospheric carbon dioxide (1980-2008).
Source Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends)

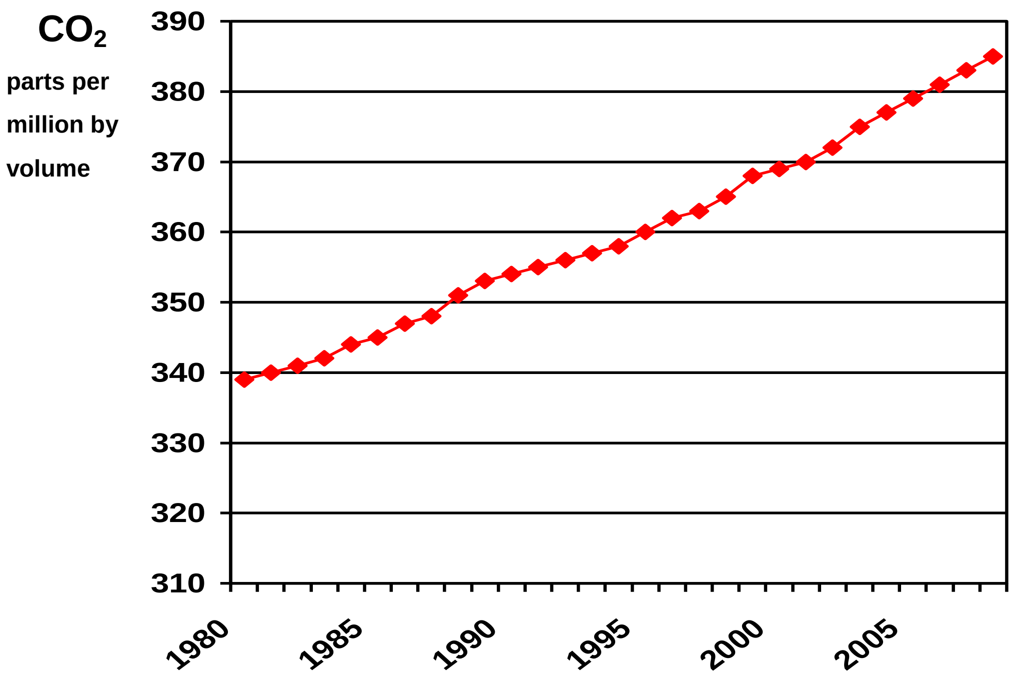

Table 1 indicates that at a level of 450 CO_2 equivalent , which will be reached by the year 2015 at current accumulation rates, there is just an even chance (33 to 66 percent probability) that the global temperature will not rise above 2C. (Note that there is a lag of several decades between reaching a concentration level, and reaching the associated temeperature.) Since emissions levels are expected to increase steadily due to the carbon-intensity of the world economy, it seems inevitable that the 2C threshold will be breached before 2050.

Research suggests that even meeting a target of 650 ppm CO_2e will be "improbable" (Anderson and Bows (2008)). At that level, Table 1 indicates that a warming of the order of 4C is likely, though the threshold may not be crossed until after the year 2100. Anderson and Bows (2008) suggest that stabilisation at 2C would require "total decarbonisation" between 2027 and 2063. The current state of the carbon markets (i.e. low prices) suggests that much higher concentration levels are possible – as much as 1,000 ppm CO_2e (Carbon Trust, 2008).

[7] There also some emissions such as sulphur dioxide which give a cooling or negative effect, but these are ignored here, as these emissions are generally short-lived, and the quantities and effects are less certain.

Table 1 Risk of exceeding temperature levels , for a given GHG concentration level
(based on IPCC, Fourth Assessment Report, Working Group III, Table TS6, 2007)

Stabilisation Concentration (CO_2 equiv ppmv)	**Probability of staying below indicated warming relative to preindustrial temperature**						*Midrange Warming (^oC above preindustrial)*
	1.5 ^oC	**2.0 ^oC**	**2.5 ^oC**	**3.0 ^oC**	**3.5 ^oC**	**4.0 ^oC**	
350	<10%	<10%	<10%	<10%	<10%	<10%	*1.0 ^oC*
400	33–66%	10–33%	<10%	<10%	<10%	<10%	*1.6 ^oC*
450	66–90%	33–66%	10–33%	10–33%	<10%	<10%	*2.1 ^oC*
500	>90%	66–90%	33–66%	10–33%	10–33%	<10%	*2.5 ^oC*
550	>90%	66–90%	66–90%	33–66%	33–66%	10–33%	*3.0 ^oC*
600	>90%	>90%	66–90%	33–66%	33–66%	33–66%	*3.3 ^oC*
650	>90%	>90%	66–90%	66–90%	33–66%	33–66%	*3.7 ^oC*
700	>90%	>90%	>90%	66–90%	66–90%	33–66%	*4.0 ^oC*
750	>90%	>90%	>90%	66–90%	66–90%	33–66%	*4.3 ^oC*
800	>90%	>90%	>90%	66–90%	66–90%	66–90%	*4.6 ^oC*
850	>90%	>90%	>90%	66–90%	66–90%	66–90%	*4.8 ^oC*
900	>90%	>90%	>90%	>90%	66–90%	66–90%	*5.1 ^oC*
950	>90%	>90%	>90%	>90%	66–90%	66–90%	*5.3 ^oC*
1000	>90%	>90%	>90%	>90%	>90%	66–90%	*5.5 ^oC*

Key:

less than 10 percent chance of exceeding the indicated temperature

10 to 33 percent chance of exceeding the indicated temperature

33 to 66 percent chance of exceeding the indicated temperature

66 to 90 percent chance of exceeding the indicated temperature

over 90 percent chance of exceeding the indicated temperature

2.2. The impacts of climate change

The impacts associated with different levels of climate change are summarised in Figure 2, taken from IPCC (2007). That report gives enough information to assign approximate probabilities to the events described happening at given temperature increases. As we have seen, we are probably locked in to up to 2C of warming, so the next 30 years is likely to see a progression across the left half of the table (Hansen et al, 2008).

Climate sensitivity is defined as the equilibrium change of temperature for the doubling of carbon dioxide. Equilibrium might take centuries to achieve depending on certain factors. The headline range for climate sensitivity in IPCC (2007a) is 2.0-4.5 C. Section 2.1 argued that it is unlikely that concentrations will be stabilised at less than 650ppm CO_2e[8], so this means that the impacts at the higher end of the table are ultimately likely. Specifically, a concentration of 650ppm implies a temperature increase of 2.4-5.5C[9].

However, from an insurance perspective, the situation is considerably more serious. IPCC (2007a) describes the range of climate sensitivity as "likely", which is defined as 66% probability. This means that there is a 33% probability that temperature rises will fall outside this range. If we assume that there is an even probability that the sensitivity will be more or less than the range, the implication is that there is a 17% probability that the temperature increase will be greater than 5.5C, even if a target of 650 ppm CO_2e (which is "improbable" (Anderson and Bows (2008)) is achieved. Therefore at some point in the future, there will be at least a 1 in 6 probability, which in many lines of insurance would be considered "uninsurable", that the impacts will be more severe than Figure 2 suggests.

Figure 2 Key Impacts as a Function of Increasing Global Average Temperature (IPCC (2007))

Temperature rise ^oC wrt global average 1980-99

0 1 2 3 4 5

Water	Less water mid-latitude and semi-arid tropics ------------**>** Hundreds of millions in water stress -----------------------**>**
Eco-systems	Up to 30% of species at risk > 40% of species extinct
Food	Subsistence communities adversely affected ------------**>** Tropical cereals yields progressively decline ---**>**
Coast	More floods and storms --**>** Significant land loss ------**>**
Health	Increasing disease and illness ---------------------------**>** Health services stretched -**>**

Recent research cast doubt on the upper bound of sensitivity cited in IPCC (2007a) due to the potential for positive feedback effects; much of this research has been subsequent to the period reviewed by the report (see for example Stainforth et al (2005), Harrison (2008), Hansen et al (2008) and Knuti and Hergel (2008)). Combined with the possibility, that greenhouse gas concentrations may exceed 650ppm it would seem reasonable to conclude that there is at least a 1 in 6 probability of the temperature increases over pre-industrial levels exceeding 5.5C. The exact probability is unknown as is the upper bound of the increase.

Whilst IPCC (2007a) presents the temperature rises as gradual, the paleoclimate record indicates that in the past abrupt climate change can occur – with double digit temperature changes within a decade - both at the regional and global level (Harrison (2008) and also see Figure 7.

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[8] Doubling of concentrations above pre-industrial levels would be approximately 560ppm, so this concentration is more than double

[9] Using the formulae for climate sensitivity: $\Delta T = \Delta T_{2x} \times \frac{\ln(\text{new } pCO_2 / \text{orig. } pCO_2)}{\ln(2)}$

Where:

ΔT = Global average change in temperature at equilibrium

ΔT_{2x} = Climate sensitivity i.e. Global average change in temperature at equilibrium for doubled CO_2

orig. pCO_2 = Pre-industrial atmospheric concentration of carbon dioxide

new pCO_2 = stabilization level atmospheric concentration of carbon dioxide

IPCC (2007) is a survey of existing literature – it deals with what is known and considered to be most likely to happen. For example sea level rises are projected to rise between 0.18 and 0.58m by 2099. IPCC (2007a) then goes on to say “Models used to date do not include uncertainties in climate-carbon cycle feedback nor do they include the full effects of changes in ice sheet flow, because a basis in published literature is lacking. The projections include a contribution due to increased ice flow from Greenland and Antarctica at the rates observed for 1993 to 2003, but these flow rates could increase or decrease in the future.”

In other words the IPCC reports on what is known with a degree of certainty, the relatively modest sea level rises, but marginalises the area where knowledge is lacking. The relatively modest temperature and sea-level increases quoted are the ones that are widely used in the press and taken up by policymakers. However, from a risk management perspective, there are residual risks in the “carbon cycle feedback” or the “ice sheet flows”. These risks are important for two reasons; firstly, given adequate resources, most countries could deal with sea level rises up to 0.58m. However, rises in the order of magnitude of meters would be catastrophic and adaptation would not work. Moreover, this is an uncertainty not a risk –the likelihood or impact parameters are unknown to any degree of certainty.

Due to the uncertainty of the upper bound of the temperature sensitivity, this raises the possibility of far more serious impacts than suggested by Figure 2, such as:

1. Positive feedbacks in the carbon cycle giving rise to non-linear responses in the climate system. For example, release of methane hydrates from melting permafrost or greenhouse gases from the large-scale burning of rain forests could dramatically accelerate climate change (USGA (2008) and Harrison (2008)).
2. Catastrophic global physical events. On passing a threshold temperature increase could give rise to catastrophic physical change, beyond mankind’s adaptive capacity. The prime concern is the collapse of the Greenland or West Antarctic ice sheets, but there are other possibilities (USGA (2008)).
3. Socio-economic collapse. It is possible for a lesser event than (2) to result in a break down in global security resulting in catastrophic consequences. For example, Himalayan glacier melt could result in water shortages in India and China, resulting in social breakdown for a third of the world’s population (Mabey (2008)).
4. Unforeseen risks. The climate system, the natural world and the human system are all complex, and a significant degree of warming may result in unforeseen consequences e.g. high volcanic activity, invasions of exotic species.

In summary, emission levels are rising steadily, scientists are upwardly revising estimates of damage and uncertainty, and it is questionable whether adequate emission targets will be set or complied with. The probability of averting “dangerous” climate change is therefore decreasing with time, and there are high potential consequences (Bettis and Silver, 2009).

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3. Role of insurance

The previous section argued that there will definitely be some adverse impacts of climate change, and there is a probability that there will be severe adverse impacts. This section examines the alternatives for managing the risk, before looking at the role for insurance. The paper will concentrate on the developing countries, which can often be vulnerable to climate events for a multitude of reasons, such as low adaptive capacity, undiversified economies relying on climate sensitive activities, and vulnerable megacities[10]

3.1 Alternatives to insurance

When faced with a risk, there are a number of possible alternatives, namely to avoid the risk, to transfer or pool the risk, and to accept the risk (RAMP (2002)). In each case, the strategy can be combined with risk reduction.

There are two alternative ways of avoiding the risks of adverse impacts of climate change; full mitigation will stop the risk occurring on a global level, but as we have seen this strategy is politically improbable. However, risks can be avoided or reduced at a local level through adaptation or risk management. Adaptation is defined as “adjustment in natural or *human systems* in response to actual or expected climatic stimuli or their effects,

[10] see http://go.worldbank.org/K2CBHVB7H0

which moderates harm or exploits beneficial opportunities." (IPCC (2007)). Risk management is a similar concept whereby the risks from climate effects are anticipated and measures put in place to avoid the damage: for example by building sea defences to reduce the damage from storm surges.

Adaptation (risk management) will reduce the risks but it is impossible to avoid climate damage completely, because for any level of protection, there is still a probability that an event can occur that will exceed the design threshold. The cost of protection rises as the threshold of protection increases, there comes a point where it is no longer cost effective to improve the defences or adaptive measures (Dlugolecki (2007), ECA (2009)). For example it is impossible to conceive of a land falling category 5 hurricane causing only minimal damage, however good preparations are. In fact, the 2005 hurricane season did $128 billion of damage, most of which was in the USA, a highly developed (and hence relatively resilient) country (MCII (2008a)).

There is uncertainty over the level of future climate change, the effect of climate change on tropical storms and other extreme events, on the cost and effectiveness of risk reduction measures. This uncertainty means that an insurance-type mechanism is likely to be cost effective. Adaptation decisions are taken at the local level, where there is much more uncertainty as to the impact of climate change than at the global level. Essentially therefore, insurance schemes over a large geographical region, even global, are more cost-effective because they can be priced more precisely. A major motivator for insurance is to pool risk – some areas definitely ***will*** have reduced rainfall patterns, it is the where and when that are unknown.

There are a number of non-insurance transfer mechanisms available (see Table 2), which could be considered alternatives to the insurance-type mechanisms.

Table 2 Insurance and non-insurance mechanisms available to manage risk (UNFCCC (2008))

	Micro scale risk financing	Meso scale risk financing	Macro scale risk financing
Mechanism	Households, small and medium enterprises, farms	Financial institutions, donor organizations, etc.	Governments
Non-insurance mechanisms			
Informal risk sharing	Kinship and other mutual arrangements, remittances (family and community solidarity)		Diversions from other budgeted programmes
Intertemporal risk spreading	Microsavings, microcredit, fungible assets, food storage (individual responsibility)	Emergency liquidity funds	Reserve funds, regional pools and post-disaster credit, contingent credit
Collective loss sharing (solidarity)	Post-disaster government assistance, humanitarian aid (national and international solidarity)	Government guarantees and bailouts	Bilateral and multilateral assistance
Insurance mechanisms			
Risk pooling and transfer, insurance	Microinsurance, insurance, weather hedges (individual responsibility)	Reinsurance	Sovereign risk financing, regional catastrophe insurance pools
Alternative risk transfer		Catastrophe bonds	Catastrophe bonds; risk swaps, options and loss warranties

The alternatives to catastrophe insurance are ex-post loans, aid or diverting funds from other activities. These options are certainly less effective and in the long run more costly than insurance; diverting funds means that future development is impaired, aid can be delayed, the amounts are unknown in advance, and are subject to the risk of donor fatigue. Loans normally are diverted from elsewhere and/or can affect a country's credit rating, debt and hence attractiveness for investment, again hampering development (Cummins and Mahul (2008)).

An interesting alternative mechanism is the International Monetary Fund's Exogenous Shock Facility (ESF). This is a halfway house between index insurance and post disaster relief; it provides and immediate injection of funds after a disaster followed by a phased income over a longer period[11].

On a local level, traditional alternatives to insurance are kinship and community solidarity or aid from governments. These are all problematic in the event of large climate impacts – whole communities can be affected by a large disaster, and a country can find itself short of funds and resources post-disaster.

3.2 The need for insurance

The need for insurance can be divided into two categories.

Firstly, there is the need for insurance against climatic events – events that happen anyway, but may be exacerbated by climate change (Column 1, Table 3). Post-disaster, a country has to rebuild infrastructure and divert spending from other activities into emergency relief. Individuals may have their homes, businesses and livelihoods destroyed; the country development is set back, the individual may be left destitute. These effects reduce resilience and increase vulnerability.

Insurance provides security against the loss of assets and livelihoods in the post-disaster period. It ensures reliable and dignified post-disaster relief, can be designed to set incentives for prevention and provides a safety net for innovative risk-taking, which is essential for development and for achieving climate resilience (Linnerooth-Bayer et al (2008)). Furthermore insurance can and should be integrated into adaptation and risk management programmes to inform decision making processes, provide information and incentives.

Table 3 – Climatic Hazards (UNFCC (2008))

Climate hazards (1)	**Climate change hazards (2)**	**Second order** (3)	**Consequential losses** (4)
• Windstorm • Sea-surges • Flood • Drought • Fire • Heat wave	• Sea level rise • Ocean acidity • Precipitation change • Melting glaciers & permafrost • Temperature rise	• Disease • Climate related extinctions and alien species invasion • Reduction in access to water • Changes in commodity prices, delays or cessation of unrelated activity	Direct climate hazards could give rise to multiple consequential losses, for example economic losses, social breakdown, worse health outcomes and forced migration.

However, there is a second group of hazards that are caused solely by climate change and could prove catastrophic to communities: the more gradual changes in column (2) Table 3. The first line of defence for such hazards will be adaptation, but this may not always be possible. For example, if sea level rises turn out to be multi-meter as has been suggested (for example by Hansen et al (2008)), it might not be possible to raise sea l defences sufficiently. People will therefore be faced with a loss of homes and livelihoods. These forms of hazard do not fit comfortably with traditional non-life insurance, which normally works best for low probability high impact, short term-events.

Section 2.2 identified risks that will exceed the conventional bounds of insurance. Firstly, the hazards or a combination of the hazards, if severe, identified in Table 3 could lead to a breakdown in socio-economic systems. For example, Figure 2 identifies that hundreds of millions of people could be exposed to water stress. This could easily lead to regional security breakdowns. Secondly, there is a probability of global catastrophic events, such as the collapse of the Greenland or West Antarctic icesheets. Again, this could lead to a breakdown of human systems.

Even if such severe events do not occur, climate change is an issue that could affect the lives of everyone in a world that is becoming increasingly integrated and inter-dependent (Developments Concepts and Doctrine Centre, 2006). Many countries' adaptive capacities may be overwhelmed, and in particular the emerging world

[11] http://www.imf.org/external/np/exr/facts/esf.htm

super-powers, like China and India, are particularly vulnerable to climate change (German Advisory Council on Global Change, 2007).

Climate change is likely to worsen the problems in fragile states, and potentially introduce new problems such as scarcity of food and water, increased incidence of infectious diseases and extreme weather events (such as storm and flood). The net result is likely to be migration as regions are unable to support their population levels. Much of the migration will be internal, further weakening fragile states, but there could be substantial international population movements, enhancing ethnic tensions and undermining the stability of the immigration country. The problems are likely to occur simultaneously in several regions (CII (2009)).

An ex-ante risk transfer mechanism can reduce the cascading effect caused by climate related natural disasters and hence reduce vulnerability. This is illustrated by Figures 3 and 4.

Figure 3 Climate event causes increased vulnerability (UNFCCC (2008))

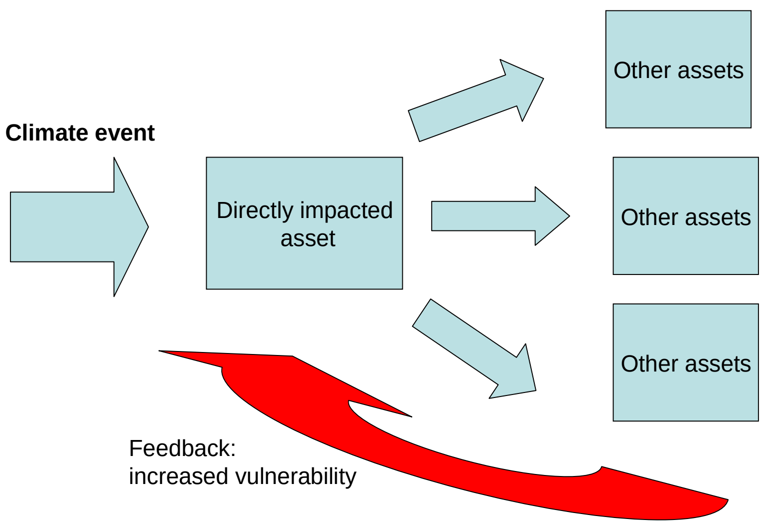
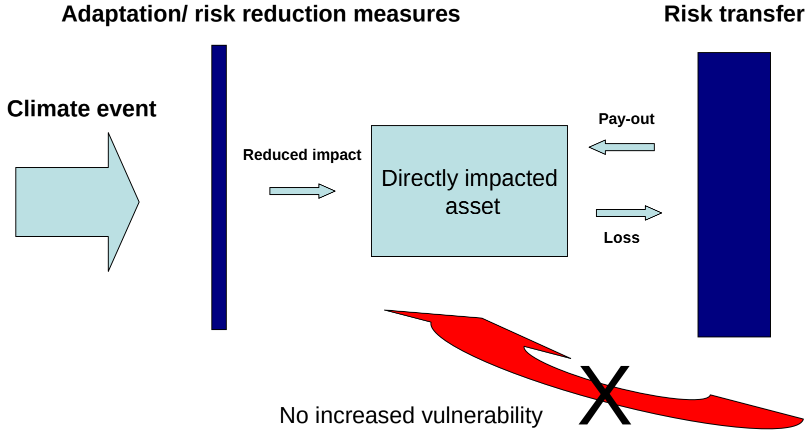


Figure 4 Vulnerability reduced by adaptation and risk transfer mechanisms (UNFCCC (2008))



Risk transfer mechanisms can compensate victims for loss of the directly impacted asset, which can be replaced, and preserves indirect assets. For example, parametric crop insurance[12] can provide a swift cash injection after a period of low rainfall. This means that farmers can maintain themselves until the next crop cycle. In the absence of this insurance, the farmer can be forced to sell livestock and migrate to avoid famine – thus destroying his livelihood[13]. This accelerated compensation is a critical feature of insurance models when compared to other risk financing schemes (UNFCCC, 2008), and is particularly strong for parametric instruments.

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[12] Parametric insurance is an instrument where the payout is determined not by the actual loss, but by the occurrence of a specified event

[13] World Bank (2005)

Crucially, insurance is required to preserve the system – to prevent forced migration and a break down in security that would result from a loss of livelihood and home as the result of climate or climate change damage.

3.3 What type of insurance model? Towards a solidarity approach

The simplest form of insurance is a risk pool, into which members pay a premium, and from which the unfortunate ones receive claims payments after they suffer a loss. No ‘blame’ is attached in this ‘solidarity’ model, and the premiums are either uniform, or tailored to reflect members’ idiosyncratic (i.e. individual) risk levels. An alternative ‘liability’ model is one where society is divided into victims and wrongdoers. In that case the wrongdoers pay premiums, generally weighted according to perceived riskiness, into a risk pool, out of which the victims receive compensation.

Vulnerability is “the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its adaptive capacity.” (IPCC (2007)). By definition, the most vulnerable societies are those most in need of a risk transfer mechanism. However, in general, these societies have the least access to forms of risk transfer such as insurance (UNFCCC(2009)). It has also been argued that richer, developed countries have been responsible for climate change and are thus liable to compensate the ”victims”. These arguments point towards a ‘liability’ model. However, developing countries are generating massive emissions now (China overtook USA in 2008), and early civilisations in those regions created huge changes in land use, with huge emissions for millennia, so the argument is not clear-cut. There are also technical reasons to avoid the liability model.- see Box 1.

Box 1 Difficulties with legal liability as the basis for compensation

The threat of litigation, particularly in the USA where the tort system has developed in a plaintiff-friendly way, has in the past proved a useful weapon in the environmentalists' armoury, because it is damaging to corporate image and expensive in management time.

There are three major questions in terms of practicability (Allen (2005):

<u>Attribution.</u> Allen (2005) argues that the technical difficulties of attribution or causation, may soon be overcome, and that it may be possible to quantify the man-made contribution to specific events.. Heatwaves are the easiest phenomenon to address, and there has so far been only one event (the European heatwave of 2003) which has been studied in terms of anthropgenic causation.. When it comes to precipitation or storminess, science is still far from consensus on predictions, so attributing actual damage is even more difficult. At the same time, slow onset chronic events such as sea-level rise, will be modest over the next few decades, and so would not be actionable in the near future.

<u>Quantum. This comprises</u> actual damage, and potential damage (Allen (2005)). A key issue is who can claim for potential damage that has <u>not</u> been crystallised today into lower property values or lost economic opportunities. Future losses may affect unborn people, while on the other hand social and economic mobility is such that it would be difficult to argue that current residents in an area are the ones who will be affected by future events in that area.

<u>Allocation</u> of damages. Recent practice in product liability legislation indicates that anyone in the supply chain can be held liable. Even if attention is restricted to upstream energy producers, the parties under this definition are considerable in number, and would probably be able to resist the argument that they should pay damages in full and recover from other responsible parties, given that there was no collusion. Any single party would be responsible for much less than 5% of fossil fuel-derived emissions. In fact perhaps 25% of the conventionally assessed anthropogenic driving force on climate is NOT from fossil fuels, but from other activities eg agriculture. Furthermore, by 2020 developing countries will create more than half of the emissions, particularly from coal, so seeking damages there would hardly serve the redistribution of wealth. Finally, companies could simply seek bankruptcy status to avoid liability.

The legal system is a slow and uncertain process. The transaction costs can be high, and it would be very inefficient in terms of actually recovering a satisfactory proportion of the damages for injured parties because of the enormous practical problems. Also, the legal system is not capable of recovering non-financial damage such as species loss.

In contrast the risk management or solidarity approach is robust and does not give rise to perverse arguments and incentives. Solidarity is defined as “union or fellowship arising from common responsibilities and interests, as between members of a group or between classes and peoples” The motivation behind a risk transfer mechanism is to provide a “back stop” that reduces the risk of a major breakdown in socio-economic systems. Ex-ante risk transfer mechanisms (like insurance) could act to pre-empt societal breakdown (Cummins and Mahul (2008)).

4 Problems of insurability caused by climate change

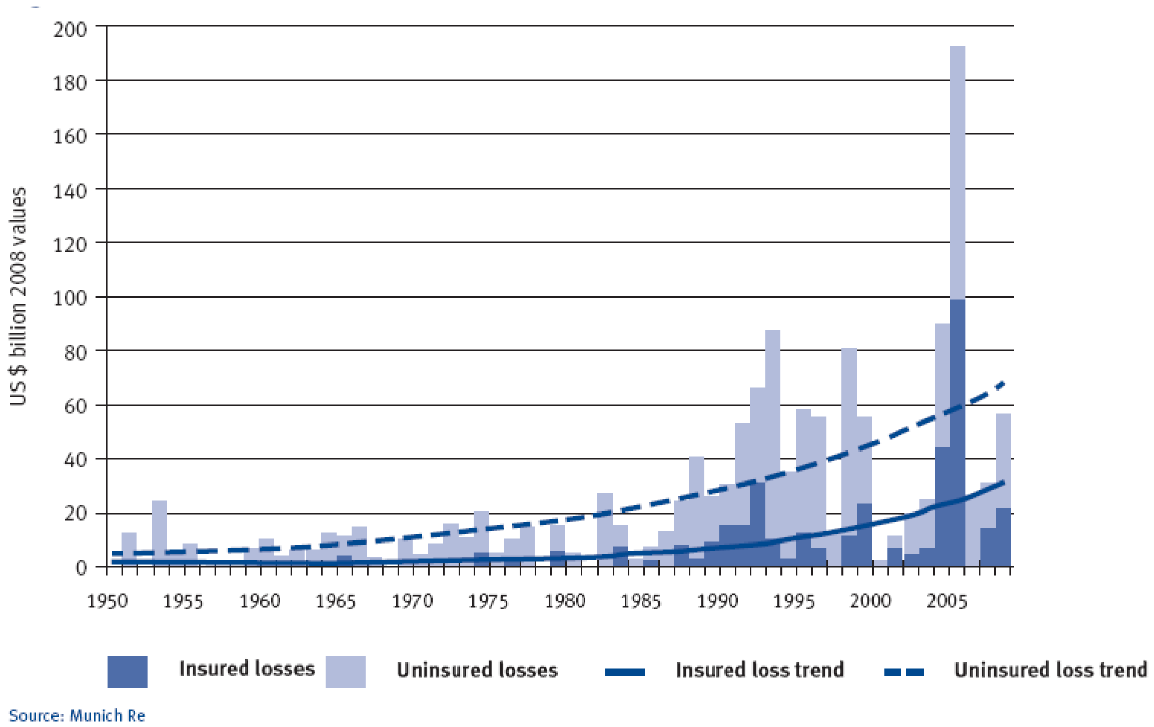
The previous section identified the need for insurance as a back-stop to preserve livelihoods of the vulnerable and to therefore pre-empt the possibility of climate change causing societal breakdowns. This section outlines the challenges that insurance or insurance-like risk transfer mechanisms might face.

4.1 Magnitude of losses

Figure 5 shows the increase in losses from natural disasters since 1950. Both the insured and uninsured losses have increased, the latter being much greater than the former, meaning that currently insurance only covers a small portion of losses. The actual discrepancy is greater than shown, as Figure 5 only looks at large and reported losses- financially less significant uninsured losses that occur in poorer countries will not appear on the graph. Also, the costs exclude slow-onset events, and indirect knock-on effects – total losses could be 5 times as high (Dlugolecki (2007)). This hypothesis of underestimation is supported by a recent critique of the UNFCCC’s study on the cost of adaptation, which claims it could be too low by a factor of 3 (Parry et al, 2009).

There has been considerable debate as to whether there is a climate signal in Figure 5. Much of the increased damage comes from increased vulnerability caused by larger populations, increase in wealth and hence an increased amount of valuable property being exposed to severe weather events. However, it is very likely that Figure 5 does contain a climate signal, as a comparable graph caused by non-weather related disasters, such as earthquakes or volcanoes, does not show such a significant increase (UNFCCC (2008)).

Figure 5 Great Weather disasters 1950-2008 (CII 2009)[14])



[14] Chapter 2: data from Munich Re

Estimates of current losses from natural disaster are between US$20bn and US$85bn[15] depending on what is included. Since the figures exclude secondary impacts such as loss of employment, the actual economic loss could be somewhat higher.

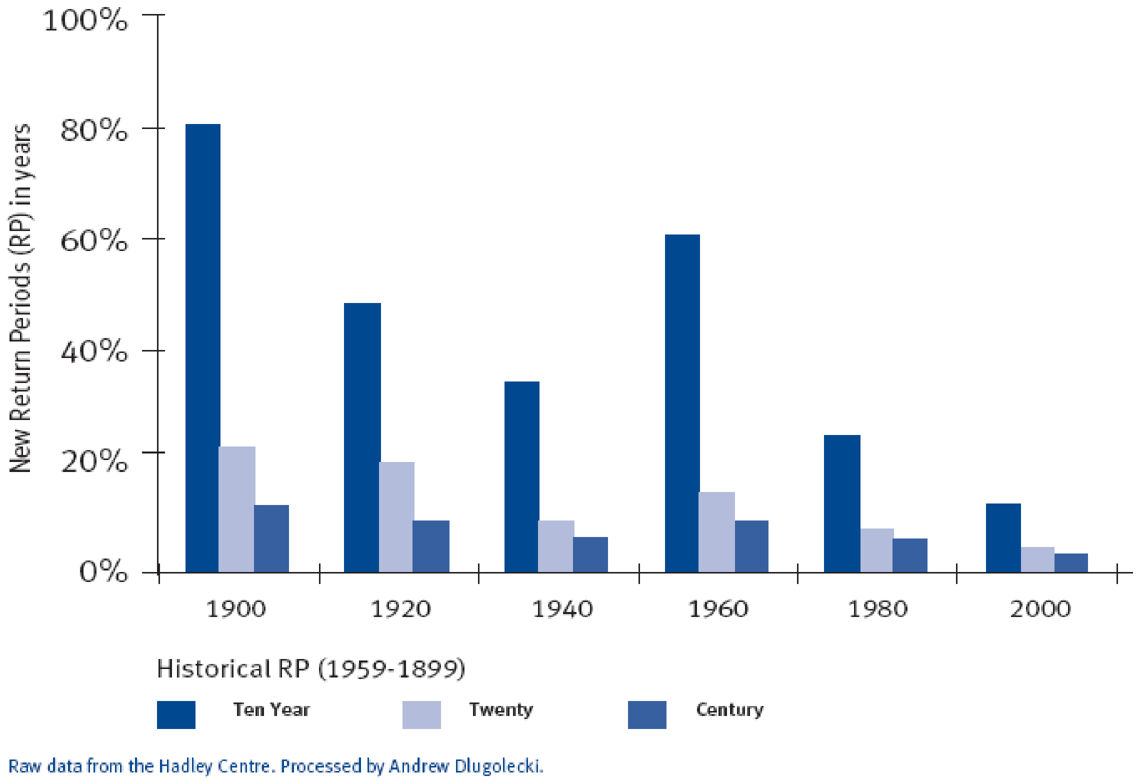
As discussed above, estimates of future losses are subject to even more uncertainty. Dlugolecki (2007) estimates that in 2030 global losses will increase to US$600bn - US$1,000bn[16], which for developing countries is between US$300bn-500bn, i.e. three to five times today's rate.

At the moment only 1% of households in developing countries have insurance coverage against catastrophe risk, so the challenge of significantly in creasing coverage is immense. However, this is small compared to the losses that would be incurred if a catastrophic event caused by climate change, for example the collapse of the Greenland ice sheet occurred. The damage caused by such an event is essentially uncapped.

4.2 Problems of pricing contracts

Figure 6 shows the change in frequency of particularly hot months in Central England. For example, a month that was sufficiently hot that it only occurred once every a hundred years in the 19th century now occurs once every fourteen years – a sevenfold increase. The return period for events that occur every 1000 years is now estimated to be 83 years (CII(2009)).

Figure 6 Actual return period for different level of hot months in Central England (CII (2009)[17])



This means that any insurance event that is directly linked to temperature extremes would have a very large increase in loss occurrence. Simplifying somewhat, the actuarially neutral cost or risk premium of an insurance contract is the product of frequency and expected loss[18]. Hence a change in a loss event from a 1 in a thousand year event to a 1in 83 year event represents an increase in the insurance cost of over 10 times. The frequency cannot be estimated empirically – insurers tend to rely on historic data, but for such a rare but rapidly more

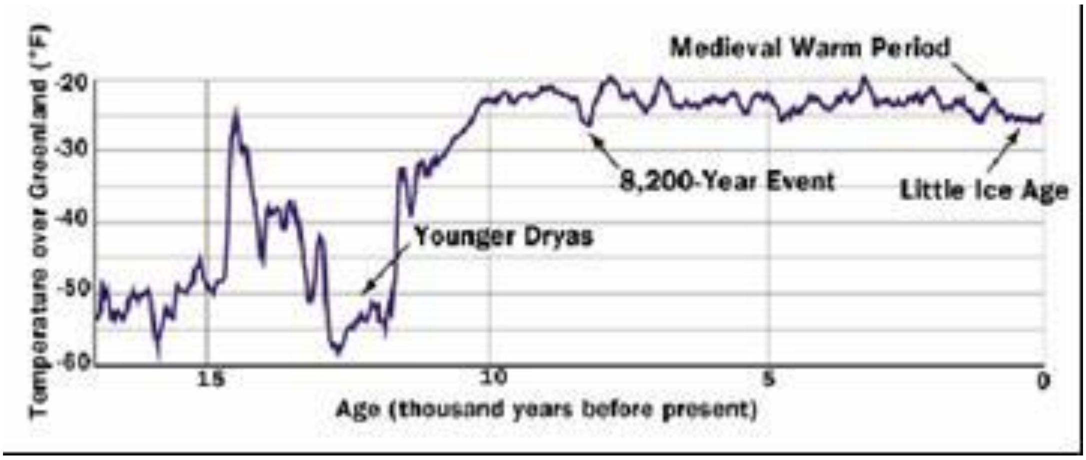
[15] Cummins and Mahul (2008), Mirza (2003), Dlugolecki (2007), Scheuren et al (2008)
[16] In 2006 US$
[17] Chapter 4
[18] It is actually the integral of the loss distribution curve. The actual premium includes expenses, distribution costs, an allowance for capital, a profit margin and a market adjustment

frequent event, historic data will be useless. As we have seen, climate change predictions are subject to uncertainty, particularly at the local level required for insurance.

Furthermore the discussion above concentrates purely on temperature. Weather events may be correlated with temperature, but it is unlikely that the relationship is linear, for example hurricane intensity has been shown to be correlated with sea surface temperature, but this can alter due to local variations, and the damage caused by hurricanes is non-linearly related to wind speed (IPCC (2007a)). Precipitation also plays a major part in extreme events, and here the science is less specific. Hence the probability of rare events is highly uncertain, which means that insurance contracts cannot be priced.

Figure 7 shows a further area for concern. In the Younger Dryas period, temperature changes of more than 10 degrees in a short space of time (decadal or possibly less) occurred. The discussion in Section 2 and recent research suggests a return to this degree of instability may be possible (see for example Stainforth et al (2005), Harrison (2008), Hansen et al (2008) and Knuti and Hergel (2008)). This would represent 1 in 10,000 year events (0.01%) becoming possible, with an unknown probability. The damage caused by such a temperature shift is also unknowable.

Figure 7 Temperatures over Greenland over last 20,000 years



Also, a private insurer needs to hold capital based on reducing the probability of ruin below a defined level. It can easily be seen that if the insurer cannot estimate the probability distribution of loss, he may not be willing to offer insurance (that is not to say that insurance products have not been sold where the underlying loss distribution is not known, but these products are not sustainable in the long run).

The implication is that private insurance alone will not be viable for any climate related hazard where the underlying loss frequency and severity distributions cannot be estimated. Private sector insurance will only be viable if the uncertainty is backed by the public sector to remove the uncertainty, or climate models improve to an extent where the risk premium can be calculated with a degree of confidence.

4.3 Challenges of risk pooling

The hazards caused by climate change are identified in Table 3. For some hazards, the frequency and severity of the risk are increasing globally: this makes risk pooling more difficult, but also more necessary. That is not to say that the increase in damage will be uniform, as vulnerabilities and degree of hazard will diverge. For example sea-level rise will affect coastal areas to differing extents[19].

For other hazards, climate change might cause no global frequency and severity increases but lead to regional differences. Rainfall patterns are an example of this hazard; it is predicted that these will change, but the geographical location is uncertain, and therefore risk pooling is possible.

[19] sea level rise is not uniform, due to oceanic currents , subsidence and other effects (Silver and Dlugolecki (2006))

Whether the risk is global or regional, there may come a point at which the risk is so severe in specific locations that they become uninsurable. Ulimately , if global temperatures go well above 2C and damage and dislocation become widespread, this may become true of most climatic damage.

One way in which insurability can be extended is to pool climatic risks with non-climatic ones, since they are uncorrelated. This is the principle of a catastrophe (cat) bond. A bond is issued which pays out[20] if an event occurs, for example a hurricane in Florida. The bonds are typically issued by reinsurance companies and sold into the global bond market. Unlike traditional insurance (for example by insuring your house, you are effectively pooling your risk with other homeowners), the bond issuer is not pooling with other insurers who risk catastrophes, but is pooling the risk with investors who are diversifying their risks. The uncertainty over the future impact of climate change could therefore be used to transfer risks into the international financial markets[21].

4.4 Unknown risks

Climate change also raises another area of uncertainty; temperature increases are at the higher end of the IPCC predictions are outside the range of human experience, and the risks caused by this increase are unknown. Therefore it is not possible to map a complete range of hazards for "unknown" risks, which means that designing an insurance vehicle is challenging.

4.5 Multi-year policies

Traditional non-life insurance and parametric insurance policies are short-term, typically 1 to 3 year-policies. However, the impacts of climate change are over a long time frame and are likely to be gradual changes punctuated by sharp increases – for example sea level rises are caused by the expansion of the oceans as they warm and gradual ice melts, but could face a sudden rise from the collapse of an ice sheet at an unknown time. The gradual increase is inevitable, although the magnitude is unknown.

The characteristics of this risk are much more akin to a life or permanent health insurance policy which is long term, and the loss is inevitable. However, there are few examples of this form of insurance being written for physical risks[22] and many non-life companies are constrained by capital requirements in their abilities to write this form of policy.

4.6 Asset classes

The large majority of insurance is written in developed countries on easily defined assets, such as a house or a car. To protect the most vulnerable, insurance will have to be written in fragile states, dealing with government, NGOs, communities and financially unsophisticated poor people, maybe with no access to a bank account. The assets that need to be insured might include livelihoods or ecosystems.

5 Insurance in a warming world

From a system point of view, uncertainty is more important than risk– either the uncertainty of large scale positive feedbacks, catastrophes or a combination of impacts causing unforeseen consequences on human, physical or environmental systems. The distinction between risk and uncertainty is defined (King (1921)):

"Uncertainty must be taken in a sense radically distinct from the familiar notion of risk, from which it has never been properly separated.... The essential fact is that 'risk' means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomena depending on which of the two is really present and operating.... It will appear that a measurable uncertainty, or 'risk' proper, as we shall use the term, is so far different from an unmeasurable one that it is not in effect an uncertainty at all"

There are two roles for a risk transfer mechanism. Firstly, it can form part of the adaptation strategy for conventional risks. Adaptation can reduce the risks identified in Figure 2, but is likely to leave residual risk. The

[20] Cat bonds are actually more complicated than this. The issuer pays a coupon, which is not paid if the named peril occurs
[21] This is only a part of the story. Cat bond s are a way of getting more capital, without going to shareholders, and are more flexible than share capital
[22] decennial buildings guarantee in France is one, and there are other examples also

aim of a well-designed insurance facility will be able to compensate the victims, who will then be able to continue their activities. Secondly, the mechanism should be able to deal with unforeseen events which were not included in Figure 2 and which have not been mitigated or adapted to, for example large sea level rises caused by the collapse of Greenland ice sheets.

The case for insurance or an insurance-like risk transfer mechanism to deal with enhanced climate risks and climate change risks is strong. However, both traditional and parametric insurance rely on the ability to price a contract, and climate change may therefore render this unavailable. Some form of public sector involvement is therefore inevitable, the justification being one of solidarity or global risk management. A successful risk transfer facility will have to exceed the bounds of conventional insurance, for example:

1. The facility will have to be accessible in areas which are particularly vulnerable, for example, due to low income and high risk. The key to this is the distribution network; the most successful micro-insurance programmes, have been undertaken with the involvement of local NGOs (Silver and Dlugolecki (2006)).
2. Insurable risks are usually quantifiable, occur randomly, and many in number, so that variations in claims are smoothed out. The facility may have to cover many risks that do not meet all or any of these criteria. This will only succeed with some form of public private partnership. In the long term, Governments may have to act as the insurer of last resort, while the private sector is employed in a risk management, product development and distribution role.
3. The risks covered are long-term, whereas traditionally non-life insurance policies are short-term. This may mean that the regulatory landscape needs to be transformed so that long-term contracts are advantageous.
4. The facility will have to cover non-traditional assets, such as forestry, eco-systems and livelihoods.
5. For a true global catastrophe that could be caused by climate change, the loss would be immense and pooling would be impossible. Therefore a facility should be targeted at the most vulnerable countries alone. It must be assumed or hoped that the wealthier countries will remain intact despite the losses.

The gaps and barriers were analysed in UNFCCC(2008) (Table 4)

Table 4 Gaps and barriers for insurance coverage in developing countries

Objectives / needs	**Gaps / barriers**	**Consequences**	**Solutions**
Insurance against natural disasters and climate change	Risk attitudes, moral hazard	Worsening loss trend, insurers withdraw	Stronger risk prevention regulations (eg hurricane shutters, construction standards; local flood defences)
	Large scale events affecting whole regions, frequent losses	Gaps in availability of insurance coverage	Reinsurance, geographical and hazard diversification, risk pools
	Lack of data on risks and exposure		Better quality and availability of data and projections
	Uncertainty over climate, historical risk data irrelevant for pricing	Unexpected losses, high prices	
	Slow-onset climate change (sea level rises, desertification)	Uninsurable risks	Risk prevention measures, temporal funding such as life and pensions insurance
	Subsidized public insurance, market price controls	Heavy losses for tax payers, private insurance available	Risk-based pricing
	Regulations hinder product innovation	Lack of insurance, slow economic growth	Less rigid government regulations
	Existence of publicly funded disaster relief	Reduced demand for insurance	Public-private partnership to segment market
	Cyclical market	Unstable prices and supply	Multi-year insurance, risk-based pricing
Expanding insurance coverage among the rural poor	Low risk awareness, no familiarity with insurance	Low demand for insurance	Education
	High transaction costs, adverse selection	Increase in cost of premiums	Microinsurance, parametric insurance, bundled products, supportive regulation
	Limited experience in these markets	Gaps in availability of insurance coverage	
	Weak rural financial institutions		Reinforcement of institutional structure

6 Proposals on the use of insurance under the UNFCCC

There have been a number of proposals for a multi-window insurance platform under the UNFCC process. Three have been developed in some detail. The first is from a consortium called the Munich Climate Insurance Initiative (MCII), in which Munich Re is prominent, the second is from AOSIS, the Alliance of Small Island States, and the third was proposed by the Switzerland negotiators. These are reviewed in Annex 1.

The AOSIS and MCII proposals have been tabled to form part of the Copenhagen Agreed Outcome, and therefore must be viewed in the context of a global mitigation and adaptation agreement. In a holistic risk management context, mitigation attacks the mechanism which causes damage, emissions. However, some level of climate change is now inevitable, so adaptation seeks to manage the residual risk. The purpose of insurance in this context is to transfer the residual risk away from the most vulnerable countries and people. However, it is important to realise that there would be preconditions on any scheme relating to governance and risk management, in order to ensure that funds were used efficiently and appropriately.

Under mild climate change scenarios, the MCII proposal would be a satisfactory response, but under more severe climate change scenarios it is unlikely to perform the role of transferring residual risk from the vulnerable. The proposed Climate Insurance Pool (CIP) will transfer risk to the private market, whilst retaining 30% of the risk. “The capital surplus ... will be retained in the fund and used for absorbing more risk during years of high reinsurance prices.” Under more severe climate change scenarios, the level of damages and uncertainty will increase through time, and therefore reinsurance will become more expensive or even unavailable. The CIP will therefore have to retain an increasing amount of risk whilst claims are progressively increasing. Finally, the MCII proposal excludes “slow-onset climate impacts”, which will be the most important risk that vulnerable people will face from climate change, for example sea level rises.

The Swiss proposal is similar to the MCII scheme, but includes the funding mechanism, a tax on emissions of carbon dioxide.

The AOSIS proposal represents an appropriate framework to deal with the residual risk from climate change. It is specifically targeted at the most vulnerable and seeks to address the excess burden of climate change, and will mean that the proposal will be more affordable, since its scope is narrower. It addresses slow-onset impacts through a rehabilitation/compensation mechanism. However, the AOSIS proposal is lacking in detail and could be strengthened by incorporating some of the details of the Swiss and MCII proposals:

1. A structure needs to be put in place so that governments are incentivised to adopt risk management measurements, for example by linking premiums to risk.
2. Actors from the private sector could be commissioned to manage the Insurance Pillar at the regional/sub-regional level. A close cooperation between the insurance facility and the private sector will be necessary in order to profit from the private sector's experience in risk analysis and the concrete handling of insurance claims, and reducing moral hazard.
3. Governance requirements should be put in place to ensure that compensation is planned for and used judiciously, but with a mechanism so that the most vulnerable countries will not be excluded.
4. Beneficiary countries should pay premiums, to ensure country buy-in, but the premiums of the poorest countries could be subsidised.
5. The insurance mechanism should retain a significant portion of the risk (if it is receiving annually $5-$10bn premiums, it will rapidly become one of the world’s largest insurers), but be run on a commercial basis. This will be necessary to build up reserves to meet large claims in the future.
6. Climate change will increase the risk of natural disasters and also increase the uncertainty, making pricing difficult and potentially increasing the cost and availability of private reinsurance. Therefore for the proposal to succeed, though the private sector can be encouraged to take a layer of the risk, the risk will have to be underwritten by governments with large balance sheets (i.e. Annex 1 and the larger developing nations), possibly through an excess of loss treaty arrangement.
7. An expanded GIIF (equivalent to MCII tier 2) should be included to make index insurance available to the poor, enabling them to preserve their livelihoods.
8. The compensation/rehabilitation mechanism should be set up as a separate entity, which will invest in climate change adaptation technology, ideally in least developed and vulnerable countries. This will allow a double use of the funds.
9. The proposal should be extended to include health insurance explicitly.

7 Novel directions for insurance

Natural forests and slow-onset damage are two specific concerns which are relevant under climate change, but have generally been regarded as uninsurable for a variety of practical and theoretical reasons. In this section we consider whether an innovative approach could introduce insurance as an element of the risk management plan for these problems.

7.1 Forestry insurance

Forests play a key role in the climate system. They store over twice the quantity of CO_2 currently in the atmosphere. If released this carbon would accelerate climate change drastically. Also forests regulate the atmospheric temperature and precipitation. However, forests are vulnerable to threats caused by climate change, ranging from novel weather conditions, alterations in nutrient availability and fires, to pests and diseases. In sum, the preservation of forests is of crucial importance to mitigate and adapt to climate change.

<u>Potential for risk-transfer mechanisms</u>
The insurance industry could help to preserve forests and promote greater use of them as tools of mitigation and adaptation in climate change policy through providing underwriting services.

From the insurers' standpoint, forest insurance has often been neglected due to low demand, the high potential for catastrophic losses, and the often low standards of risk management. Many commercial forest owners do not purchase insurance, but rely upon geographical diversification and physical risk management, while up till now no-one has sought to insure natural forests, because they have not been assigned an economic value: this could change under future international agreements on climate change, biodiversity etc.

Insurers could help to stimulate or underpin the growth of forestry as a tool of climate policy by providing innovative products, or servicing new sectors of demand, in addition to their conventional products. At the same time, an expansion of the market into new areas would enable reinsurers to offer lower premiums because risks could be spread by constructing portfolios from a wide geographical range and variety of forest types. There are four potentially innovative products that could be considered by the insurance industry:

a) *Multi-year insurance contracts*, based on closely specified products like weather derivatives and catastrophe bonds. These would give forestry investors simple risk transfer solutions, with a duration that more closely matched their financial interest. By hedging against some of the risk, it would make forestry more attractive to investors. Such products would also increase the pool of available insurance capital, since cat bonds are a useful alternative asset for the capital markets.

b) *Insurance for small forestry-based communities in developing countries*. The products might cover a range of activities centred on the forests, from planting, to conservation, harvesting, and production of forestry products like timber and manufactured goods. This would meet the growing demand that mitigation of climate change must be interwoven with sustainable development. In particular, simple products like weather derivatives would ensure speedy claims payouts, which are essential for marginal communities.

c) *Forest carbon insurance* This could address concerns over the 'non-permanence' of carbon in forests. Given that forests can only store carbon for a limited period, and that entire forests can be destroyed rapidly, the UNFCCC process has been reluctant to grant carbon credits for efforts to preserve forests. This product would operate to compensate the insured party for a specified liability or asset loss, following the unintended release of carbon. Preliminary analysis indicates that it is economically viable or superior compared to other approaches[23].

d) *Restoration of Natural Resource Damage (NRD).* If an area rich in biodiversity is destroyed, the operator or 'guardian' may be required to reinstate the environmental status quo. This is an insurable risk. NRD remediation generally includes the cost of damage assessment, planning, restoration of the status quo, and compensation for the loss of the resource and/or the benefits or services derived from it during the period of interruption.

<u>Obstacles to Insurance Industry Involvement</u>

[23] Subak, S. Replacing carbon lost from forests: an assessment of insurance, reserves, and expiring credits. *Climate Policy*, *Volume 3, Issue 2*, June 2003, 107-122

There are of course many obstacles to be overcome in introducing forestry insurance more widely and for natural forests in particular[24]. These include political/country risk, physical risk, regulatory risk and reputation, but such barriers have been overcome for other financial products. It may be that in the first instance a collaborative public-private sector approach would be the most effective way to spread the development costs.

7.2 Parametric all-risk insurance[25]

Climate change will bring a wide range of problems for developing countries, from increasing temperatures and sea-level rise, to unreliable rainfall and unfamiliar river flow patterns, to novel patterns of storminess, to exotic species (IPCC, 2007). In turn these could cause major harm to critical sectors of their economies e.g. agriculture and fishing; to infrastructure, particularly from storm and water damage; and to human health and wellbeing. However, currently scientific techniques are not able to predict in detail how these situations will apply, or to what degree and when. Indeed, one of the key messages from the climate change science is to expect surprises.

In some cases it is not possible to specify at exactly what level a cumulative change will start to be harmful. For example, the effects of steadily rising temperatures or saline levels on crop yield are modified by other factors, and laboratory conditions cannot mimic field conditions perfectly.

This raises problems with some of the financial instruments that have been suggested for coping with the impacts of climate change like catastrophe bonds and weather derivatives. They are finely tuned to the expected critical threshold of climatic parameters like rainfall, drought or windspeed, in the anticipation that when that severity is exceeded, there will generally be damage to the key economic sectors, and, by implication, that when they are not exceeded the economy will perform adequately. The early experience with CCRIF, the Caribbean risk pool, has cast some doubt on this highly-specified approach. Also, if in fact damage arises from an unexpected source, as seems quite possible, then no compensation will be payable. Again, if the critical impact is from a cumulative, gradual change, then a "threshold" approach based on extreme values in a pattern of rainfall or windspeed may not mirror the impacts. For some locations, there may not be sufficient historical data on extreme events to specify a parametric risk transfer instrument.

All-risk cover insurance.
The growth of all-risk covers in general insurance (i.e. property/casualty or non-life) provides a useful concept. Rather than trying to define exactly what the circumstances of situation causing a loss might be, these contracts operate whenever a loss occurs, except for a very few prescribed exceptions, such as radiation. This avoids the circumstances where compensation is not paid because the causation is in doubt, or where a completely novel cause of loss occurs. Premiums for such contracts are of course higher than for conventional specified-risk policies, and usually feature significant deductibles to avoid minor claims for miscellaneous incidents. However, these contracts still mean the policyholder has to prove his or her loss, so claims adjustment is still necessary.

A parametric "all-risk" concept
Parametric insurance was described briefly earlier. Despite the problem of basis risk, they have many practical advantages. Is it possible to combine the administrative simplicity of the parametric approach with the comprehensive cover of the all-risk contract?

The key lies in finding a parameter that captures the progress of climate change in the geographical area concerned. If that can be done, then one can set aside the detailed specification of critical variables and thresholds, based on perhaps very limited information.

For most countries, it is likely that annual temperature is a good indicator of climate change. For islands, where the surrounding waters moderate the land temperature, it may be that sea level is a better indicator of climate change. These have the merit of simplicity, but would need to be reviewed for adequacy before being adopted.

Defining the trigger and compensation
The climate change parameter (annual temperature for example) can be expected to progress steadily upwards, though there may be short periods of regression due to interannual variability or exogenous factors like a volcanic eruption. It is likely therefore that the trigger would be the **annual change** in the climate change parameter.

[24] Eliasch, J. *Climate Change: Financing Global Forests. The Eliasch Review*. HMSO, UK, 2008
[25] This section is extracted from UNFCCC (2008), and was originally written by one of the present authors, A. Dlugolecki

Arriving at the compensation payable from changes in the trigger variable would have to be based on a stakeholder and expert consultation process, since the intention is to capture a range of possibilities in which harm to the economy might arise.

Inevitable loss
Some economies may be untenable in the long-term due to climate change, for example those in certain small island states or those based on arctic hunting. The all-risk concept could, if suitably calibrated, provide a way to transfer sufficient funds so that an alternative economic and even geographical configuration could be planned, financed and established over a period of years. This could be compared to life and pensions insurance, where funds are accumulated over a long period, whereas disaster financing is compared to property insurance and reinsurance.

Risk management
As with other parametric instruments, there is no incentive for the policyholder to engage in risky behaviour, since the compensation payable will not increase if the losses increase. In fact, the reverse might apply; if the policyholder reduces the risk, there will be a margin of compensation available for additional economic development, over and above restoring any climatic damage.

Eligibility
Since this product could be costly, access might be restricted to very poor countries which are highly vulnerable and have very low emissions.

8 Conclusions

Recent experience suggests that climate change is likely to reach dangerous levels within the next few decades. This means that there will be an escalation in damage and disruption to natural and socio-economic systems. Without some mechanism to spread the burden of these costs there is a risk that the dislocation could become widespread. Clearly insurance is a possible answer, since its role is to pool risks.

The current proposals on introducing insurance into the global deal on insurance at Copenhagen are unsatisfactory but ,with some modifications, a workable scheme could be designed that would offer great benefits to the vulnerable parties, and create new markets for private insurers and service providers. Public-private collaboration would be essential to establish such mechanisms, and to fund the risks that were not commercially viable.

Even risks that are classically ‘uninsurable’ such as natural forests and slow-onset ‘inevitable’ events could be brought within the ambit of insurance through innovation.

Annex 1

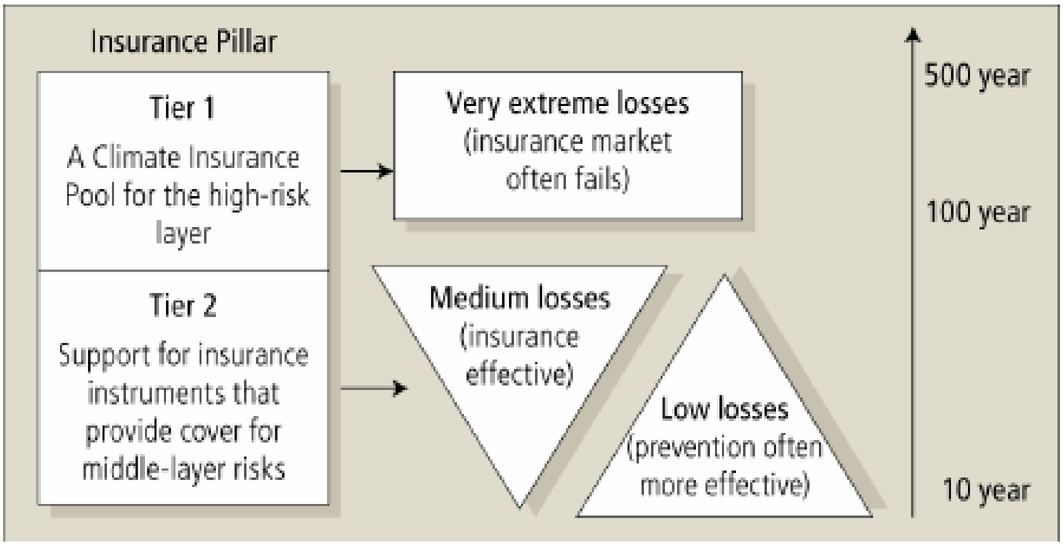
Three proposals under the UNFCCC negotiations

At the COP 14 meeting in Poznan, two proposals were tabled for an insurance facility to form part of the Copenhagen Agreed Outcome (CAO), one by the Munich Climate Insurance Initiative (MCII), and one by the Alliance of Small Island States (AOSIS). It is possible that some form of insurance arrangement will form part of the CAO (MCII (2008)).

a) MCII proposal[26]

Under this proposal, the insurance module is split between an insurance pillar and a prevention pillar, the two pillars being closely linked to promote risk reduction measures. Both pillars will be an integral part of a larger adaptation framework. The insurance pillar is further split into two tiers as shown in Figure A1.

Figure A1: A two-tiered insurance pillar as part of an adaptation fund (MCII (2008a))



Tier 1, the Climate Insurance Pool (CIP), provides insurance cover for property and infrastructure in developing countries for extreme weather events that are "high level", i.e. exceed the ability of a country to pay. The CIP will effectively be funded by richer countries on an "ability to pay" or "polluter pays" principle, through the medium of a multi-lateral adaptation fund. The international risk pooling element means that the scheme as a whole requires much less reserve capital than would be required on a national basis[27] (Linnerooth-Bayer et al (2008)).

Tier 2 will provide support for "middle layer" risks - risks that are within the ability of an individual country to cope. The purpose is to facilitate the establishment of public/private safety nets for unpredictable climate related shocks. "The core of this second tier is the provision of capacity building and technical support, which might include such activities as collecting and disseminating weather data, financing risk assessments or weather stations, or supporting delivery systems, all of which render these systems more accessible and affordable to poor communities. In addition, this tier can provide more direct support by offering or brokering pooling and reinsurance arrangements, or even, if appropriate, subsidizing premiums." (Linnerooth-Bayer et al (2008)).

[26] The details of the MCII proposal are contained in MCII (2008a), with supplementary material from Linnerooth-Bayer et al (2008). Unless otherwise stated, all details of the proposal in this paper refer to one of these documents.

[27] The capital required by an insurance entity is a reserve or buffer to reduce the probability of insolvency below an acceptable level. The probability of insolvency is greatly reduced by diversifying the risk, i.e. risk pooling between different countries means that the risk of losses happening in many countries simultaneously is relatively low, so the capital requirement is lower.

b) AOSIS proposal[28]

The Alliance of Small Island States (AOSIS) also prepared a proposal for Poznan providing details on a possible international insurance mechanism. This proposal envisages a Multi-Window Mechanism consisting of three inter-dependent components – insurance; rehabilitation/compensation; and risk management. Each would have a technical advisory facility and each a financial vehicle / facility.

The objective of the proposal is "To institute a mechanism to reduce vulnerability and enhance adaptive capacity to climate risks in SIDS, LDCs and other developing countries particularly vulnerable to the adverse impacts of climate change." The mechanism is to be funded by developed countries based on their "responsibility" due to historic emissions and ability to pay based on GDP. The mechanism is summarised in Table A1.

The insurance component will also consist of "high level" risks that exceed countries' adaptive capacities. Unlike the MCII proposal, the AOSIS proposal does not specify the types of insurance tools that might fall under this scheme, and has been deliberately left open.

The rehabilitation component addresses the slow-onset events specifically excluded by MCII by accumulating a fund paid for by richer countries. Both funds will be supported by a risk reduction component. The funding of the scheme is mainly a political consideration and should be a separate decision to the mechanism of the scheme.

Table A1: AOSIS proposal of multi-window insurance mechanism

MULTI-WINDOW MECHANISM TO ADDRESS LOSS AND DAMAGE FROM CLIMATE CHANGE IMPACTS		
MULTI-WINDOW MECHANISM BOARD		
1. Insurance Component	**2. Rehabilitation / Compensatory Component**	**3. Risk Management Component**
To address climate-related extreme weather <u>events</u> such as hurricanes, tropical storms, floods and droughts, which result in loss and damage	**To address <u>progressive</u> negative impacts**, such as sea level rise, increasing sea and land temperatures and ocean acidification, that result in loss and damage (e.g., land loss, coral bleaching, impacts on potable water availability, reduction in fisheries, desertification, etc.)	**To promote** risk assessment and risk management tools and strategies at all levels; to facilitate the implementation of risk reduction and risk management measures
Triggers – e.g., might include precipitation, wind speed, storm surge	**Parameters**[29] – might include sea level rise, temperature increases, loss of land, damage to coral reefs, loss of fisheries, salinisation of aquifers, or use an all-risk parameter	
A. TECHNICAL ADVISORY FACIILITY		
With respect to Insurance Component: - Provides advice and guidance to countries on types of available instruments - Advises on best practices and innovative approaches for identified needs - Provides technical support for the establishment of appropriate risk	**With respect to Rehabilitation/Compensation Component:** - Works with countries to establish baseline parameters in local context - Verifies when parameter thresholds exceeded - Considers means to graduate parameters to reduce basis risk	**With respect to Risk Management Component:** - Provides advice to countries on risk management techniques in the context of climate change - Facilitates collection of weather data and analysis (e.g., that can support development of insurance tools) - Identifies hazards and provides

[28] The details of the MCII proposal are contained in AOSIS (2008). Unless otherwise stated, all details of the proposal in this paper refer to this document.

[29] See FCCC/TP/2008/9, paras. 361-371 (on parametric all risk insurance)

sharing and risk transfer schemes as requested (e.g., risk pooling arrangements; indexed insurance mechanisms such as catastrophe bonds, weather derivatives; reinsurance schemes; public private partnerships etc.)		support to risk assessments - Recommends appropriate investments in risk reduction - Assists in building capacity for managing risk and reducing risk exposure
B. FINANCIAL VEHICLE/FACILITY		
With respect to Insurance Component - Enables/administers/supports risk sharing/risk transfer schemes as required/requested through start up financing, subsidization - Manages and invests reserves accumulated from assessed Annex I Party contributions, premiums/contributions from covered private and public sector institutions and from other donor sources	**With respect to Rehabilitation/Compensation Component** - Accumulates funds from assessed Annex I Party contributions, preferably through the proposed Convention Adaptation Fund based on GHG emissions (responsibility) and GDP (capacity) - other donor sources - Pays out when parametric threshold crossed	**With respect to Risk Management Component** - Fund measures to support risk reduction and risk management measures -e.g., data collection, hazard mapping, risk assessments)
C. ADMINISTRATION - UNFCCC SECRETARIAT		

c) Insurance proposal made by Switzerland[30]

"The **objective** of the Insurance Pillar is preserving/restoring public goods in case of severe weather events related to climate change. The insurance shall compensate damages – otherwise non-insurable – of extreme, climate change related weather events (storms, floods and droughts) to infrastructure and productive capital assets in medium and low-income countries. Furthermore, the Insurance Pillar will develop pilot projects for weather risk insurances (e.g. for agriculture) at sub-regional level by linking regional authorities, micro insurance initiatives and private insurers to design common solutions. Also, a small amount of the Insurance Pillar budget will be used for developing the data basis required for such schemes (technical assistance)."

The insurance pillar and a **prevention pillar** will make up the Multilateral Adaptation Fund (MAF). In principle, this is essentially the same as the MCII proposal. It will be aimed at covering low probability, high damage events. However, there are some differences in the detail:

- The MAF will be funded by a levy on CO_2 emissions of $2 per tonne. This will result in $9.2bn per annum being allocated to both the insurance and prevention pillar.
- Incentives for disaster risk management will come in the form of reduced pay-outs if measures are not implemented.
- Vulnerable groups will be targetted through subsidised premiums
- The private sector will provide insurance at the regional level, with the public sector taking the excess "uninsurable" risk.
- A share of the revenue from the Insurance Pillar will be used for capacity building to develop insurance markets in developing countries.

[30] Described in Swiss (2008)

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