INSURING AGAINST FUTURE CLIMATE CHANGE: THE USE OF MANDATORY CATASTROPHE RISK INSURANCE AND MICROINSURANCE TO PROMOTE MITIGATION AND ADAPTATION

by

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ABSTRACT

This thesis examines the potential of insurance to reduce greenhouse house gas emissions and help societies to equitably adapt to predicted gradual and catastrophic climate change impacts. The paper explores how insurance might operate as a mitigation and adaptation tool for states and enterprises with high-coping capacities and proposes a new insurance product: climate change catastrophe risk insurance. As explained in the paper, the proposed catastrophe risk insurance would further the goals of implementing the polluter pays principle in the context of climate change. The paper also examines how insurance might be used as an adaptation tool for vulnerable groups and individuals with low-coping capacities and proposes a regionally distributed microinsurance product to be funded by proposed national or global carbon taxes.
# TABLE OF CONTENTS

Abstract ......................................................................................................................................................... ii
Table of Contents ........................................................................................................................................... iii
List of Figures ................................................................................................................................................ iv
Acknowledgments ........................................................................................................................................... v
Introduction ................................................................................................................................................... 1
Structure of Paper .......................................................................................................................................... 8

Part 1-Adaptation and Mitigation .................................................................................................................. 8
  A. Climate Change Science ......................................................................................................................... 8
  B. Impacts ................................................................................................................................................... 12
  C. Adaptation and Mitigation: UNFCCC and Kyoto Protocol ................................................................. 14

Part 2-Insurance as Prevention-Based Governance ....................................................................................... 23
  A. Basic Concepts of Insurance: Defining and Managing Risk ................................................................. 24
  B. The Role of Insurance as Providing Governance for Climate Change ................................................ 33

Part 3-Insurance as Adaptation and Mitigation in Countries with High Coping Capacity ................. 41
  A. Insurance as Adaptation ....................................................................................................................... 42
  B. Insurance as Part of a Long-Term Mitigation Strategy ........................................................................ 62
  C. Creation of a Mandatory Nationally Based Corporate Catastrophe Risk Insurance ....................... 70

Part 4-Insurance as Adaptation in Countries with Low Coping Capacity .............................................. 86
  A. Role for Microinsurance in Climate Change Adaptation ................................................................. 95
  B. Advantages and Disadvantages of Microinsurance ........................................................................ 101
  C. Regional Microinsurance ................................................................................................................... 103

Part 5-Mitigation and Adaptation in China ................................................................................................. 111

Conclusion ..................................................................................................................................................... 115
Bibliography ................................................................................................................................................ 117
LIST OF FIGURES

Figure 1.1 Mean Variation in Temperature since 1860 ............................................................... 9
Figure 1.2 Predicted Future Concentrations of Carbon Dioxide .................................................... 17
Figure 3.1 Natural Disasters 2008 ............................................................................................. 72
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Everybody talks about the weather, but nobody does anything about it.
--Attributed to Mark Twain

Some say the world will end in fire,
Some say in ice.
--Robert Frost

**Introduction**

In 2009, the world economy and the world ecology are disquieting subjects. Over the last fifty years, the global economy has grown at an unprecedented rate. The world’s ecosystems have changed more rapidly in the last fifty years than at any other time in recorded human history.\(^1\) Human-induced changes in the last fifty years have resulted in new economic development opportunities for some groups of people and aggravation of poverty for the most vulnerable groups of people.

To the bewilderment of some and the expectations of others, the climate system has taken on an unpredictable life of its own that doesn’t seem to be capable of easy human control. We have created an invisible dragon that fuels our world but endangers our comfortable existence. As captured vividly in the National Oceanic Atmospheric Agency’s research, the atmospheric concentrations of carbon dioxide (represented by the black line in the graph below) have been steadily increasing each year in spite of a growing scientific and political consensus that we need to reduce our greenhouse gas emissions if we wish to avert an unknown but palpable future catastrophe.\(^2\) Since 1750, the atmospheric concentration of carbon dioxide has increased from 280 ppm\(^3\) to almost

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\(^2\) Pieter Tans, National Oceanic Atmospheric Administration, Earth System Research Laboratory, Dr. Pieter Tans, NOAA/ESRL, www.esrl.noaa.gov/gmd/ccgg/trends

\(^3\) Intergovernmental Panel on Climate Change, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS. J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K.
386 ppm (an increase of 37%) caused in large part by the fossil fuel dependent economy and the mass deforestation. Most of these surges in carbon have occurred in the last fifty years with almost 4% (10 ppm) of the overall increase occurring in the last five years.

These annual increases in carbon dioxide concentration may seem to be the esoterica of climatology since scientists have not positively established the exact correlation between temperature increases and carbon concentration. While the nuanced mechanisms of climate sensitivity are still under debate, the debate is over as to whether anthropogenic emissions have contributed to climate change. As carbon concentrations are climbing, the number of climate-related tragedies grows and is likely to continue growing if scientists are correct in concluding that some amount of future damage is inevitable no matter how ambitious our mitigation targets. A March 2009 study concluded that even if every country implemented its leading mitigation proposal in preparation for the United Nations Framework Convention on Climate Change meetings to be held in December 2009 the researchers models predict that the level of carbon dioxide in the atmosphere will still rise from approximately 380 ppm today to roughly


http://downloads.climatescience.gov/sap/sap3-3/sap3-3-final-ExecutiveSummary.pdf ("It is well established through formal attribution studies that the global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases.")
500 ppm by the year 2050 and 775 ppm by the end of the century resulting in a
temperature increase of about 3°C (5°F) by 2100.5

In these economically shaky times, increasing global temperatures are causing
particular anxiety among insurers. For Munich Re, one of the global reinsurance giants,
2008, as adjusted for inflation, was the third most expensive claim year on record.6
Torsten Jeworrek, a member of Munich Re's Board of Management commented that the
current trend where climate change “is very probably contributing to increasingly
frequent weather extremes and ensuing natural catastrophes” will “generate greater and
greater losses because the concentration of values in exposed areas, like regions on the
coast, is also increasing further throughout the world.”7 He calls for his company to, “
press for effective and binding rules on CO2 emissions, so that climate change is curbed
and future generations do not have to live with weather scenarios that are difficult to
control.”

Other insurers and reinsurers are facing the same almost existential crisis. John
Coomber, the former CEO of Swiss Re, announced in a 2006 interview that from the
perspective of insuring against risk “climate change is the number one risk in the world

7 Id.
ahead of terrorism, demographic change and other global risk scenarios.” When asked by an interviewer why an insurance company should care about climate change, Martin Gansneder, an executive at Allianz observed that it was affecting his company’s bottom-line, “through higher claims, especially in the property insurance.” Not surprisingly, insurers support government intervention to help achieve climate change mitigation and adaptation. Unrestrained climate change means a higher probability of more weather disasters, more claims, less profits and possible insolvency.

Zurich Financial Services took a sanguine approach in its 2008 report to its role in ameliorating the effects of climate change:

There is also little doubt that climate change is one of the most serious and complex risks confronting the insurance industry, with a confluence of climate change hazards and risks poised to increase insurers’ losses, erode their markets and even test their regulatory compliance. It is also very clear that relatively few insurers have made much progress in either climate-readying their business lines or educating their distributors or customers about the climate-related risks and adaptation options. Ironically, it is also clear that insurers are uniquely placed to facilitate society-wide risk management and adaptation to climate change impacts and greenhouse gas emission constraints. Converting these opportunities into real products and services will be critical for the long-term prosperity of general insurers.

Given that recent modeling seems to suggest that it no longer matters whether countries comply with their Kyoto Protocol or their yet to be promised COP-15 targets in terms of averting world-wide temperature increases, what role does the insurance industry play as suggested by Zurich Financial Services “to facilitate society-wide risk management and adaptation to climate change impacts”? This paper makes two contributions to the ongoing dialogue about climate change mitigation and adaptation. Its

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9 Rob White and Alice Cahill, Zurich Financial Services Australia, Climate Change and the Insurance Industry - no silver-bullet solution, October 2008, p. 3. (emphasis added).
10 Id.
first contribution is to offer a just alternative to “litigation as usual.” Its second
contribution is to ask how some form of insurance may be able to both compensate those
populations who are least to blame for the climate change mess and to address an
expected environmental refugee problem.

As to the first contribution, in the “litigation as usual” world of North America,
unrecoverable losses are not easily tolerated. As individuals and companies begin to
experience sizable uninsured losses, litigation is sure to follow. In fact, litigation is
already wending its way through the courts. The native village of Kivalina, which is
likely to have to relocate its village, has sued ExxonMobil and twenty-three other large
carbon emitters in a United States district court for causing through their greenhouse gas
emitting business activities the early melting of the winter ice that had historically
protected the village from winter storms. The Inuit community alleges public nuisance,
private nuisance, and civil conspiracy.11 If the court does not accept the nuisance claims,
the civil conspiracy claim may not survive.12

But civil litigation as a means to resolving our climate change mess is time-
intensive, resource-intensive and unlikely to lead to the needed adaptation and mitigation
that scientists and policymakers demand. Courts, at least in the US, have been wary of
extending their jurisdiction over alleged short-term or long-term climate change damages

11 Native Village of Kivalina and City of Kivalina v. ExxonMobil Corporation, et al.,
United States District Court for the Northern District of California, San Francisco
Division, Civil Action. No. 08cv1138-SBA, February 26, 2008, Complaint Found at
12 State of Rhode Island v. Lead Industries Association, Inc., et al. (2008), 951 A.2d 428,
441(2008).
into areas of political question.\textsuperscript{13} In many civil law countries in Europe, causation requires a very high level of probability linking a party to a harm which may be difficult to prove with climate science in flux.\textsuperscript{14} This paper proposes instead to place some of our hopes in state regulators and insurance industry who may be able to provide new risk-based management approaches that may just provide the necessary stimulus for meaningful mitigation and adaptation.

As to its second contribution, this paper understands the probable environmental refugee problem as a problem to be addressed immediately. While the media has covered the plight of the 110,000 people of Kiribati and the 385,000 Maldives, these are populations that could from a purely instrumental point of view be relocated because they are relatively small in terms of existing permitted immigration numbers.\textsuperscript{15}

\begin{footnotesize}
\begin{itemize}
\item[\textsuperscript{13}] See e.g. a number of U.S. lawsuits dismissed on the grounds of lack of standing and non-justiciability under the political question doctrine. See \textit{Comer, et al. v. Murphy Oil}, et al., Case No. 1:05-cv-00436-LTS-RHW, in the United States District Court for the Southern District of Mississippi, dismissal currently on appeal to the Fifth Circuit Court of Appeals (Appeal No. 07-60756) (plaintiffs blamed the severity of Hurricane Katrina on global warming); \textit{State of California v. General Motors, et al.}, Case No. C-06-05755-MJJ, in the United States District Court for the Northern District of California, dismissal currently on appeal to the Ninth Circuit Court of Appeals (Appeal No. 07-16908) (California sued six automakers for creating, and contributing the public nuisance of global warming); \textit{Connecticut v. American Electric Power Company, Inc.}, Case No. 04 Civ. 5669-5770 (LAP), in the United States District Court for the Southern District of New York, dismissal currently on appeal to the Second Circuit Court of Appeals (Appeal No. 05-05104) (the District Court rejected public nuisance claims brought by eight state Attorneys General against five power companies based on the companies’ greenhouse gas emissions.)
\item[\textsuperscript{14}] Monika Hinteregger, “Comparison” in (Monika Hinteregger, ed.) \textit{Environmental Liability and Ecological Damage in European Law} (Austria, German, Greek, and Spain require a “very high level of probability, close to certainty” that links defendant to a particular harm.”) 2008, p. 609.
\item[\textsuperscript{15}] The U.S. Immigration and Naturalization Act currently allows in approximately 480,000 family sponsored immigrants and 140,000 employee sponsored immigrants as legal permanent residents. (INA § Section 201). Hypothetically, it would be possible to
\end{itemize}
\end{footnotesize}
approximately 51 to 97 million people living in vulnerable coastal zones\textsuperscript{16}, the plight of Bangladesh is of a completely different magnitude. No single country could absorb the potential sea level rise refugees. Given its extremely high population density, it is not clear that Bangladesh itself can even absorb its own internal refugees. Under the guise of terrorism concerns but more likely spurred by its inability to keep out refugees from poverty and increasingly difficult environmental conditions, India is building a fence between itself and Bangladesh. \textsuperscript{17} This paper proposes the use of internationally funded locally implemented microinsurance to allay some of the future relocation problems and adaptation challenges.

**Structure of Paper**

The paper is divided into five substantive sections. Part 1 describes some important aspects of climate science as well as the legal dialogue over the concepts of adaptation and mitigation. Part 2 analyzes the ability of insurance to provide a form of social governance based on prevention. Part 3 examines how insurance might operate as a mitigation and adaptation tool for states and enterprises with high-coping capacities and proposes a new insurance product: climate change catastrophe risk insurance. Part 4 examines insurance as an adaptation tool for vulnerable groups and individuals with low-coping capacities and proposes a broadly distributed microinsurance product to be funded by proposed national or global carbon taxes. Part 5 includes a few comments about China put these permanent residency applications on hold and admit South Pacific Island sea level rise refugees.


\textsuperscript{17} Id.
as both a country with high-coping capacity in terms of having a stable government and resources but large numbers of vulnerable individuals with low-coping capacity.

**Part 1- Adaptation and Mitigation**

This part starts with a review of some key principles in climate change science followed by a sobering summary of expected impacts. The physical and social impacts described reflect a partial categorization of the type of impacts that insurers may need to grapple with either directly or indirectly as they develop and refine insurance policies to reflect accurate climate change risks. After reviewing what scientists predict will be the future of unmitigated climate change, the paper examines how international policymakers have responded to the climate change crisis with a particular focus on the 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol.

**A. Climate Change Science**

Effective international environmental law and policy depends on getting the science right. Like the climate, climate science is in flux. Yet there is broad consensus across the spectrum of catastrophists and skeptics on some facts and models. Before reviewing the legal concepts of mitigation of climate change and adaptation for climate change, a quick survey of the uncontested claims of climate science is helpful. Scientists generally agree that even though the earth’s average temperature varies year by year, there is a long-term warming trend of global temperatures. According to the World Meteorological Organization, 2008 was the tenth warmest year since meteorological records have been kept and the eighth warmest in the northern hemisphere.\(^\text{18}\) The following chart from the Intergovernmental Panel on Climate Change’s 2007


\(^{18}\) 2008 Among Warmest Years on Record, UN Reports, December 17, 2008
Assessment Report illustrates year-to-year mean variation in temperature since 1860 with a clear rising trend of approximately 1 degrees Celsius (1.8 degrees Fahrenheit).

Figure 1.1. Mean Variation in Temperature Since 1860, Source: IPCC, Working Group 1, Chapter 3, FAQ 3.1, page 253.

Scientists also agree on the general mechanisms of the greenhouse effect whereby the accumulation of greenhouse gases in the atmosphere has trapped some amount of energy which otherwise would have radiated back into space. This energy is now contributing to the warming of the earth. Climate scientists agree that certain gases are the greatest culprits for anthropogenically caused climate change. Sixty percent of the infrared blockage is blamed on carbon dioxide generated by fossil-fueled plants and
transport vehicles. Methane from cattle farms, oil and gas drilling, coal mining, landfills, and rice paddies is also a sizable contributor to infrared blockage. Other contributors include nitrous oxide from fertilizer products and halocarbons in refrigerants.

Yet for all that is known about greenhouse gases, their composition, and their interaction with the environment, there are sizable gaps in the knowledge. For example, there is a current lack of scientific understanding of how greenhouse gases as warming agents and aerosols as cooling agents operate together to affect the overall absorption of infrared energy in the atmosphere.

Three feedback events provide particular nightmares for scientists: water vapor cycle, deforestation, and tundra melting. A recent report in Science predicts that warming due to increases in greenhouse gases will lead to higher humidity in the atmosphere that in turn will cause additional warming because water vapor itself is a greenhouse gas. IPCC scientists who are responsible for writing the state of the climate reports also fear that in a business-as-usual world, forest-carbon feedback loops and arctic permafrost feedback loops will raise the climate change ante. If tropical forests dry out or are removed in the name of human progress, billions of tons of greenhouse gas will be released because the forest as a carbon sink would be converted to the forest as a carbon

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19 Richard Wolfson and Stephen Schneider, Understanding Climate Science in (Stephen Schneider, Armin Rosencranz, John Niles, eds.) CLIMATE CHANGE POLICY, 2002, p. 17.
20 IPCC, SYR, Figure 2-2.
source. Likewise, if the permafrost in the Arctic tundra thaws, previously frozen plant material will release billions of tons of locked carbon and feed the warming cycle.

With so many unknowns about how the atmosphere functions, predicting next century’s long-term impacts from climate change becomes a complicated exercise in prediction and speculation that is attracting a new breed of modern day Cassandra. No one really knows if or when the Greenland Ice Sheet will collapse. No one really knows by how much the ocean temperatures or sea level will increase. No one knows how climate change will be experienced region to region. Yet in the midst of all of this uncertainty, there are a couple certainties. Carbon dioxide is increasing at exorbitant rates, there is an urgent need to do something now, and in a worst-case scenario,

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23 Id.

24 See http://www.newscientist.com/topic/climate-change for a sampling of such articles. Andy Coghlan, Global warming could suffocate the sea, January 25, 2009 (Reviewing a University of Copenhagen study that concluded that in a global warming worst-case scenario, average ocean oxygen levels will fall by up to 40%, and there will be a 20-fold expansion in the area of ‘dead zones’), Jim Giles, Human emissions could bring ‘irreversible' climate chaos, January 27 2007 (Reviewing National Center for Atmospheric Research’s conclusion that even with a halt in emissions, CO2 concentrations will remain for the next millennium a third higher than pre-industrial levels.)


26 Stanford University, supra note 22 (Citing IPCC Scientist Chris Field “We now know that, without effective action, climate change is going to be larger and more difficult to deal with than we thought. If you look at the set of things that we can do as a society, taking aggressive action on climate seems like one that has the best possibility of a win-win. It can stimulate the economy, allow us to address critical environmental problems, and insure that we leave a sustainable world for our children and grandchildren.
climate change damages will be expensive no matter whose climate model is used. In fact, for those events that insurers have attributed to climate change such as the 2003 European heat wave\textsuperscript{27} and the 2009 Australian heat wave\textsuperscript{28}, the damages are already expensive.

\textbf{B. Impacts}

Given the uncertainties of climate science, there is no definitive picture of what a worst-case global scenario might entail. Using a combination of observational data and modeling, the Second Working Group of the IPCC has predicted certain long-term impacts of climate change by region. The IPCC has “high” confidence that some of the impacts will happen as climate change runs its course.\textsuperscript{29}

In Africa, the IPCC predicts increases in droughts leading to grain shortages and a crisis in food security especially for food-importing countries.\textsuperscript{30} Rise in global sea levels will inundate settlements along the Gulf of Guinea, Senegal, Gambia, Egypt, and

\textsuperscript{27} In the summer of 2003, an unprecedented heat wave in Europe caused 52,000 deaths and caused major crop loss. Examining that event, scientists estimate that human influence on the climate has at least doubled the risk of another heatwave exceeding the 2003 scorching temperature. Peter A. Stott, D. A. Stone, M. R. Allen , Human contribution to the European heatwave of 2003, 432 Nature 610-614 (December 2, 2004).

\textsuperscript{28} In some ordinarily temperate communities in Australia record temperatures topped 109.4 degrees Fahrenheit, bush fires consumed homes, leaves have been withered off trees in the middle of summer and residents in nursing homes were putting their clothes in the freezer for some relief. Geoffrey Lean and Kathy Marks Parched: Australia faces collapse as climate change kicks, The Independent, February 1, 2009, http://www.independent.co.uk/news/world/australasia/parched-australia-faces-collapse-as-climate-change-kicks-in-1522529.html

\textsuperscript{29} Intergovernmental Panel on Climate Change, Climate Change 2001: Impacts, Adaptation and Vulnerability, contribution of Working Group II to the Third Assessment Report of the IPCC, 2001. “High” is defined as 67-95\% certainty.

\textsuperscript{30} \textit{Id.} at 5.1.2.
Southeast African shore. If scientist’s predictions come to pass, climate change will divide Europe into a wetter north and a drier south accompanied by loss of habitat in wetland and tundra areas. In Central and South America, the climate outlook is severe. Climatologists expect glaciers to retreat causing a combination of catastrophic flooding and water shortage. Climate change threatens Latin America with an increase in intensity of tropical storms causing flooding, storm surges, and wind damages. Subsistence farmers may lose their crops. North America is not immune from climate change. IPCC predicts that a rise in sea level will result especially along the U.S. Atlantic coast in accelerated coastal erosion, coastal flooding, loss of coastal wetlands, and an increase in storm surges. Commenting on North America’s vulnerability, the IPCC observes that insurance planning has not taken into account climate change information and that there is a potential for surprises.

For purposes of gauging the momentum of climate change, the two canaries in the coal mine are the polar regions and the small island states. IPCC noted that changes in

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31 Id. at 5.1.5.
32 Id. at 5.2.4.
33 Id. at 5.3, 5.3.1 and 5.3.2.
34 Id. at 5.4.1 and 5.4.2.
35 Id. at 5.5.1.
36 Id. at 5.5.
37 Id. at 5.5.4.
38 Id. at 5.6.1.
39 Id.
the climate have already taken place in the Arctic region with thinning of Arctic sea ice, thawing of permafrost, eroding of coasts, and shrinking of endemic species.\textsuperscript{40} IPCC expects the largest and most rapid changes in the polar region with repercussions for the Arctic, Antarctic Peninsula, and the Southern Ocean.\textsuperscript{41} The small island states will face the brunt of sea level-rise including displacement of population, loss of land and property, and saltwater intrusion into fresh water resources.\textsuperscript{42}

Significantly, most of these impacts, with the exception of the impacts on natural ecosystems, can be actuarially expressed in monetary terms using existing insurance schedules for losses and damages. Because these impacts can be monetized, insurance is likely, as the rest of this article will explain, to play a leading and necessary role in adaptation and mitigation.

This list also reveals a second important characteristic of climate change damages. The damages will either happen gradually with the eroding of coasts or the thawing of permafrost. Or the damages will be catastrophic with coastal flooding and hurricanes. Recognizing the different temporal qualities of climate change damages is critical for developing effective risk sharing tools such as insurance.

\textbf{C. Adaptation and Mitigation}

In contrast to the bleak outlook of IPCC scientists and other climatologists, States have acknowledged that climate change “may adversely affect natural ecosystems and

\textsuperscript{40} Id. at 5.7.
\textsuperscript{41} Id.
\textsuperscript{42} Id. at 5.8.2 and 5.8.5.
humankind.” 43 and have sought to negotiate some amenable strategy to respond to long-term climate change impacts.

1. Mitigation under UNFCCC and Kyoto Protocol

When the UNFCCC was negotiated in 1992, States optimistically committed themselves to stabilizing greenhouse gas concentrations “at a level that would prevent dangerous anthropogenic interference with the climate system”44 from the atmosphere. To achieve stabilization, Annex 1 industrialized nations were expected to mitigate their impact on the atmosphere by adopting strategies to reduce greenhouse gas sources and emissions while enhancing greenhouse gas sinks.45 It was understood by the parties that greenhouse gas emissions would not be eliminated but simply capped at a non-dangerous level. The treaty did not specify what level of greenhouse gases in the atmosphere would constitute a global danger.

In 2007, states generally agreed as part of the Bali Action Plan that developing nations had a responsibility to consider “verifiable nationally appropriate mitigation commitments or action.”46 While states were left to determine what is “nationally appropriate”, it was a first step towards requiring mitigation efforts from all nations and a departure from the previously negotiated “common but differentiated” approach adopted in the UNFCCC and the Protocol.

Two parallel approaches to mitigation that appear in the literature are contraction and convergence. Contraction requires a universal reduction in global emissions in order
to reach an agreed upon target concentration of parts per million of carbon dioxide. Convergence is a proposal to reduce emissions on a per-capita basis so that mitigation is apportioned equitably and fairly and not based on the size of an economy. 47

Scientists accept that even if human emissions cease and carbon concentrations drop, there will be long-term residual effects from the accumulation of carbon. As the chart on the next page demonstrates, even in the most optimistic climate model labeled S550 (stabilization at 550 ppm), the carbon dioxide concentration will increase for 100 years. As suggested by the most recent climate models, even ambitious mitigation programs are not sufficient to prevent what is otherwise an unavoidable increase in global temperature.48

47 See also the Contraction and Convergence proposals from Global Common Institute www.gci.org.uk/contconv/cc.html (Parties agree to a greenhouse gas concentration level and determine the global annual emissions levels needed to achieve the target. Allocations of permissible annual emissions are given to each country based on population size with the intent that per-capita emissions converge. A cap would be set to prevent additional accrual of emission rights based on population growth. )

48 Sawin et al. supra note 5.
Without defining any ultimate identifiable globalwide target for concentrations or temperatures, States negotiated the Kyoto Protocol in 1997 to establish legally binding commitments for the reduction of greenhouse gases produced by industrialized nations by collectively 5.2% when compared to a 1990 baseline year. Mitigation efforts under the Protocol have been broadly criticized and it is broadly accepted that with the exception of the European Union few other Protocol signatories will achieve their 2012 Kyoto targets. Without having an identifiable global target such as an agreed upon atmospheric concentration for carbon dioxide, it is not clear what its means environmentally to have achieved a Kyoto Protocol target. Overall emissions have increased sizably for non-
Protocol parties, parties to the Protocol who were not assigned legally binding commitments (so-called Annex II countries) as well as Annex I countries who have undertaken legal obligations to cut emissions. Across the globe, anthropogenic CO2 emissions have grown about four times faster since 2000 than during the previous decade.\textsuperscript{49} Some of this growth is fueled by the rapid development in regions such as India where, for example, commercial energy demands grew almost threefold between 1981 and 2001.\textsuperscript{50}

Mitigation under the Kyoto Protocol has become a laissez-faire endeavor. Even though the Protocol has penalties for Annex 1 countries that fail to meet their targets for the first commitment period (2012) in the form of having to meet their previous target plus an additional reduction of 30 per cent in the second commitment period through the purchase of credits, these penalties are less likely to have the sanctioning power where a number of Annex 1 countries may not meet their targets.\textsuperscript{51}

2. Adaptation under the UNFCCC and Kyoto Protocol

As the graph above demonstrates, mitigation alone is an inadequate strategy for reducing existing vulnerability in places such as Bangladesh or the Pacific island states.

\textsuperscript{51} Even though the European Union as a unit may achieve its target, individual member states such as Spain and Italy are unlikely to meet their targets. As of 2007, Spain was expected to see a 37% increase in emissions even though it was committed to a 15% reduction and Italy was excepted to increase its emissions by 11% even though it had agreed to 6.5% reductions. Spain will pass on 40% of the costs of having to buy extra credits to businesses with the remainder going to tax payers. Italy is expected to pass 75% of the expenses to tax payers. Kristian Rix and Matthew Carr, Japan, Spain, Italy Face $33 Billion Kyoto Payments, November 30, 2007, available at \url{http://www.bloomberg.com/apps/news?pid=20601109&sid=aktImREihjy0&refer=home}. 
Even in the best-case scenario described above of stabilizing carbon at 550 ppm, the carbon concentration is still expected to rise in the long-term which likely means an increase in temperature. In its 2007 synthesis report, the IPCC observed that “Adaptation is necessary both in the short term and longer term to address impacts resulting from the warming that would occur even for the lowest stabilization scenarios assessed.”

Understanding that what cannot be mitigated for will need to be adapted to, state parties agreed in the UNFCCC to cooperate to prepare for adaptation to adverse climate change. All Parties were expected to “Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change …and measures to facilitate adequate adaptation to climate change.” Industrialized nations in Annex I and nations in Annex II further agreed to “assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.”

During UNFCCC negotiations, little attention was given to how insurance might contribute to adaptation to climate change even though parties explicitly named insurance as an adaptation measure for developing countries including small island countries, countries with low-lying coasts, countries prone to desertification, and other vulnerable regions. As part of the adaptation process all parties were expected to “develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture.” African nations were additionally charged with developing and elaborating plans for the protection and rehabilitation of areas “affected by drought and

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53 UNFCCC Article 4.1(b).
54 Id. Article 4.4.
55 Id. Article 4.8.
desertification, as well as floods.” The specific methods of how particular regions would adapt was left to future Conferences of the Parties.

The Kyoto Protocol failed to provide any more specific clarification but simply adopted the adaptation concept from the UNFCCC. Article 3.14 of the protocol requires a closer examination of insurance as a possible adaptation strategy. Under the Bali Action Plan drafted in 2007, parties agreed to enhance their action on adaptation. While adaptation is not defined by any of the treaties or protocols, the Bali Action Plan interprets the term as referring to international cooperative efforts around capacity building and planning, risk management and risk reduction strategies, disaster reduction strategies, and economic diversification to avoid vulnerabilities. 56 In 2008, the UNFCCC Subsidiary Body for Implementation, agreed to improve information on accessing existing funds for adaptation, enhancing access to existing funds for adaptation, enhancing national planning for adaptation, and promoting risk management approaches. 57

All manner of specific responses could fall under the general rubric of climate change adaptation as understood by state parties to the UNFCCC and Kyoto Protocol including planting new crop varieties, building desalinization plants, changing building codes, and constructing sea walls. Whatever responses are taken by state parties as part of a climate adaptation strategies, any *ex ante* response to climate change impacts is likely to be motivated by the precautionary principle where states should not use the “lack of

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full scientific certainty…as a reason for postponing cost-effective measures to prevent environmental degradation” where there are “threats of serious or irreversible damage.”\textsuperscript{58}

While scientists cannot agree to disagree about the assumptions being used to correlate carbon concentrations in the atmosphere with temperature changes, some policymakers have already agreed to operate under the precautionary principle and are adopting anticipatory adaptation strategies without waiting for further verification from science. For example, overseas funders such as the World Bank are requiring their project teams to build bank-funded infrastructure in anticipation of altered future climate.\textsuperscript{59}

Mentioned in passing in the UNFCCC treaty and subsequent documentation, insurance is one form of precautionary adaptation that will meet the UNFCCC’s intention to promote risk management approaches to meet adaptation goal. This paper argues that priority should be given to insurance approaches to adaptation because they have the potential to both pool disparate risks and to change attitudes and behaviors concerning greenhouse gas emissions.

3. Cost-Benefit of Adaptation and Mitigation

In terms of treaty and protocol obligations, one of the UNFCCC principles indicates that states should undertake in good faith those mitigation and adaptation strategies that are cost-effective and will provide “global benefits at the lowest possible cost.”\textsuperscript{60} This explicit reference to cost-benefit analysis highlights the need to efficiently tackle both shared and individual mitigation and adaptation obligations.

\textsuperscript{60} UNFCCC, Article 3.3.
Today the level of carbon dioxide in the atmosphere is approximately 380 parts per million and growing. If both preventive mitigation and long-term adaptation approaches fail to achieve reduction in the levels of atmospheric carbon to reduce the extent of climate change damages, the humanity is confronted with three unpalatable choices. Population numbers will need to be frozen and states will have to change the rules of citizenship in order to provide refuge for vulnerable populations. Existing affluent populations will need to radically change the lifestyles to which they have become accustomed. Or states will have to agree to manage greenhouse gases through technical fixes such as modifying the earth’s chemistry.

Given the socio-cultural narratives associated with family, population control is a relatively taboo subject in general policymaking. Likewise, a return to less carbon intensive pre-industrial practices is regarded as reactionary and unwarranted by both political and economic decisionmakers. The only option left would be a technological fix. Given the consequences of humanity’s rapid industrialization and the uncertainties of climate science, what can we reasonably expect of deliberate tinkering with the ecosystem? If we release sulfur into the atmosphere or seed iron into the oceans, will it work? Or worse yet, will there be “surprises” as the IPCC labels them caused by nonlinear responses to anthropogenic forcing? 62

Before facing decisions of whether to intervene with the global ecosystem as a whole through geoengineering schemes, there are numerous untested adaptation and mitigation tools that have the potential to transform how individuals and companies

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61 Martin Heimann, Searching out the sinks, Nature Geoscience 2, 3 - 4 (2009)
approach changes and impacts attributed to greenhouse gas emissions. This paper argues that insurance has an important role to play in the coming decade as both a tool of adaptation and mitigation. Creating climate-change triggered insurance policies will not unilaterally fix our industrial excesses, but the insurance industry may be one of the only industries that can moderate our current excesses, ensure adequate capitalization for disaster relief in industrialized countries, and provide timely relief to the most vulnerable sectors of society who may otherwise become the first victims of climate change. As insurers review their current exposure to risks, the industry is likely to become an ever more vocal champion of change. Before describing how insurance may participate in creating a post-carbon economy and addressing climate change inequities, the following section reviews how the insurance industry has historically functioned as an agent of risk management and risk prevention to avert social disasters such as city wide fires.

Part 2- Insurance as Prevention-Based Governance

State and international policy makers are relying on the insurance industry as part of the larger solution of adaptation to climate change. This is not a surprising strategy on the part of governments. After all, the insurance industry is the world’s largest industry in terms of yearly revenues and is a powerful socio-economic actor. If the industry were a country, it would be the world’s third largest country with annual revenues of $3.2 trillion a year.\(^{63}\) Almost eight percent of the global GDP comes from insurance premiums.\(^{64}\)

Unlike other industries where intra-industry competition is the primary motivating factor for making industry wide changes, insurance companies are in unique position to

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demand behavioral changes from other industries by refusing to provide insurance for certain types of risks unless certain standards are met and precautions are taken. For example, after the 2007 floods in Great Britain, the insurance companies indicated that they would no longer provide insurance for new construction built in flood plains.\textsuperscript{65} Without proof of flood insurance, banks would not finance mortgages on the flood vulnerable properties. This provoked a panic leading to an eventual agreement between the insurance industry and the government that the insurance industry would until 2013 continue to offer flood coverage to existing domestic and small business customers who are at significant flood risk as long as there are plans to reduce the risk to an acceptable level within five years.\textsuperscript{66}

This section looks at how insurance works as a generalized tool for sharing risk and losses and begins with a discussion of how insurance has functioned in the past as an institution of social governance. The section continues by looking at how the risks associated with climate change might be translated into quantifiable risks that can be insured and the insurance challenges associated with quantifying large-scale disasters.

\textbf{A. Basic Concepts of Insurance: Defining and Managing Risk}

Insurance is the business of defining and managing identified risks. Where the business can define the parameters of a given risk and assign a monetary value to

compensate for the risk, it “finds ways to insure what had previously been regarded as uninsurable.” 67

1. Defining Risk

In order to define the parameters of a given risk, insurers ordinarily rely on historical data including the frequency of events, the amount of losses associated with particular risks and the number of units exposed to a given risk. With this information, the insurer can calculate an average “pure premium” which it can use as a base for underwriting. In the case of auto theft, defining the insured risk is relatively straightforward since there is a large amount of data about the number of cars in a given area and the number of car thefts across various geographical areas. Calculating the premium is straightforward since the insurance industry can rely on historical trends.

Defining the parameters associated with climate change risks presents additional challenges since there is insufficient historical data about both gradual and catastrophic climate change. To find frequency patterns in large-loss weather disasters, insurers must rely on modeling. To identify the amount of losses and the number of units exposed to a risk, insurers develop large-scale simulations of disaster scenarios and then calculate insured losses within a given circumference of the disaster epicenter.

Reliable long-term climate modeling is hotly contested. 68 If the climate as a whole is considered to be a complex, non-linear, mathematically-chaotic object, risk exposure modeling becomes tricky without sufficient data about feedback loops. Climate

68 See generally http://scienceandpublicpolicy.org (Scientists expressing skepticism about climate change modeling) and http://www.realclimate.org (Scientists recognizing limitations on climate modeling but suggesting that climate modeling provides some basis for action.)
catastrophe skeptics argue that the IPCC conclusions about the nature of climate
catastrophe are excessively alarmist since the models omit essential factors such as the
role of evapotranspiration from the oceans and reflectivity of cloud cover. Climate
concerned scientists argue back that even with factoring in these physical processes, the
result from all of the models is the same: long-term global average increases in
temperature.

Ultimate attribution of certain climate change damages to recent anthropogenic
emissions is also heavily disputed. Some scientists argue that any increase in damages
resulting from extreme weather events cannot be attributed to effects of climate change
but are instead the result of changes in land use patterns, demographics or a lack of
insurance coverage (e.g. lack of flood insurance).69

Given the need to rely on some sort of model to define risks, what does the
acrimonious debate among scientists mean for insurers ability to define their long-term
risks? It means educated guessing. Some form of attribution of impacts to climate change
will be necessary for insurers to define their climate change risk as insurance
commissioners are now demanding. In a world of shrinking gaps between insurance
premiums and weather-related losses that might be attributable to climate change, the
rational insurer is apt to rely on worst-case scenario modeling. A solvent insurer is not a
risk-adverse insurer but rather a conservative insurer. Until there is long-term historic
data to suggest otherwise, a solvent insurer defines its climate change risk on the basis of
higher than historic averages of extreme weather events with extensive damages.

69 Stephen Schneider and Kristin Kuntz-Duriseti, Uncertainty and Climate Change
Policy, in (Stephen Schneider et al. ed.) CLIMATE CHANGE POLICY, Island Press, 2002,
p. 61.
Catastrophe modeling is likely in contrast to traditional actuarial modeling to become the primary tool for predicting risks, damages, and losses.\textsuperscript{70}

2. Managing Risk

In order to effectively manage an identified risk over a long period of time and/or a widespread physical area, insurers rely on a number of practices and principles including risk pooling and loss prevention.

i. Risk Pooling

First and foremost among these practices is risk pooling. Insurers aggregate the uncertainties posed by individual risks into a larger group of risks where the uncertainty can be more optimally calculated. Various types of pools exist including government funded pools and privately managed pools. When private insurers engage in risk-pooling practices, they engage in social governance activities by creating conditions of social security and solidarity in order to minimize potential harms to insured citizens.\textsuperscript{71}

Risk pooling relies on the law of a large numbers, a probability theorem that explains why insurance policies need to be adopted across various risk groups in order for profits from a given insurance product to be stable. If only a few insurance policies were issued for a random risk such as an urban flood, then the insurance agency would have too broad of a deviation of risk to ensure sufficient capital from premiums to cover losses in the case of a flood resulting from a single clogged storm sewer. The more policies that are issued, the more stable long-term results become. Not every insurance policy in the


\textsuperscript{71} Richard V. Ericson, Aaron Doyle, and Dean Barry, \textit{Insurance as Governance}, University of Toronto Press, 2003 at p. 47.
pool will be for property in the neighborhood next to the clogged storm sewer. If all of the insurance policies in a given pool were underwritten for the same affected neighborhood, then the law of large numbers ceases to apply and the insurer may be at risk of being undercapitalized.

One method of pooling risk is through private mutual insurance. Under this approach, all of the insured parties agree to share equally in the losses. For example, all members of a neighborhood become policyholders in a company and agree to collectively share in losses caused by flooding of the neighborhood. Based on historical records, there is usually one incident of flooding per year that costs a homeowner $10,000 to repair. If 100 homeowners agree to pay $100 each, this would cover the costs of a repair. If there are two incidents in one year, homeowners would be obliged to pay a total of $200 for the year. Pooling risk through a mutual insurance approach motivates individuals to not only protect against personal losses but also to ensure that other members of the collective do not engage in behavior that is likely to incur sizable losses.

Since most insurance products are not based on small-scale mutual insurance approaches, an insurer’s ability to pool risk is dependent on addressing certain economic and moral risks. Two of the troublesome aspects of adequately pooling risk are “moral hazard” and the process of “adverse selection.” Moral hazard comes into play when a party that is already a policyholder engages in behaviors that add to the risks for which they are already covered. Take, for example, a hypothetical policy issued to a firework production company for the full value of all property. Arguably, if there are no exceptions in the policy, the firework production company could choose to store its gunpowder near its chemicals because it saves money in the production of each firework.
From a merely financial perspective, the existence of the insurance justifies otherwise dangerous behavior. Arguably without the financial security of insurance coverage, the company will act differently in order to avoid losses.

Adverse selection is common in voluntary insurance programs where parties that expect to suffer a loss opt for insurance and parties that do not expect a loss opt out of insurance. After parties have made presumably rational choice selections, the insurers are left with a narrow insurance pool where risks are not adequately spread across groups or across geographical regions. Flood insurance presents the classic adverse selection problem. Only parties that live along rivers that have flooded are likely to purchase the insurance leading to a problem of undiversified risk. From a practical perspective, insurers address moral hazard and adverse selection concerns by writing exceptions into policies, requiring deductibles, and promoting loss preventive behavior.

It could be argued that even without the problems caused by moral hazard and adverse selection, the risks associated with climate change are uninsurable because there are so many uncertainties in both the scientific and policy approaches to climate change. But as insurers have demonstrated through the creations of terrorism insurance and political risk insurance, just because something is risky or uncertain does not mean that it remains outside the boundaries of risk management. As Ericson and Doyle argue “A given political culture’s most dreaded risks – for example, nuclear energy production, child safety, terrorism, global warming – may be non-distributable when viewed through the cultural lens of severity and the limits of scientific knowledge…. However, this
cultural reaction does not make them non-distributable from an insurance viewpoint.”\(^{72}\) Rather, it presents a technical challenge for an insurer of how best to define risks that are sufficiently independent to prevent catastrophic losses and to prevent these risks from occurring.

ii. Loss Prevention

Loss prevention through the avoidance or mitigation of certain high-risk behaviors is a primary insurance strategy for long-term risk management. Instead of defining themselves as being in the business of loss protection, insurers actually understand their social role as being in the business of “loss prevention…[and] getting right to the causes and stopping claims before they happen.”\(^{73}\) Insurers become “agents of prevention.”\(^{74}\) When insured parties cooperate with loss-prevention efforts, insurers reward them with lower premiums or lower deductibles not only to reflect a change in the insured parties’ risk profile but also to create an incentive for further loss prevention efforts.

In the insurance industry since perceptions of a threats are often as important as real threats, the industry is committed to warning of harmful situations that may affect their risk analysis. Even if there is nothing that the insurance industry can do to fully avert a potential harm, the industry will promote a loss prevention culture by encouraging social cognizance of various types of harm and risk-reducing behavior. For example, in the case of storm surges, people can be warned about potential storm surges by long-range weather forecasting and encouraged to storm proof their homes or, in the case of


\(^{73}\) Ericson and Doyle, \textit{supra} at note 71, p. 271.

\(^{74}\) \textit{Id.} at 268.
earthquakes, groups can practice evacuation exercises. In some cases the installation of after-market products such as automatic sprinklers and fire alarms have played an important role in reducing insurance losses. In the context of climate change, the International Hurricane Research Center in Florida is working on designing an aerodynamic attachment for roofs that may reduce wind damage caused by Category 4 hurricanes with winds between 131 and 155 miles per hour.\textsuperscript{75}

Global insurer Allianz Group captures the role of the insurer in creating a risk-management strategy based on loss-prevention. On their industry webpage dedicated to climate change solutions, the insurer provides a plethora of information about climate friendly approaches to technology and energy generation. One article describes how flying airplanes at slower speeds will reduce fuel use and reduce carbon dioxide emissions by seven to eight percent.\textsuperscript{76} Another article highlights the promise of algae-based biofuels.\textsuperscript{77} Why would an insurance company be circulating this type of information? Even though it doesn’t currently insure for the larger phenomenon of climate change, Allianz knows that it already has long-term exposure to climate change impacts through its various casualty insurance lines. The earlier that insured parties adopt climate friendly technology, the better the loss outcome may be for the insurer.

Insurers have long been crusaders for loss prevention and are both early adopters and creators of potential loss-reducing technologies. To better pool risk and control their

\textsuperscript{75} Evan Lehmann, Company Develops Rooftop ‘Fins’ as a way to Reduce Coastal Storm Damage, ClimateWire, November 21, 2008 at http://www.eenews.net
\textsuperscript{76}“Efficient Aviation: The Sky is the Limit” http://knowledge.allianz.com/en/globalissues/climate_change/climate_solutions/aviation_emissions_reduction.html
\textsuperscript{77} Bioenergy from the Scum of the Earth http://knowledge.allianz.com/en/globalissues/climate_change/climate_solutions/algae_bioreactor_biofuel_carbon_sequestration.html
loss ratio, insurers regularly seek to implement risk-reducing technology. For example, after the Great Fire of London in 1666, the insurance industry created specialized companies to extinguish fires. Later, insurance companies were instrumental in establishing safety standards in building construction. In order to spread and manage risk, insurers began to demand from insured parties the installation of certain technologies in order to receive negotiated premiums. For example, in 1865, Boston Manufacturers, a mutual insurance company, made it clear to mill owners after an inspection that it would offer insurance at a certain price if an additional fire pump was installing. Without the pump in place, the owners would be required to pay a substantial additional business expense of $10,000 (which would be the equivalent in 2007 U.S. dollars to $131,312).

Some insurers envision a similarly active role in addressing the challenges of climate change. “[Insurance industry] needs to prepare itself for the adverse effects that climate change may entail on its business and on its customers. … [and] find solutions to reduce the economic risks linked to climatic evolutions and possibly to help society to cope with the root that causes global warning by promoting new technologies that should enhance mitigation of GHG emissions.” Potential technological solutions exist in the form of either improving energy efficiency or reducing the amount of greenhouse gases emitted per unit of energy generated. Proposals to reduce emissions include developing renewable sources, carbon sequestration, and carbon separation.

79 Id. at p. 20-21.
While loss prevention and risk reduction seem like intuitive strategies for the insurance industry to manage risk, how actively an insurer pursues these strategies depends on the market. When potential insured parties face a risk but refuse to pay large premiums because they cannot adapt to the proposed insurance conditions or may not want to adapt, these entities will often self-insure through captive insurance companies. In the “soft commercial insurance market” of the 1990s, insurers relaxed their loss prevention requirements in order to capture some of the business that would have otherwise opted to self-insure.\(^{81}\)

Even where insurance companies insist upon certain standards in order to underwrite a policy, insurance company practice still provides examples where the insured can negotiate for individual standards. For example, commercial property insurance policies usually include the need for adequate sprinkler systems. Yet companies will still underwrite policies where an insured agrees to phase in adequate safety measures because sometimes the business relationship with the insured is considered more important than the potential loss.\(^{82}\)

**B. The Role of Insurance as Providing Governance for Climate Change**

Insurers’ large-scale ability to pool risk and implement risk-reducing technologies positions the insurance industry in a unique cross-disciplinary position. Through its array of products and services, insurers are all at once agents of management, economics, law, risk aversion, and politics. To the extent that insurance is successful in managing losses associated with identifiable social risks such as reckless driving or unlicensed doctors, insurance is an effective form of social governance.

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\(^{81}\) Ericson, *supra* note 71 p. 294.

\(^{82}\) *Id.* at p. 295.
Insurers may also be the needed economic agents to muster the capacity for change and the will to act in a timely fashion that is largely absent from the international arena of climate change negotiations. When the United Nations Framework Convention on Climate Change entered into force in 1994, there was some expectation that the convention would result in the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” \(^{83}\). Sixteen years later, there are few signs of stabilization but a marked growth in the perceived dangers of climate change. Many attribute the failure of the UNFCCC regime to achieve meaningful emission reductions through the Kyoto Protocol (calling for a 5% overall reduction for certain historical emitters) to the lack of greenhouse gas emission targets for Annex II countries including many transition economies who have not just caught up to the industrialized countries but surpassed them in production. \(^{84}\) Since 2008, China has been the largest global emitter of carbon dioxide. \(^{85}\) A secondary explanation and perhaps equally important reason for the lack of action under the UNFCCC is the perceived irrelevancy of the UNFCCC to private actors, many of whom are responsible for increases in emissions. As a treaty between states, the UNFCCC’s obligations do not directly apply to private entities and governments can only influence private sector behavior in a limited fashion. As David Victor observes, even government that are motivated to meet targets are unable to singularly achieve emission targets because of a lack of influence over factors such as technological change and

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83. UNFCCC, Article 2.
economic growth. The treaty alone cannot change the behavior of those most responsible for continued emissions—industries and consumers.

The UN has urged participation from the private sector. In a 2007 address to the United States Chamber of Commerce, Secretary-General Ban Ki-moon urged the private sector should take a leadership role in climate change by investing in clean technologies and encouraging countries and industries to make the necessary adaptations to promote these clean technologies. More recently, there has been a growing interest in how financial sectors and the insurance sector can contribute to reducing emissions and fostering adaptation.

Insurance is likely to be a widely debated strategy for private sector engagement in climate change. Insurance creates a different relationship where insurers and insured parties speak the same language of financial losses, capital investment and profits. Unlike the generalities inherent in the UNFCCC and the Kyoto Protocol, insurance is about specifics. To the extent that insurance has historically fostered a culture of long-term loss prevention associated with fire damage, insurance may also provide a needed parallel form of governance to achieve stabilization of GHG concentrations.

The Munich Climate Insurance Initiative is an example of a parallel social governance scheme spearheaded by the private reinsurance industry. Organized in 2005 by Munich Re, the initiative is intended “to create a balance between the emitters of

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86 Victor, supra note 84 at p. 11.
greenhouse gases and the developing countries.”  

It includes as its members intergovernmental organization such as the World Meteorological Organization and the UNFCCC Secretariat. In keeping with its insurance industry origins, the initiative identifies its mandate as contributing to “loss reduction measures for climate-related events” and developing and piloting “insurance-related solutions to help manage the impacts of climate change.” Yet, the Climate Insurance Initiative has proven to be more than a mere exercise in generic corporate social responsibility. In December 2008 at the UNFCCC Conference of Parties in Poznan, Poland, the insurer-led initiative made explicit proposals for widespread public-private climate risk insurance to help people especially in the developing world adapt to some of the weather-related risks associated with climate change. With an existing track record in promoting types of climate risk insurance in the developing world, Munich Re’s proposal to the COP offers a pragmatic approach to the recurring and recalcitrant problem of assigning state responsibility for past environmental harms.

Insurers are conscious of their new governance roles and responsibilities. The industry understands that it is regarded as a leader in the face of competing uncertainties. In an internal communication from the Association of British Insurers about how to broach the subject of climate change with customers, the association observes “insurance industry has the authority to become one of the most trusted sources of information and

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88 http://www.munichre.com/en/ts/geo_risks/climate_change_and_insurance/opinion_we_need_to_reassess_the_risk/mcii.aspx
89 http://www.climate-insurance.org/front_content.php?idcat=146
advice on climate change, in particular on how we can protect ourselves from its impacts."90

Risk Management Services, a consultant to insurers, reinsurers, trading companies, and other financial institutions on catastrophe risk, recently noted in the Geneva Papers composed for insurance industry that, “The insurance industry can act to tackle …. hazard trends by playing its part in climate change mitigation, through the promotion of ways to reduce greenhouse gas emissions, for instance, in the form of coverage for renewable energy infrastructure…. [and] promoting the effective limitation and management of risks from extreme weather-related hazard.”91

In a move that surprised some industry insiders, the insurance regulators adopted rules in March 2009 to require insurance companies with annual revenues of at least $500 million to begin reporting on how they are persuading policyholders to reduce their contributions to global warming and how the companies are factoring into their products the financial risk associated with predicted climate change impacts.92 The U.S. insurance industry split in December 2008 over whether adopt nationwide rules. Companies such as the Reinsurance Association of America supported the rules because “it’s good business to be focused on climate change.” Other companies such as Property Casualty Insurers Association of America thought that the insurance regulators were acting beyond their authority. It remains to be seen how the rules will be implemented but the chairman of

the National Association of Insurance Commissioners hopes the rules will “provoke a lot of mitigation activity.”93

While insurers alone will not achieve the goals of climate change adaptation and mitigation that states have not been able to achieve, the insurance industry is a necessary political ally because adaptation and mitigation strategies will be ultimately measured as effective on local and regional levels not global levels. Even though there are annual meetings and regular reports from the UNFCCC, there seems to be little impetus at the international level to implement large-scale adaptation and mitigation efforts. Emerging economies such as China and India are still arriving at the negotiating table with their right to development as a priority agenda item. These countries argue that because of their path of development that they are entitled to “common but differentiated” responsibilities meaning that China and India should be given additional time to develop in a “business as usual” fashion before being required to contribute to emission reductions. In concept, the “common but differentiated” principle makes sense for economies that contribute little industrial production. But, as noted above, China who ascribes to the “common but differentiated” principles is now the leading GHG emitter as a nation. Even China has had since June 2007 a National Climate Change Program to mitigate GHG emissions and to adapt to the consequences of climate change, there has been little progress in meeting its goals to reduce energy intensive activities, double renewable energy, and close inefficient facilities.94

93 Id.
Even with the combined reluctance to set targets and inability of large transition economies to achieve national targets, the insurance industry still has the independent incentive to seek systemic changes now rather than to simply respond to future uncertain events given its existing exposure to insured losses. Cooperation between the state and insurers makes sense where both the state and the insurers have similar goals albeit different motivations. The insurance industry has the capacity and ability to require greater accountability from its insured parties. For example, in the field of automobile insurance, insurers have changed their vocabulary to speak about automobile crashes rather than automobile accidents. From the perspective of the insurance industry, accidents happen, but individual drivers cause crashes.\textsuperscript{95} If you assign the highest premiums to those who are likely to cause crashes rather than simply those who are unlucky and accident-prone, then the insurance industry can demand greater personal responsibility and accountability from its insured parties. Similar logic could be applied in the context of climate change. Large-scale emissions don’t simply happen but are rather caused by companies who pursue certain business practices and activities.

The Zurich Report, a white paper prepared by Zurich Financial Services, emphasizes the entrepreneurial approach to climate change risk and new structures of climate change governance, “[W]here there is risk, there is opportunity – opportunity to manage risk and invest in risk mitigation, as well as help the community adapt to the impacts of climate change….While the private sector cannot take the place of governments, it can certainly work to facilitate the achievement of public policy goals that are properly structured, simultaneously meeting the needs of its shareholders and

\textsuperscript{95} Ericson et al. supra note 71 at pp. 272-273.
stakeholders.” 96 Zurich Financial Services sees its engagement in managing the risks inherent in climate change as a fivefold process “– to reduce the hazard (e.g. by reducing the emissions that cause climate change); – to reduce their [Zurich Financial’s] vulnerability (e.g. by helping customers avoid potential losses); – to optimise their exposure (e.g. by entering markets that may need new insurance cover); – to recognise new opportunities (e.g. servicing new low-emission industries); [and]– to develop capacity to manage new risks and deliver opportunities (e.g. by training staff and creating new products).” 97 Even though Zurich Financial is quick to suggest that insurance is not the “silver-bullet solution” 98, it understands itself as an agent of change offering specific solutions to reducing emissions and helping customers to adapt to potential losses. The remainder of this paper reviews various opportunities for insurers to become international agents of change to provide just compensation in the event of a climate-change induced disaster.

In summary, the insurance industry has at its disposal the necessary experience to pool similar risks and to influence behavior to reduce losses. In the context of climate change, the insurance industry appears to be prepared to act in terms of ensuring climate change risks, but for an insurance program to be effective, there needs to be government support. The following section proposes compulsory catastrophe risk insurance as one means of ensuring that the insurance industry is able to viably pool risks and influence behavior.

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96 Zurich Report supra note 9 at p. 1.
97 Id. at p. 2.
98 Id. See title of report.
Part 3- Insurance as Adaptation and Mitigation in Countries with High Coping Capacity

What sort of role could private industry such as the insurance play in the apocalyptic future predicted by some forecasters? To answer this question, it is important to look at alternative forecasted realities. One alternative is the business as usual, do-very-little beyond what is politically essential scenario. Under this scenario, it is 2050 and large emitters like the United States and China are still in good faith attending the annual UNFCCC meetings but unable to agree on an effective treaty architecture that will satisfy domestic constituents. In both countries, the political pressures to generate jobs have exceeded any domestic push to meaningfully mitigate emissions. There are some putative cap-and-trade systems, but they are not fully functioning. Proposals for offsets haven’t quite worked though many entrepreneurs have thrived from the concept. Chicago, Los Angeles, Las Vegas, New York, Beijing, and Shanghai have experienced devastating heat waves. The high tide line is reaching ever farther up the beaches in Florida, Hawaii, California, much of the Gulf Coast, a fair portion of the Eastern seaboard, and most of the Chinese seaboard. The permafrost in Canada and Russia is melting. The warm temperatures in the northern oil fields may cause trillions of dollars of damage to the existing fossil fuel pipelines. It is a time when it is too late to plan for the future because countries are too busy simply reacting to the future.

A second climate alternative would shift the burden of initiating action from the negotiating tables of world conferences to the boardrooms of multinational business enterprises. In this second alternative, industries would proactively and independently undertake adaptation and mitigation measures because of market incentives to secure
assets against climate losses. In this second scenario, the insurance industry would play a major role in pooling and distributing risks while putting corporate pressure on large emitters to achieve mitigation targets because the “insurance approach … strongly supports starting modest but persistent intervention on a global scale as soon as possible.”99

This section examines how insurance may operate as both an adaptation and mitigation strategy for countries with high-coping capacity in terms of available resources and finances. In this first subsection on insurance as a tool for adaptation, suggestions are made about how to additionally “climate proof” some of the existing insurance products or to adapt existing products to meet the demands of compensating for future climate disasters. Mandatory climate change insurance and differential governmental disaster payouts are two of the ideas discussed at some length.

In the second subsection insurance is examined as a tool for mitigation. This section reviews existing efforts from the insurers to reduce greenhouse gases and the polluter pays principle. In the final subsection, we propose a mandatory corporate catastrophe risk insurance scheme as a viable approach to stimulate needed emission reductions among large-scale national emitters while meeting the needs to capitalize state-based disaster and climate change adaptation funds.

A. **Insurance as Adaptation**

In the first subsection, three different types of insurance mechanisms are reviewed that currently exist as insurance products and might be adapted to climate change: private

hazard insurance, government sponsored insurance for natural catastrophes, and earthquake insurance.

1. Gradual Loss Compensation

Existing insurance products cover many of the gradual impacts of climate change including flooding caused by sea level rise or coastal erosion. Yet for at least some of these products, the risk assumptions under which some of these products were originally underwritten have changed. Insurers recognize that beachfront property is not just expensive to buy but expensive to protect in a changing climate. Some insurers are agreeing to address the new risks posed by climate change. For example in Australia, Zurich Financial Services has agreed to automatically provide flood insurance for commercial parties. 100

Other insurers need to improve and reassess existing products so that polices are not simply unilaterally canceled. Families in areas perceived to have high losses from severe weather events such as Cape Cod, Massachusetts are losing their property insurance coverage because of growing concerns about undercapitalization for certain types of large-scale weather related events. 101 Responding to the losses associated with Hurricane Katrina, three of the largest insurers Allstate, State Farm, and Liberty Mutual substantially reduced its exposure to Katrina-like events by turning down all new homeowner insurance in New Jersey, Connecticut, Rhode Island, Maryland, Massachusetts and the eight downstate counties of New York. 102

100 Zurich Report, supra note 9 at p. 2.
On their company pages, insurers understand that climate change matters to their business interests and profitability. As Martin Gansneder with the Allianz Insurance Company observes, “We [Allianz] are affected through higher claims, especially in the property insurance, and the variability of these claims is also rising. We could simply adapt our underwriting policies and pricing models, but that would mean that some customers could not afford insurance any more. So, it is in our interest to offer our customers ways to adapt to climate change, avoid excessive losses, and even participate in mitigating climate change.”

Allianz representatives’ words suggest that the insurance industry has reached an impasse in continuing business as usual. The insurance business recognizes that its insured parties must actively implement reasonable adaptation measures now to avoid a flurry of claims that would have been preventable. In order to underwrite new policies, insurers can provide a combination of non-structural and structural guidance that may contribute to nationwide adaptation. For example, property insurers can refuse to insure any new development in climate hazard-prone areas such as exposed areas of coastline. In areas where there is already development, property insurers can require retrofitting to bring buildings into compliance with climate-proofing codes such as raising the floor of a building in anticipation of a certain amount of seawater encroachment or demand higher premiums for high risk properties. Life insurers might require the installation of passive cooling systems such as planting heat-resistant shade trees to protect individuals against summer heat wave temperatures or require insured parties to pay higher premiums. With

the concern over spread of disease vectors as animals and insects migrate, health insurers may require insured individuals to demonstrate that their homes have screen doors and windows to protect against malaria or dengue fever carrying mosquitoes or pay significantly higher premiums.

Rather than creating a new regulatory environment, the established need to insure property, life, and health in a financially viable manner may be the needed social catalyst for stimulating nationwide adaptation for climate change. Inexpensive measures may be enough to substantially reduce certain types of risk and ensure the continued viability of the insurance industry. This was the lesson from evaluation of hurricane losses caused by Hurricane Gilbert in 1988 where one-third of the direct losses ($956 million) were caused by the loss of roofs that could have been prevented by inexpensive roof strapping.104 Local civil engineers had estimated that expending 1% of a structure’s value on retrofitting the properties against storm damage would reduce the probable maximum loss from a category three windstorm by one-third. While hurricanes result in qualitatively different losses from gradual climate change losses, the Gilbert example illustrates that certain simple adaptation measures may be sufficient to avoid certain types of losses and reduce the quantity of other losses.

Without requiring from its insured parties some adaptation measures, insurance companies will not be able to effectively spread risk. In the case of gradual climate change damages, the insurance industry will be exposed to a large quantity of high frequency, low damage events. This would introduce unnecessary volatility in the

existing insurance marketplace. Reinsurers may refuse coverage of an excess of a particular type of high-frequency risk such as residential first-floor flooding. Without adequate reinsurance many primary insurers would be forced to withdraw future coverage. As of 2009, the insurance industry is uncertain of what it should reasonably demand from its customer pool to climate proof their assets. With tight margins due to the current recession, the insurance industry may be loathe to mandate customer standards for insurance and instead are focused on eliminating coverage for those entities whose location or activities involve too many unpredictable risks.

2. Disaster Compensation

The media and non-governmental hype around climate change damages is focused primarily on catastrophic impacts rather than gradual effects. When insurers circulate statistics with the press, they share damages from catastrophic weather impacts. For example, Munich Re reported that 2008 was fourth most severe hurricane season since meteorological historical data started being compiled since eight of the annual windstorms reached hurricane strength and five of the tropical storms were classified as major hurricanes.105

Arguably, all insurance is disaster insurance. When unpredictable events happen that result in major losses, companies and individuals look to their existing insurance policies as possible sources of compensation. In some instances insurers will offer catastrophe specific insurance policies or will levy addition premium sums to cover losses attributable to catastrophes. In order to insure for region specific catastrophes,

105 Munich Re: Climate agreement is urgently needed, December 29, 2008 available at http://www.munichre.com/
insurers tend to spread their risks across time rather than across geographical communities.  

i. Government as Ultimate Risk Manager

Since only about 20 percent of global disaster losses are privately insured, citizens in high-coping capacity nations generally look to their governments as the ultimate reinsurer and provider of relief. Most high-coping capacity governments are involved in some sort of risk management strategy as primary insurers, reinsurers, or underwriters for extraordinary risks. Depending on the country, coverage may be voluntary or compulsory. Some of the compensation arrangements are ad hoc while others operate through state or quasi-state institutions.

In France, the government passed in 1982 a national disaster compensation scheme. It covers earthquakes, floods, landslides, hailstorms, avalanches, tsunamis, and droughts. All property damage policies sold by private insurers include compulsory natural disaster coverage with rates set by the government. The coverage is triggered when 1) a natural disaster is officially declared by the government, 2) the damaged property was protected under the policy, and 3) the claimant proves that the property was damaged by the natural disaster. After an insured meets a mandatory deductible that is calculated by the government, the insurer pays for material losses as well as business interruptions. In order to guarantee the solvency of this system, the government offers natural disaster reinsurance to the property insurers with unlimited coverage.

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106 Pollner supra note 104 at p. 23.
108 Law 82-600 (July 13, 1982), Loi relative a l’indemnisation des victimes de catastrophes naturelles.
In Spain, the Consorcio de Compensacion de Seguros is a society wide compensation scheme for extraordinary risks that originated in response to the man-made losses during the Spanish Civil War. The organization’s work is grounded on the principles of solidarity among the insured, compensation for risks across different regions and hazards, cooperation between the private market and public, and reliance on public funds as a last resort. It is run as a statewide business attached to the Ministry of Economy and Finance but has assets and liabilities that are separate from the state. It pays claims when an extraordinary risk such as damage is not specifically covered by another insurance policy or the risk is covered but the company cannot meet its financial obligations. The types of risk that are covered include floods (except for the flooding of artificial canals), volcanic eruption, sea surges, earthquakes, storms including windstorms with winds greater than 135 km/h, terrorism, and civil unrest. To create a sufficient capital reserve and achieve its goals of building solidarity, the Consorcio collects compulsory sums that are levied for all accident and property insurance policies. The Consorcio puts these partially tax deductible sums in a stabilization reserve. Historically, the Consorcio has also temporarily covered risks where there is no market activity to protect parties such as the risk of terrorism and war after the September 11, 2001 attacks. Unlike the French model described above, compensation from the Consorcio does not depend on an official declaration by the state of a disaster. The General Manager of the Consorcio is aware that climate change will present a challenge to the Consorcio and has

110 Id. at p. 341.
111 Id. at 342.
observed that even though the insurance industry is not the exclusive solution to compensation for climatic events, “it will have to offer insurance alternatives according to each climatic reality.”

New Zealand introduced the Earthquake Commission Natural Disaster Fund in 1994 to cover natural disaster losses including storms and floods for residential properties. The coverage is compulsory whenever fire insurance is purchased. The premium for natural disaster coverage is collected by private insurers and then sent to the Earthquake Commission, a state entity, who administers the natural disaster insurance including processing the claims and organizing reinsurance. As with the French compensation scheme, the government is the ultimate reinsurer.

In the Netherlands, some government compensation may be provided under the Calamities and Compensation Act. The available compensation is limited to those situations when a flood results in a disruption of public safety and requires a coordination of civil services. Damage caused by storm surges is not covered because it was considered too difficult to calculate the costs of such events.

Some countries such as Australia use fund mechanisms created from tax revenue. Through its Natural Disaster Relief Arrangements fund, the Commonwealth provides after a catastrophe funding to both States and Territories to cover specific expenses. The fund is intended to supplement private insurance.

In Turkey, a national disaster insurance scheme provides relief to Turkish households in the event of an earthquake. Depending on where a home is located, how

112 Id. at 347.
the home is constructed, and what risk-reduction measures have been taken by households, the insurer calculates a premium. Every household is required to pay an insurance premium to a privately administered, public fund. The World Bank provides reinsurance in the form of low-interest loans to cover losses that occur before there is sufficient capital in the insurance fund to cover losses or where losses are unusually high.\textsuperscript{114}

What do all these government sponsored risk management schemes suggest in the context of climate change? These schemes all provide possible government sponsored models and mechanisms for compensating for climate change damages. They point to a society wide inclination to allow the government or a quasi-governmental agency to be the primary risk managers for catastrophic disaster relief. The proliferation of the schemes mean that the insurance industry, the world’s largest industry, has been reluctant to apply the law of large numbers and the rules of the free market to catastrophic risks. While, as some argue, nearly anything can be insured, that does not mean that all risks are equally attractive to insure.

While the private sector has generally shied away from insuring certain types of catastrophic risk, this does not mean that the private sector is absolved from any role in compensating for losses associated with catastrophes. Rather, the private sector is still expected to pay out for damages covered under the terms of its insurance policies.

Yet even with the private insurance payouts, the government is still perceived as the loss manager of first resort. For many who cannot afford private insurance, as is the

case with floodplain residents in the United States, the government is the first and only lifeline of compensation. Given the principle role of the government in so many natural disaster compensation schemes, should citizens be required to have mandatory insurance especially those in high risk areas?

ii. Mandatory Natural Disaster Insurance

A number of the models discussed above share an important feature. Disaster coverage is a mandatory part of a number of property and fire insurance policies. In order to cover future projected losses, should governments collect some form of climate change insurance from not just property insurance but also health insurance, business interruption insurance, and life insurance? Governments often make certain types of insurance mandatory when it anticipates that a group at risk will misperceive the nature of certain risks and not insure. Mandatory workmen’s compensation insurance exists because the government believes that the shared benefits of solidarity exceed the premium costs to an individual. When analyzing a large scale climate change disaster from the perspective principle of the law of large numbers, a mandatory climate change levy on existing insurance products makes sense. The levy would In covering catastrophes such as floods, severe ice storms, hurricanes, and droughts, a comprehensive climate change insurance policy would spread the risk broadly across not just geographical areas but also across different types of damages and hopefully multiple risk carriers. In addition, a single comprehensive climate change insurance policy avoids the transactional costs associated with determining whether damage observed in a given property is covered. Unless climate change induced weather events trigger each other
across a geographical region, risks should be sufficiently independent to ensure that one
or more catastrophes will not deplete the reserves of a catastrophe fund.

Ideally, mandatory insurance mechanisms also overcome deviations from the
“rational actor” mode. As economists have been learning, not all economic agents take
actions which are to their benefit and avoid actions which are detrimental. Mandatory
policies take the ambiguity out of decision-making processes especially when the
individual and business decisions that are being made have no immediate downside and
only a potential for long-term consequences. Mandatory insurance coordinates consumer
and corporate time horizons with public policy time horizons.

But is such an insurance mechanism feasible? Howard Kunreuther, who has
written extensively about management for low-probability high loss events, observes that
“many potential victims of disaster perceive the costs of getting information about the
hazard and costs of protection to be so high relative to the expected benefits that they do
not consider investing in loss reduction measures or purchasing insurance.” 115 Disaster
insurance is considered by many people as a discretionary expense because of budgetary
constraints.116 For many individuals, insurance only becomes attractive after an
individual experiences either a personal loss or a near loss. 117

Kunreuther observes that even where disaster insurance is mandatory, the
requirement is frequently breached. For example, the Federal Emergency Management
Agency observed after a major flood in Vermont that 84% of the homes in a special flood
hazard area were uninsured even though 45% of those homes were required to have

115 Id. supra note 78 at p. 178.
116 Id. (Kunreuther observes that after events such as Hurricane Katrina, individuals may
reconsider whether they can expect a “Samaritan” response from the government.)
117 Id. at 179.
insurance because all homes in special flood hazard areas that obtain federal mortgages must demonstrate insurance coverage. The banks who were providing the federal mortgages blatantly disregarded the insurance requirements.

In spite of these significant lapses in individual coverage, politicians continue to seek national solidarity in policies that might function as climate change insurance. In March 2009, United States Representative Gene Taylor from Mississippi introduced a bill to add mandatory wind coverage to the federal flood insurance program in hopes of spreading the hurricane risks across the nation since not all flood insured areas are also subject to high winds. Leaving aside the existing challenges faced by the National Flood Insurance Programme, there is unlikely to be widespread consensus for Representative Taylor’s proposal after the U.S. Senate’s refusal to act in 2008 on the same proposal.

If it is not viable to mandate system-wide climate change insurance because of problems with mustering public will, are there any possibilities of creating market incentives that might make self-insurance a more attractive option? Understanding the larger context of government funding for disasters is critical. While most disaster funds and government-run disaster compensation programs have reserve funds for extraordinary events, few of these reserve funds are adequately funded to cope with multiple catastrophic events in a short period of time. In a worst-case scenario for climate change, multiple catastrophes may hit across a widespread area. In the event of multiple

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118 Id.
119 Evan Lehmann, Storm-wary Australian officials ponder costs of coastal development, Mar. 4, 2009 http://www.eenews.net/climatewire/2009/03/04/archive/1?terms=insurance
disasters, there will simply not be enough government compensation funds to make losses whole if the losses are not already covered by private insurance.

One option that furthers the goals of risk sharing through insurance mechanisms is giving payout priority to those who can either demonstrate that they have taken appropriate and verifiable adaptation measures to protect against climate change damages or have purchased minimum statutorily mandated levels of insurance from the private market. In the event of an extreme weather event attributable to climate change, the government would have in its disaster reserves or in the reserves of a specialized quasi-governmental agency a certain sum of available money for compensation for property damage and business losses. The first group to receive payouts from this government or quasi-government pooled reserve would be those parties who can demonstrate that they have adopted reasonable climate change adaptation measures such as moving production facilities away from exposed coastlines and purchasing the appropriate amount of first line private compensation insurance. The second group to receive payments of catastrophe claims would be those parties that have adopted reasonable climate change adaptation measures. The final group to receive some compensation for their claims would be those who had contracted for minimum levels of private insurance. Those who purchased insurance but have not taken adaptation measures would be the last to receive payments in order to avoid the moral hazard problem that simply having insurance will cover the costs associated with continued risky behavior (e.g. non-adaptation behavior). Depending on the size of the available fund for disaster relief, uninsured groups who have not demonstrated efforts to adapt may receive no compensation.
The idea behind distinguishing between different populations for the purposes of compensation may seem inequitable given the different levels of sophistication and financial capacities of various property and business owners. Yet the concept behind offering a minimum level insurance product is to create a culture of responsibility, to stimulate a systemwide proactive response to large-scale future risks, and to distribute the financial risks of adaptation. For those such as elderly on fixed incomes or other low income households who simply cannot afford the costs of adaptation, a high coping capacity government could provide grants or subsidies to cover needed adaptation expenses.

This idea of various tiers of payment based on making certain private insurance payments and/or complying with certain adaptation activities is intended to both reward responsible behavior and to act as a disincentive for behaviors that run counter to building a sense of cross-sector solidarity. The private sector becomes the primary risk manager rather than the government.

This approach of creating a hierarchy of relief avoids otherwise insurmountable moral hazard problems in relying upon the government as the primary insurer and reinsurer. Otherwise, there is no incentive to insure where a party is guaranteed to receive potentially similar levels of insurance as those who took steps to reduce risks. Or even where a party insures, it may insure at politically viable but economically unviable premium levels that “fail to consider the true costs of living within punching range of stronger hurricanes and higher storm surges.”

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Some companies with potentially high losses who may be limited in their ability to adapt because of the location of existing infrastructure such as ports or airports should be required to carry certain levels of mandatory property insurance to cover property and business losses from a climate change catastrophe. Government regulations requiring this insurance might avoid some of the criticisms associated with recent government compensation funds. For example, after the terrorist attacks of September 11, the U.S. government established the Victims Compensation Fund to provide some compensation to the beneficiaries of those who had experienced wrongful death. In return for the agreement not to sue, relatives of the victims would receive a payment from the fund that would be offset by any sums due under insurance or pension. The Fund was criticized by some as a government-financed bail-out of the airline industry for its lack of adequate risk management and insurance.\footnote{Ericson \textit{supra} note 72 at pp. 261-262.} Without proper capitalization through the insurance markets to protect commercial businesses against the large-scale costs of climate change disruption, governments may find themselves propping up businesses in the case of a future climate change induced crisis. Assuming that it is not fair to bail-out the airline industry using a compensation fund in the context of an extraordinary and unprecedented terrorist event, it would be even less fair to bailout companies that are delaying in adapting their businesses to the potential consequences of future climate change and underinsuring against future climate change losses.

While mandatory climate change insurance may not be viable in the economic climate of 2009, a more concerted effort is necessary to increase the numbers of individuals or corporate entities carrying insurance to protect against the projected effects
of climate change and more effort is needed to involve the private sector in an area that has been managed by default by the government. The proposal of a multi-tiered system of claim payouts that would depend on having some level of private insurance would create new opportunities for the private insurance. What might this private catastrophe insurance product look like? Existing earthquake insurance provides some useful examples of how private insurers can contribute to insurance schemes for disaster prevention and compensation.

iii. Climate Change and Earthquakes: What Does Earthquake Insurance Tell Us about Climate Change Insurance?

While scientists are well informed about what happens during and after an earthquake, the tools to forecast earthquakes remain underdeveloped. While there are substantial challenges with obtaining information about when an earthquake will happen, there are ample models about what losses are likely in the event of a certain magnitude earthquake. So while insurers do not know when to expect a given magnitude earthquake, they can make predictions about how much damage a given magnitude earthquake would cost. While wary of insuring for earthquakes because of the uncertainties of timing, private insurers have offered and continue to offer certain levels of earthquake insurance. A review of earthquake insurance products may inform a discussion of potential climate change insurance.

Like climate change, the modeling of earthquakes is based on “dubious assumptions and subjective criteria related to what might happen over the next several hundred years.”\textsuperscript{122} What data does exist on historic earthquakes is limited. Yet private

\textsuperscript{122} Id., at p. 34.
insurers have not completely shied away from offering insurance products to cover against long-term geological risks. They have simply instead relied on more creative and imaginative analytical techniques, collected more evidence including independent geological surveys, and then issued policies on the basis of certain educated assumptions about geological risk.

Insurance companies view earthquakes from the point of view of not “if” but “when.” With the emphasis placed on “when”, the companies consider their contribution to be one of amassing capital that will be made available to protect the monetary value of assets “when” there is a disaster. Where earthquake insurance is offered as part of property and casualty insurance packages, some nationwide insurers provide affordable premiums by packaging the earthquake coverage as a non-negotiable part of the policy regardless of the actual risk of earthquakes. This means that property owners in areas where there is no danger of earthquake subsidize future payouts for earthquake losses.

In order to create somewhat affordable premiums with a broad enough market for risk-pooling, the insurers currently rely on contributions from both the government and insured parties. Governments can provide some security and incentive for insurers who offer earthquake insurance by either reinsuring certain high-level risk or by offering capital reserve-building tax benefits to insurers including relief from paying income tax on earthquake insurance premium income. Governments additionally provide some society-wide earthquake insurance by funding critical infrastructure retrofits to ensure

123 Id., at p. 191.
124 Id., at p. 208.
that bridges, road infrastructure, gas lines, and water lines are likely to survive a major earthquake impact.  

Like other kinds of insurance for “uninsurable” risks, earthquake insurance has its own challenges. One of the greatest challenges is to convince parties to purchase insurance since earthquakes are improbable risks. The second challenge is to ensure that insurers are actually setting premiums aside from its general pool into an earthquake reserve pool. The general perception in the industry is that earthquakes are distant dangers that do not require short-term financial planning. The final challenge is making sure that the reinsurance on earthquake risks does not result in a “house of cards” effect if one reinsurer was to collapse because it has assumed too much risk from irresponsible underwriters.

The challenges faced by earthquake insurers are informative for would-be insurers of climate change. Both events involve a high magnitude of damages with poor levels of predictability. While no one knows when or how likely it is that key ice shelves will melt, existing earthquake insurance schemes may provide lessons for how climate change losses can be insured. A viable climate change insurance scheme would likely include some form of government reinsurance, may need to be both mandatory and risk-differentiating to ensure adequate capitalization, and would require from its insured parties more preventive efforts such as “climate proofing.”

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125 Id., at p. 184.
126 Id., at p. 199.
127 Id., at p. 200.
One possible model for a climate change insurance scheme is the Japan Earthquake Reinsurance Company.\textsuperscript{128} This is a public-private model where the public and private sector share responsibilities for compensating for losses. When a homeowner purchases insurance for earthquakes, volcanic eruptions, and tsunamis, the private insurance company carries liability up to 75 billion yen for each earthquake. Anything above this sum and up to 1.0775 trillion yen are carried 50 percent by the insurance company and 50 percent by the government. Anything above this sum and up to 4.5 trillion yen is 95% carried by the government and 5% by the insurance industry. This model acknowledges that while the private sector has a critical role in loss management and prevention, the private sector will be unlikely to extend coverage for claims that may result in large losses. As the insurer of last resort, the government becomes the primary risk manager for large losses. By sharing the compensation for moderate sized losses, private insurers have an incentive to ensure insured parties minimize potential losses by earthquake proofing and dissemination of earthquake safety practices.

A second possible model for a climate change insurance scheme is the publicly managed but largely privately funded California Earthquake Authority which provides available earthquake insurance to every homeowner through a partnership of the state, primary insurers, and reinsurers.\textsuperscript{129} The Authority is able to offer a financially more accessible product to large numbers of homeowners by only insuring for a policyholder’s dwelling and not covering non-essential portions of a property including swimming pools, patios, and detached structures. It has collected its $8 billion of current funds from


\textsuperscript{129} http://www.earthquakeauthority.com/
earthquake-insurance premiums, assessments on participating insurance companies, reinsurance, and the return on invested funds. The agency does not pay federal income tax and is not permitted to file for bankruptcy.

Perhaps, similar Climate Change Authorities could be established at national, state, provincial, or regional levels depending on the interest and the perceived risk. The government could mandate certain basic coverage that must be made available by the authority or possible mandated by the state or province. In addition to contributions from the individual premiums, state legislatures might find a suitable source of funding from regional corporations that are major greenhouse gas contributors. A carbon tax on these corporations could be used to capitalize some portion of a climate change damage reserve fund.

An outstanding issue with the creation of an Authority is the adverse selection problem. Should subsidized insurance policies be made available to parties that might be able to participate in the private market to the extent that there is an available private market? This question is currently being hotly debated in Texas. The Texas Windstorm Insurance Association has been approached for policies by two windfarm developers with large projects proposed to be built along the coast in a coastal zone with a high-risk of windstorms. Should taxpayers be footing the bill for good development such as renewable energies in locations subject to objective climate risks?

Tying compensation to a tiered payout system and promoting products where both public and private sectors share responsibility has the potential to operate as a viable adaptation strategy where governments lack adequate disaster fund capitalization and the

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private sector is unwilling to fully finance unknown risks. While the role of insurance as part of an adaptation strategy supports a “business as usual” with some minor changes to meet agreed upon climate-proofing standards, insurance also has the potential to play a greater role in transforming “business as usual.” The following section examines insurance as part of a potential mitigation strategy for substantially reducing surplus greenhouse gas emitting activities.

**B. Insurance as Part of a Long-Term Mitigation Strategy**

Mitigation in the context of climate change refers to those strategies that reduce greenhouse gases. As the world’s largest industry, the insurance industry is a greenhouse gas emitter simply based on its use of products and services from other emitters including airline travel, electricity, and automobiles. The insurance industry could play some role in shrinking its greenhouse gas footprint as an emitter by reducing commute times for employees, creating conditions for more efficient computer server farms, reducing paper waste, or requiring teleconferencing rather than offsite meetings.

The insurance industry can also assist other businesses in mitigating their emissions through insurance policies designed to guarantee mitigation efforts or through policies that may motivate further mitigation efforts.

1. **Insurance Policies Designed to Promote Mitigation**

A number of insurers are beginning to release insurance policies related to mitigation approaches such as carbon trading schemes or clean development mechanism credits. For example, Swiss Re, one of the largest reinsurance companies, recently developed an innovative insurance product to manage the risks associated with the activities of RNK Capital LLC, a private investment firm focused on environmental
markets. The insurance product provides RNK with coverage in connection with project registration for Clean Development Mechanism (CDM) projects under the Kyoto Protocol and the issuance of Certified Emission Reductions.

Zurich Financial Services Group has recently announced a line of insurance relating to carbon capture and storage including financial assurances for geologic sequestration and political risk insurance for carbon credit projects. The insurance group offers political risk insurance for countries where political decisions might interfere with an investor realizing the benefits associated with earned emission credits.

Live Assets offers one of the more unusual insurance products with implications for climate change mitigation in countries with high coping capacity. The product insures against the loss of trees, shrubs, vines, and non-agricultural plants and flowers by freezes, hurricanes, fire, hail, and limited flooding. One climate change related business market for this product would be private forests on which carbon sequestration credits have been sold to provide carbon offsets. The insurance replaces damaged trees and will provide coverage of up to $10,000,000 per policy. $100,000 per tree and $1,000 per shrub or bush.

As the first forays of the insurance industry into climate change specific products, these products face similar challenges. They do not seek a holistic approach to mitigation reduction but instead approach climate change in a piece meal fashion insuring for investments or against unknowns such as the sequestration system. This approach may be

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132 http://www.liveassetinsurance.com
effective in securing society wide changes—only future claims will tell. Yet there seems to be a need for more coordination across products.

Other areas that insurers have expressed interest in developing additional products supportive of mitigation goals include insurance to protect investors who enter low-carbon technology markets, insurance to protect energy service industries in achieving energy savings, electrical reliability insurance for renewable energy sources, and insurance to guarantee the long-term stability of forest carbon sinks. Where disputes arise over claims, the legal community will play a leading role in interpreting the terms of these new insurance products.

2. Insurance Policies Designed to Motivate Long-term Mitigation

In 2007, the United States Climate Action Partnership (USCAP) issued a report with legislative proposals. Among the proposals were calls for emission targets and offsets, a cap and trade system, and periodic assessments. None of these are new ideas. But hearing these ideas from USCAP was unexpected since USCAP was a consortium of major greenhouse gas producers including among others Alcoa, Conoco Philips, BP, GM, Ford, Duke Energy, Rio Tinto, and Shell. Surprisingly, the companies agreed to the need for a “mandatory domestic climate program” with the cap and trade system meeting their preference.

Quick to point out that 20% of the global emissions are the product of deforestation and land-use change in the developing world, USCAP failed to mention in the report their members’ contributions to emissions. Instead, a tacit understanding runs through the report that companies are being socially accountable by pushing for a cap and

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133 Zurich Report, supra note 9 at pp. 11-13.
trade system that will affect how business is done in the US. The proposed targets for the cap and trade system coupled with USCAP’s version of offsets will bolster business as usual. For example, the proposed target for 2012 would be 97% to 102% of 2005 emissions and 2020 is 80% to 86% of 2005 emissions.¹³⁴

The rate that companies are willing to cut emissions is slow and choosing 2005 as a baseline date is self-servingly arbitrary. By 1995, states as signatories of the UNFCCC were well aware of the potential of greenhouse gases to destabilize the climate. Yet USCAP asks for a 2005 date knowing that supplies the cap and trade system with an additional 681.7 million metric tons of carbon dioxide equivalents.

Why this castigation of USCAP and its market actors? It is offered to suggest that self-policing in the field of greenhouse gas emission reductions is undesirable. We simply cannot slay the climate change dragon in time to avert the catastrophic increases in temperature if polluters make and enforce the rules. This subsection of this paper will review the evolution of the polluter pays principle and propose creating a system of mandatory nationwide corporate catastrophe risk insurance to address the problem of industry climate change externalities.

3. Polluter Pays Principle

While there is a lively controversy over whether the polluter pays principle is a binding principle, there is substantial literature identifying the principle as a general principle of law. The polluter pays principle emerged in the 1970s in response to pressures from environmental regulators for industries to internalize the costs associated with environmental harms.

When introduced as a governing principle for the OECD, the intent was for polluters to fully comply with existing regulations and to either absorb the cost of abating pollution as a capital expense or to incorporate the price of pollution abatement into the prices of goods and service.\textsuperscript{135} As the name of the principle suggests, individual corporations are held accountable for the environmental costs of their activities rather than the state and the individual taxpayer. States hold corporations accountable through user fees, taxes, product standards, removal of subsidies, regulations, and liability.

The concept has evolved over the decades from a pure cost-benefit allocation to a more holistic concept of corrective justice. The polluter pays principle is now understood as holding polluters accountable for the harm that they cause and not just for pollution abatement efforts. Policy makers and legislators no longer consider an industry’s use of the atmosphere as a free good.

The polluter pays principle is not without its vocal legal critics. Scholars suggest that the concept is not binding international environmental law because there is insufficient practice. Patricia Birnie and Alan Boyle propose that the OECD’s articulation of the principle when combined with the Rio Declaration’s general discussion of the principle,\textsuperscript{136} the weak citation to the principle in treaties, and the inconsistent state practice are insufficient to establish a customary law requiring the polluter to pay.\textsuperscript{137}

\textsuperscript{136} Rio Declaration Principle 16 “National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.”
In defense of the legal viability of the principle are scholars promoting the polluters pay principles as a corollary to the existing “no harm” discourses underlying state responsibility. States must be prepared to hold responsible those industries that cause harm to its citizens.

The polluter pays principle also has its strident economic critics. Since a polluter will arguably conduct activities up to the point where benefits equal the costs of a tax, user fee or expense to implement a regulation, it is possible that a polluter pays liability model would inadvertently diminish social welfare.\footnote{Dieter Schmidtchen, Christian Koboldt, Jenny Monheim et al. The Internalisation of External Costs in Transport: From the Polluter Pays to the Cheapest Cost Avoider Principle, Center for the Study of Law and Economics, December 2007 available at SSRN: \url{http://ssrn.com/abstract=1069622} at p. 64.} For example, in order to comply with a climate change regulation designed to reduce carbon emissions in order to protect against long-term sea level rise, it might be more efficient in terms of transaction costs for a large greenhouse gas emitting company to invest in building flood resistant structures rather than to redesign its product in order to reduce carbon emissions. While building flood resistant structures might avoid the harm associated with long-term sea level rise, this approach to avoiding harm is too narrow to deal with some of the larger ecological implications of climate change. Even though a hypothetical greenhouse gas emitters seeking a more efficient economic outcome has protected against the harm of loss of man-made property during a flood, the emitter has failed to protect the wetlands, deltas, and other natural environments.

In the context of climate change, the polluter pays principle should be more than simply an efficiency principle to shield the state and its citizens from the effects of
climate change. It can and should be used to stimulate conditions for a meaningful cap on carbon emissions.

4. Costs of Unmitigated Climate Change

In grappling with the scale of the climate change problem, economists have calculated the expenses and opportunity costs of doing business as usual. In his 2007 report, Nicholas Stern observed that climate-proofing existing infrastructure will be expensive for countries belonging to the Organization for Economic Co-operation and Development. With no differentiation between made between emissions being emitted today or 50 years from now, he expects OECD countries to spend from $ 15-150 billion each year (0.05-0.5% of GDP), with one-third of the annual costs being paid by the United States and one-fifth in Japan.139 Not all economists agree that the costs of climate change are as high. William Nordhaus argues that while climate change will have social costs, the social costs will be less extensive than those predicted by Stern.140

In recent reports in the United States, economists looked at the economic impact of climate change on two states. The authors conclude that doing nothing to mitigate for climate change will ultimately cost states such as Washington around $3.8 billion and Oregon around $3.3 billion141 in states that are experiencing in 2009 substantial budget

141 University of Oregon, Program on Climate Economics of the Climate Leadership Initiative, An Overview of Potential Economic Costs to Washington of a Business-As-Usual Approach to Climate Change http://climlead.uoregon.edu/pdfs/Inaction_WA_FnlRpt.pdf, p. 5 and 6 (Washington Report); University of Oregon, Program on Climate Economics of the Climate
shortfalls. If calculated on a per-household annual rate in Washington state, this would work out to approximately $1,250 for 2020 (2% of current median income) and, $1,800 for 2040 and $2,750 for 2080. The per capita climate change expenses in Oregon accounted for even greater amounts of median income. Most of the expenses in both states will result from additional energy and health care costs.

The state based report cited above looked at the effect that predicted increases in temperature, increases in storm events, and decreases in snowfall would have on both Washington and Oregon. By 2020, in Washington economists predict that the total annual costs associated with business as usual will be $222 million for increased energy-related cost, $35 million for decreased food production, $1.3 billion for increased health costs, $102 million for wildfire, and $72 million for increased storm damages. By 2020, in Oregon increased energy-related costs would cost $119 million (2020); reduced salmon populations would cost $632 million; reduced food production would cost $13 million; increased health-related costs would cost $764 million and; increased wildfires would costs: $206 million.

In calculating these numbers, the report authors took a conservative approach and did not estimate costs associated with other sources of economic damage from climate change including increased costs for air conditioning and refrigeration in transportation, increased pumping costs to replace surface water with groundwater for irrigation, increased costs associated with agricultural pests and diseases related to climate change,


142 Id. (Oregon report) at p. 4 and 5.
143 Id. (Washington Report) p. 6.
reduced productivity of rangelands, increased costs to bring warmer streams into compliance with water-quality standards, or increase insurance costs for storms, fires, sea-level rise and other effects of climate change. 144

While there are substantial differences among economists about how best to calculate the social costs of climate change, the Stern report, the Nordhaus report, and the more recent state based reports all share the message that climate change has measurable social costs including needed investments in infrastructure and increased “business as usual” costs (e.g. health, energy, food production). In the context of corrective justice and equity, who should carry the burden of these costs? As indicated above, the polluter pays principle, to the extent that it is a general legal principle, holds the polluter accountable for the social costs of climate change. One means of achieving this accountability is through carbon taxes where companies must internalize costs that were considered to be formerly free. A second means that could work in conjunction with a carbon tax is the introduction of a mandatory catastrophe risk insurance for companies considered to be major contributors to a nation’s greenhouse gas emissions.

C. Creation of a Mandatory Nationally Based Corporate Catastrophe Risk Insurance

The law and policy dialogues on mitigation for climate change are primarily conducted at an international level with scientists and policymakers seeking a uniform global limit to carbon emissions. After seventeen years of international discussion, it seems that international problems may not necessarily require international solutions. The search for international solutions has only led to repeated cycles of delay with new

144 Id. (Oregon Report) p. 6.
optimism at each UNFCCC Conference of Parties that states will implement radical carbon reducing policies.

Regulating the largest greenhouse gas producers has proved difficult because effective regulation requires challenging “business as usual” and creating new businesses. Existing and proposed market tools such as carbon markets are proving difficult to design and implement because of never-ending debates about optimal levels of carbon. While some oil production companies such as British Petroleum are trying to make a transition in the public eye from being an “oil company” to being an “energy company”, the transition remains unhurried as long as there is extant oil to be accessed, no carbon taxes, and no responsibility for climate-change induced damages.

With insurance agencies beginning to attribute particular disaster events to climatological factors (see Munich Re’s loss map on p. 72), it makes sense to reconsider what it means to hold a polluter accountable in the context of climate change.
Assuming that Birnie and Boyle are right and there is no international law obligation requiring polluters to pay, then the principles of state-oriented international law will be of limited application in the face of a climate change catastrophe. Yet this is an unsatisfactory result since it is clear that some private entities have been the true financial beneficiaries of the carbon economy. Is it possible to hold these entities responsible and accountable for the consequences of their business activities and
decisions? Since the UNFCCC in 1992 when it was apparent that greenhouse gases posed a long-term threat to both the human and natural environment, most business entities have done little to prevent additional emissions and have instead continued to accrue profits from environmentally damaging technology.

Even though international environmental law may not currently have a binding concept of requiring the polluter to pay for its harms, most states will hold civilly liable a party that knowingly causes harm. This means that the polluter pays principle remains alive as a national civil liability concept.

What does this mean in the context of climate change? If we accept two propositions: 1) that certain carbon or carbon-equivalent emitters cause atmospheric pollution not because of what they are emitting but how much they are emitting and 2) these carbon or carbon-equivalent emitters are or should be knowledgeable of the long-term impact of their emissions, then these emitters can be held accountable for losses attributable to their contribution to national emissions.

In the previous section of this article discussing insurance as adaptation for countries with a high-coping capacity, it is clear that some form of disaster insurance whether issued by the government or a private insurer is likely to be part of a larger risk management strategy. But is it fair for states to shoulder the financial costs of carbon pollution damages that have been caused largely by private entities?

This paper argues that one of the most efficient and effective mitigation instruments in states with high coping capacity is a mandatory catastrophe risk insurance scheme for all large emitters in those industries that have disproportionately contributed to emission increases. Instead of allowing companies to decide amongst themselves who
would be required to mitigate through an emission trading approach, a mandatory insurance scheme would require some mitigation on behalf of all large greenhouse gas emitters. The term “large greenhouse gas emitters” would be a legally defined term based on a dialogue between policymakers and scientists. The catastrophe risk insurance would both ensure that greenhouse gas emitters pay an equitable share of losses considered to have been triggered by climate change while providing a clear monetary incentive for companies to adopt future business practices that would decrease the amount of greenhouse gases emitted.

The mandatory nature of the insurance would fit with the current trends for requiring insurance to safeguard against corporate insolvency in the face of a manmade disaster. Legal precedent suggests that while the state will often shoulder the costs associated with “act of God” natural disasters, private insurers are expected to pay costs associated with technological disasters. With climate change, corporations are introducing new oscillations and perturbations to natural systems. The blessing and bane of our technologies have given us the ability as a species to impact our climate but not yet control our climate. Until humans can control the climate to protect against adverse impacts, the producers of greenhouse gas intensive products and services must be prepared to accept the potentially high price of technology.

Requiring mandatory insurance products such as catastrophe risk insurance to be offered by the insurance industry is controversial. In February 2009, insurers resisted being required to offer a product such as pay-as-you-drive insurance in order to reduce car emissions. David Snyder, a vice president with the American Insurance Association,

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claims that when the legislature creates mandatory policies it puts insurers in a “regulatory straitjacket.”¹⁴⁶ Yet without mandating a policy, there is unlikely to be either large scale behavioral changes leading to meaningful reductions in emissions or adequate capitalization for the insurance to be viable.

How would catastrophe risk insurance as a mitigation scheme operate? As part of its overall mitigation strategy, a high coping capacity state would pass legislation mandating catastrophe risk insurance for certain large emitters whose activities contribute to a state’s greenhouse gas emissions. A state could determine who is a large emitter either based on tons of carbon or carbon equivalent emitted annually (raw quantification approach) or on the percentage of carbon emitted annually (proportionality approach).

Insurers would calculate initial general premiums sums based on the corporate sector’s overall contribution to national emissions and expected financial losses resulting from predicted climate change catastrophe such as an anomalous heat wave, storm surge, ice storm or a series of class three plus hurricanes. Individual premiums would be based on risk-specific factor for each insured party. The individual risk-specific factor might be calculated based on a raw quantification approach (e.g. for premium insurance purposes if carbon is valued at X per unit, an entity would pay a risk-specific premium for volume emitted multiplied by X ), a proportionality approach (e.g. emitting 3% of the corporate sector’s carbon contribution would result in premium covering 3% of the expected damages assigned to the corporate sector), or some combination of the two. Using any of these approaches to calculate premiums should provide incentives to emission producing companies to focus either individually on cutting emissions or collectively to reduce the

corporate sector’s emission contribution. Currently, the consumption of electricity is responsible for 39.5% of the anthropogenic carbon dioxide emissions with over 80% of these emissions coming from coal-fired power plants.\textsuperscript{147} Any reduction in the corporate sector percentage would translate into reduced premiums for each company.

Initial premiums would be based on the operation and production activities of an industrial entity over the 5 year period prior to the implementation of the insurance. Subsequent premiums would depend on whether a company had increased or decreased its carbon share in comparison to both its initial baseline and to other national emission sectors. The idea behind requiring the insurance is to provide some tangible incentive for individual companies to cut their emissions while also continuing to hold large-scale polluters responsible for the harms caused by their ongoing activities.

i. Claims under Mandatory Catastrophe Risk Insurance

What kind of claims might be processed under this mandatory insurance and how would the claims be processed? In response to the first part of the question, claims for catastrophe risk insurance would not be available for damages alleged from before the policy was issued. This approach simplifies one of the recurring debates about extending climate change responsibility retroactively to cover the actions of historic emitters and avoids employing insurance as a form of reparation. Daniel Farber observes that while a reparation model of compensation has a certain moral appeal, such a model relies on connecting a specific damage to a specific wrongdoer and then somehow assigning responsibility through an indeterminate intergenerational approach. While the reparation approach satisfies the equity concerns of making the polluter pay, the approach raises

technical problems with attributing historical pollution since many previous polluters
have ceased to exist and the pre-1990 amount of emissions has been dwarfed by current
emissions. 148 A reparation approach also raises issues of whether we can hold parties
accountable when there was both conflicting knowledge of the long-term consequences
of greenhouse gas emitting activities and society wide approval of the economic growth
associated with the early carbon economy.

The only possible claimants under this insurance would be the state and federal
governments who are the first responders in the cash of a catastrophe, climate change
induced or otherwise. The state and federal governments are in the best position to
understand how much a given catastrophe costs a community and have the resources to
pursue and document the losses for a catastrophe risk claim. The catastrophe risk
insurance would make single payments to the government that would either be
reimbursals for work that the government agencies had done in response to a catastrophe
or disaster rehabilitation payments to individuals where the government was unable to
respond quickly enough to avoid losses. In the case of disaster rehabilitation payments,
the government would need to send someone to document the extent of losses.

In response to the second part of the question of how claims will be paid, this
paper proposes use an index-based approach for triggering payments of insurance claims.
This approach avoids problems of causation that are inherent in other liability approaches
such as nuisance. In the context of climate change liability, much has been written on the

892. (Scientists suggest that two-thirds of the greenhouse gases in the atmosphere by the
2020s will have been emitted post-1990.)
difficulty of causation and attribution. How can one reasonably trace a particular weather event to a particular set of greenhouse gases emitted by an identifiable defendant? Until we can successfully tag and color-code emissions, physicist Myles Allen proposes one potential methodology for attributing damage to anthropogenically caused climate change. He argues that even though we cannot know with certainty how greenhouse gas emissions alter the risks associated with events such as flooding, it may be able to work out a “mean likelihood-weighted liability” through averaging over all the possibilities. If Allen is correct about this, we can then calculate what percentage of a given event is attributable to climate change factors. If it is possible to assign a climate change attribution rate to any given event, then all that is needed to assign costs for damages in a nationally equitably way is the collective carbon share of all insured parties and the national carbon share for each insured party at the time of an event covered by the insurance policy.

But Allen’s probability and percentage approach could prove very complicated and would leave ample space for interminable legal wrangling about whether an event was actually caused by anthropogenic climate change. Instead, insurers could decide in concert with climate scientists, who are not employed by the government, what measurable environmental triggers would result in a claim. For example, heat waves of a certain temperature and duration in a particular location that result in damages might

150 Allen, supra note 148.
trigger a claim. This approach would enhance the objectivity of the claim process and would lend a strict liability approach to recovering damages under the insurance policy.

Even though damage recovery would be a more objective exercise for an index insurance product, setting the insurance trigger parameters would still remain a subjective practice. Creating reasonable climate-change attribution triggers would require a careful refinement of climate models coupled with eventual judgment calls by scientists. This trigger-based insurance approach avoids a constant battle of experts over each claim. Whether a trigger has been activated will be easily ascertainable. Without a formal finding by an expert or a judiciary, the events that trigger insurance claims would be considered for purposes of insurance payouts climate-change attributable events.

Setting appropriate triggers is likely to be primarily a scientific endeavor coupled with an economic judgment call. Arguably the insurance industry could set triggers that are unreasonably high such as 10 day heat waves of 150 plus in Anchorage, Alaska. While setting the triggers at this level would result in low premiums, which would be favored by the companies, it would provide no incentive for undertaking emission mitigation or other loss prevention measures. At the other extreme, setting the triggers too low would result in potentially multiple payments by insurers, high premiums, and a higher likelihood of insolvency on the part of both insurers and insured companies.

How would the government be able to collect either reimbursal or disaster payments from corporate entities on a claim? For illustration purposes, take the following hypothetical case. A heat wave hits Seattle, Washington with temperatures in excess of 125 degrees Fahrenheit over the course of five days. It results in $10,000,000 dollars of damages. Heat waves of greater than 115 degrees in the Seattle area that last for more
than 2 days trigger claims under the mandatory catastrophe risk insurances. Once the
government had demonstrated that the trigger elements in the policy had occurred, the
insurer would pay the claim for losses and damages attributed to the trigger elements
such as costs of acquiring water from another water district or the loss of lives during a
heat wave.

Even though not all of these emissions are from high-emission parties who are
required to carry insurance or from parties under the jurisdiction of the insurance scheme,
the insured parties would be responsible for some proportion of the losses. In the current
heatwave hypothetical, if 25% of the Seattle heat wave triggering emissions were
assigned to the insured parties, all insured parties would be collectively responsible for
$2,500,000.

Under the proposed catastrophe risk insurance, the state and insurance companies
would be able to collect from all indemnified in a single action. If all indemnified are
required to pay, then the insurance premiums become a type of carbon tax set by both
private insurers and the government as the regulator of private insurers. Because each
insured would only be held accountability for a proportional amount of the damages
associated with a particular event, then the government would have the option of seeking
indemnification only from those actors that it believes requires the greatest incentive to
change behaviors. For example, if power company A has made a concerted effort to
reduce its emissions by using alternative less polluting fuels and power company B has
continued to use coal-generated power plants, the government could seek indemnification
only from power company B with the intent that power company B would seek to
emulate power company A’s practices and avoid having to pay future indemnities. As
premiums climb for late-adopters of climate friendly practices, the market will demand emission reduction or large recalcitrant emitters will simply become less competitive.

The requirement for certain large emitters to have insurance coupled with the government’s ability to seek indemnity only from certain corporate actors has certain advantages. It means that not only will insurance companies be seeking systematic changes from its insured parties that reduce the amount of emissions, but the government will also be putting pressure on particular corporate entities to more rapidly adopt or develop emission reducing technologies.

How large of an insurance policy needs to be carried by each party could be calculated based on a company’s market share. Under the insurance scheme, each greenhouse gas emitting insured party has the potential to be held financially responsible for some portion of a climate-change induced catastrophe. To set a baseline for share in the carbon economy, insurance agencies might undertake audits of direct emissions for each insured. In subsequent years, insured parties would be required to submit updated third-party greenhouse gas reports calculated based on parameters established by the initial insurance audits. These reports could be used to monitor progress in reducing emissions. Market share audits would be the subject of heated contestation. Insurers, insured parties, and government environmental regulators are likely to dispute what is appropriately within the gamut of an audit designed to capture an entities contribution to national greenhouse gas inventories. For a company such as Wal-Mart, should they be held responsible only for the emissions associated with operating their chain of stores in the United States? Or should they also be held accountable for the emissions of their suppliers in China who are providing goods specifically to the U.S. market or the
transport emissions by third-party transpacific shippers who are contracted to move goods to the U.S. market? The federal legislature or state legislatures would need to make final decisions regarding which types of emissions would be covered. Arguably, most types of emissions associated with a product should be included so as to provide a realistic footprint of a given entity's production activities.

Since insurance is generally a nationally-based institution and states may not have access to insurance recovery in another country, it seems advantageous from the perspective of the state and the private insurers to be as inclusive as possible in defining the parameters of direct emissions to ensure that a company's insurance premiums and amount of coverage reflect the reality of a carbon-intensive global supply chain. In the case of a multinational such as Wal-Mart, if the emissions audit is restricted to its activities in the United States, it may have a relatively modest greenhouse gas footprint in comparison to other similarly sized industrial actors. But, when the focus is broadened to include all of its manufacturing and shipping activities across the world, the footprint becomes noticeably larger. From a pure carbon mitigation perspective, it makes sense to include the manufacturing and shipping activities as part of Wal-Mart's footprint because the strategy of using certain suppliers and internal shippers contributes overall to Wal-Mart's profit.

ii. Analysis of Mandatory Insurance Scheme as a Mitigation Strategy

The success of this type of insurance scheme as a climate change mitigation project that stimulates corporate behavioral changes depends on insurers setting accurate base premiums that would cover their projected losses in the event of a climate change catastrophe or other projected costs. If the insurance premiums become simply another
minor business expense, it will have little influence on promoting behaviors that will result in measurable emission reductions and will expose insurers to insolvency in the case of a claim.

In addition to addressing the nationwide equities of whether corporate polluters should pay for long-term damage, the catastrophe risk insurance policies might also be effectively used to address larger equity issues between currently industrialized states and states that have neither benefited from nor contributed to the carbon economy. A government may be entitled to seek through the insurance process a portion of any contributions it makes to global insurance pools for states with low coping capacity such as the Pacific Island states or Bangladesh. This would not only result in an implementation of the polluter pays principle but also would also satisfy the goals of distributive justice by transferring wealth to those communities where the global carbon economy has unfairly exposed individuals to human-created conditions of vulnerability.

The advantage of this insurance proposal is that it provides a fast-track approach for greenhouse gas mitigation with key roles for non-political agents to ensure compliance with insurer-insured negotiated mitigation targets. In fact, before such a mandatory insurance system would go into effect, insurance companies, seeking to manage its potential losses, might demand easy to implement risk loss measures from their insured parties (e.g. energy efficiency measures or investments in emission reducing production practices). In order to reduce initial premiums, companies may voluntarily undertake emission reduction measures before requesting a coverage policy.

This mandatory indemnity proposal avoids the problems faced in the aftermath of the Exxon Valdez disaster. The United States endeavored to make Exxon internalize the
costs of its dangerous activities by requiring Exxon to pay for the cleanup and restoration of the environment. The result was a “dilatory and inadequate response.”151 Here the Valdez problem is avoided because the large carbon emitters are internalizing the costs of cleanup and restoration before a potential disaster through the payment of annual premiums.

Because certain corporate entities are being targeted for participation in the program, certain equity dilemmas and issues of equal protection emerge. Any mandatory insurance system has to have parameters. In an ideal world of textbook equity, all corporate entities regardless of size would be required to undertake climate-proofing of their activities and to indemnify the government in the event of a climate change induced catastrophe without any distinction based on how much a given entity emits. This approach is, however, not feasible since the transaction costs associated with establishing a nationwide comprehensive program would be far more than the benefit accrued from requiring a single restaurant owner to reduce deliveries or a consultant to reduce face to face meetings.

In weighing the advantages and disadvantages of the proposed insurance system, two sets of questions emerge. The first set of questions address industry to industry relations. Will implementation of this insurance policy cause one set of industries to ultimately bear the responsibility burden that should be more broadly shared by other industries? For example, should the electricity industry have to bear the largest burden because its direct products and service are greenhouse gas intensive while other companies such as car manufacturers are only being held accountable for their direct

151 Birnie and Boyle, supra note 137 at p. 93.
production emissions and not for the indirect emissions resulting from consumers? Should car companies be held accountable for some additional share of emissions because they have demonstrated the capacity to produce low-emission vehicles and yet continue to manufacture fossil fuel driven vehicles to meet what they perceive as consumer demand?

The second set of question addresses the relationship between industry and consumers. Where a business is faced with new regulations and expenses, it frequently passes some portion of the costs onto consumers. In the context of climate change damages, it is arguably fair that automobile drivers, energy users, airline passengers, and other consumers of greenhouse gas-intensive products and services pay for the privileges of participating in the carbon economy. After all, as discussed above, the polluter should pay for harm caused by their choice of activities. But is it fair to allow corporations to pass on all of its costs to consumers when consumers had little to no influence over the design of the cars available on the market? How can our legal system truly hold a corporate actor responsible without triggering a ripple effect of responsibility that ultimately ends up in consumers funding catastrophe risk insurance costs through the future price of goods and services?

These are the dilemmas that will surface when trying to define specific rules for an insurance approach would combine carbon mitigation with long-term accountability. The focus on the relationship between climate change and insurance should be on these sorts of questions rather than the currently debated question of whether climate change as a phenomenon is insurable. Requiring mandatory catastrophe risk insurance for high emitters is not a silver bullet solution. But, the concept of requiring companies to take a
hard look at their emissions in the context of risk management has the real potential to catalyze timely emission reducing actions on the part of large emitters. In sum, corporate indemnity insurance is a reasonable approach to implementing the polluter pays principle in the context of the climate change crisis while providing needed capital to underfunded government disaster compensation schemes and infrastructure funds.

**Part 4-Insurance as Adaptation in Countries with Low Coping Capacity**

This final part of the paper focuses on providing compensation for the populations that are most likely to be affected first by climate change impacts and whose governments are unlikely to be able to cover the full costs of reconstruction after a disaster.

In the do-nothing or do very little scenario, the outlook for populations living in countries with low-coping capacity and high disaster vulnerability is discouraging. This part of the paper looks at the potential for microinsurance to contribute to both adaptation for countries that have the least capacity to cope with society-wide catastrophe.

What might happen in a worst case scenario in a country such as Bangladesh which is already struggling with a growing population living on inundated floodplains? Imagine forty years have elapsed. It is 2050 and while North America is battered by ever more intense storms and scorched by recurring droughts, Bangladesh is struggling both to stay above water and obtain enough water to meet basic needs.152 During the monsoon season, Bangladesh will receive too much water in the form of sea level rise and precipitation. Villages will be flooded and food crops will be destroyed by salt-water

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inundation. During the winter, the freshwater sources will be scarce since the glaciers that had previously fed the water sources have lost most of their mass. Without adequate water even for drinking, many of the basic health and hygiene practices that involve water will be ignored. Diseases such as dysentery will become rampant. Many of the almost 240 million Bangladeshis\(^{153}\) will be contemplating making the dangerous move across the borders to India even though India made it clear in 2007 that large influxes of environmental refugees are not welcome with its construction of a 2,100 mile border fence.\(^{154}\) States with equally limited coping capacity in other parts of the world will face equally daunting scenarios.

Even though there is a marked difference in ability to respond to a disaster, low capacity coping states face similar adaptation issues as high coping capacity states. What should low coping states be doing now to respond to an uncertain future with highly disruptive impacts? One option for low coping capacity states is to demand greater accountability from high-coping capacity states. High coping capacity states, many of whom are Annex I states, have obligations under the UNFCCC and Kyoto Protocol to finance and support adaptation measures under UNFCCC Articles 4.3, 4.4, and 4.5. A failure to do anything meaningful within the treaty architecture would be to reaffirm Ugandan President Museveni’s assertion that climate change is an act of aggression by the rich against the poor.\(^{155}\)

\(^{153}\) Currently there are approximately 142 million Bangladeshi people but the population is expected to increase in the upcoming decades.

\(^{154}\) India Fences off Bangladesh to keep Out Muslim Terror, The Sunday Times, November 13, 2005, http://www.timesonline.co.uk/tol/news/world/article589627.ece

Currently, low coping capacity states are seeking examples from high coping capacity states of how best to deal with large-scale natural disaster relief. The ability of fledgling insurance pools in low capacity coping states to offset the uncertain damages of climate change disasters has not been tested. One of the particular challenges is for low coping capacity states to fully fund local disaster relief efforts. For example, in India the budget for Calamity Relief Funds depends on what the historical average is for expenditures on natural calamity expenditures for the previous 10 years. Since this earmarking approach relies on historic information about disasters, the funds available in India may be inadequate to cover the cumulative sorts of damages envisioned by climate change scientists.\footnote{C.S. Rao, Managing of Extraordinary Risks Including Terrorism in India, Achievements and Perspectives, (OECD, ed.) \textit{CATASTROPHIC RISKS AND INSURANCE}, 2005, p. 394.}

If there are not enough funds to provide disaster relief, the world will face a refugee crisis of epic proportions. The current international climate change response funds including the specially designated UNFCCC funds (the Adaptation Fund to implement “concrete adaptation” programs, the Least Developed Countries Fund to support National Adaptations Programs of Action, and the Special Climate Change Fund for technology transfer and creation of new livelihood opportunities) have fallen short of expectations. High coping capacity countries have regarded these funds as extensions of overseas development aid. Contributions to the funds are regarded as voluntary donations rather than damage costs associated with responsibility or accountability for the current
state of the climate. Presently, the funds have $200 million dollars pledged until 2012; the expected costs for adaptation range between $9 billion and $41 billion.\textsuperscript{157}

While the funds have not been as successful as expected, states and academics have proposed a number of creative solutions for adaptation to address the challenges within low coping capacity countries. The following sub-sections describe several of the proposals in the literature with comments about the limitations on the proposals. The final subsection proposes a regional microinsurance approach that builds on the existing microinsurance proposals.

i) Alliance of Small Island States International Insurance Pool

In 1991, The Alliance of Small Island States (AOSIS) proposed the first funding scheme to ensure compensation for losses in certain low coping capacity states. AOSIS proposed that industrialized countries finance an international insurance pool to cover the damages caused by gradual sea-level rise in small-island and low-lying developing states.\textsuperscript{158} Intended as a political solution, the proposal was modest in its scope. An insurance entity under the control of the UNFCCC Conference of Parties would collect mandatory contributions from industrialized countries. Developing countries would conduct an audit of assets that would be potentially affected by sea-level rise and register the audit with an insurance entity. If sea-level rose to a certain negotiated level and the insurance entity determined that the loss or damage could not be avoided by earlier preventive measures, developing countries would receive payments from the fund.

\textsuperscript{157}Benito Müller, International Adaptation Finance: The Need for an Innovative and Strategic Approach, Oxford Institute for Energy Studies, EV 42, June 2008 at pp. 6-7.

In the original AOSIS proposal, much was left open to negotiation between the parties that would be making the payments and the parties receiving the payments. Items to be negotiated include what level of sea-level rise would trigger a claim and what constitutes a loss-reduction measure. While the AOSIS proposal has not been adopted since 1991, the idea for an international insurance pool remains alive.  

The AOSIS proposal has legal appeal because it meets the obligation of Section 4.8 UNFCCC parties to “give full consideration to what actions are necessary under the Convention, including actions related to….insurance… to meet the specific needs and concerns of developing country Parties.” Yet, the AOSIS proposal does not provide any mechanism to ensure accountability by non-state polluters. As a basic international environmental law concept, the polluter pays principle ensures that users and producers of pollutants and wastes bear responsibility for their actions. Under the AOSIS insurance pool, only industrialized states are responsible entities. While some of the greenhouse gas emissions are produced by the state either through the activities of its departments and ministries or through state-owned industries, most of the greenhouse gas emissions are the product of private companies and individuals. This leads to a disconnect between the entities who are most responsible for pollution and those who are being held responsible for the pollution.

In the context of international law, holding the state responsible simplifies the otherwise difficult task of figuring out which entities should be held accountable. The idea is that states will hold their domestic entities responsible for pollution. Yet, holding states singularly responsible for the consequences of climate adverse acts has the

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unintended result of permitting negative business externalities. Except in countries that
collect emission taxes that might cover the costs of participation in a compensation
scheme such as the AOSIS insurance pool, companies have no incentive for reforming
their business activities to reduce risks of climate change. Without pressure from states
and with no additional legal obligation outside of the more general polluter pays
principle, businesses will not transfer any profits from their emission intensive activities
to vulnerable states.

While it has been notoriously difficult to achieve international legal accountability
from companies especially multinationals, some companies have shown willingness to
participate in voluntary schemes. It may be possible to initially capitalize the AOSIS
insurance fund with donations from companies involved in the “Caring for the Climate”
initiative of the United Nations Global Compact.

ii) Regional Public-Private Partnerships

Some low coping capacity countries are managing their risks through public-
private partnerships such as the Caribbean Catastrophe Risk Insurance Facility (CCrif).
Established in 2007, the CCRIF insures governments by quickly providing short-term
liquidity in the event of a catastrophic hurricane or earthquake.

The long-term success of these partnerships remains untested. On one-level these
partnerships reflect the pragmatic future of risk-management in economies where
sufficient assets for adequate disaster payments cannot be segregated from the budget due
to more urgent pressures for limited resources. On another level, the power within these
partnerships remains uneven so that sovereign nations may in the event of a disaster find
themselves deferring to the multinational insurers who provide the necessary reinsurance.
iii) Climate Impact Relief Fund

Benito Müller has proposed since early 2000 the creation of a Climate Impact Relief Fund to ensure that adequate capitalization is available to respond to disasters in the developing world. Presently, disaster relief is coordinated by the UN Office for the Coordination of Humanitarian Affairs based on voluntary donations. He proposes instead a system of advance (‘up-front’) contributions, as opposed to retrospective (‘ex-post’) donations. As conceived, the fund would be capitalized by each country paying a proportional sum based on their differentiated responsibilities in causing climate change and their ability to pay.¹⁶⁰

Like the AOSIS proposal, this idea relies on funding from industrialized countries. Unlike the AOSIS proposal, countries designate their contributions for administration by a UN agency rather than claims under an international insurance pool. While the proposal is somewhat vague about which nations will be responsible for financing the fund, the proposal makes the suggestion that only Annex 1 and OECD countries might pay into the fund. This approach is unacceptable for countries such as the United States that have insisted on global emission targets for heavily industrialized developing countries such as India and China. While the United States might contribute disaster relief funding to a UN agency, it would also expect some meaningful contribution from rapidly developing nations.

While Müller’s idea has not been adopted as proposed, the World Bank has created a partnership with the United Nations International Strategy for Disaster Relief to

create the Global Facility for Disaster Reduction and Recovery (GFDRR). One of the primary projects of this facility is to leverage country resources for ex-ante investments in disaster prevention and mitigation activities in order to manage risks such as sea level rise and hurricanes. For low income countries the GFDRR will provide disaster relief but only if a certain portfolio of pre-disaster mitigation instruments are implemented.

iv) Modified Insurance Scheme

Building on the work by Müller and the AOSIS scheme, Christoph Bals has proposed a global catastrophe insurance program to cover the losses of infrastructure in least-developed countries. The program would be administered by a public and private entity. Countries would pay into the scheme based on a risk-based premium depending on their emissions. To be eligible for post-disaster indemnities for infrastructure, recipient governments would be required to take specified measures for preventing disaster losses. Insurance would be limited to low-probability, high-consequence events. Governments could optionally purchase commercial insurance for lower-impact, higher frequency weather events.

v) Tiered Insurance Strategy

Joanne Linnerooth-Bayer and Reinhard Mechler at the International Institute for Applied Systems Analysis (IIASA) propose a two-tiered climate change insurance-related mechanism. The first tier provides support for insurance initiative undertaken by developing countries such as the regional insurance pool in the Caribbean and index-

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161 http://www.unisdr.org/eng/partner-netw/wb-isdr/wb-isdr.htm
162 Christoph Bals et al. Insuring the Uninsurable: Design Options for a Climate Change Funding Mechanism, Climate Policy 6, (2006).
163 Joanne Linnerooth-Bayer, Reinhard Mechler, Insurance for Assisting Adaptation to Climate Change in Developing Countries: A Proposed Strategy, Climate Policy 6 (2006).
based insurance mechanisms. The first tier would share responsibility at the local, national, and global levels in a stand-alone global insurance facility. Insurance would be available to cover losses associated with property, crops, health impacts, public infrastructure damages, and government relief spending. The second tier is a global relief fund. Developed countries could contribute voluntarily to cover losses that are otherwise uninsurable. The second tier would be similar to calls for post-disaster relief from humanitarian agencies except that the relief would be available only to those countries who could demonstrate some risk reduction behavior.

vi) Global Index Insurance Fund Facility

While not as expansive as Linnerooth-Bayer and Mechler’s proposals, the World Bank through the International Finance Corporation has formed a Global Index Insurance Fund Facility to underwrite indexable weather and other indexable natural catastrophe risks in developing countries.164 The European Commission provided €24.5 million in funding as the first donor for the Global Index Insurance Facility (GIIF) to provide compensation for certain types of climatic damages in African, Caribbean and Pacific countries.

vii) The Munich Climate Initiative

The Munich Climate Initiative has two pillars: a prevention pillar and an insurance pillar. The prevention pillar provides for risk management assessment for vulnerable countries including recommendations for risk reduction. Participating in the

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risk pillar portion of the program may serve as a qualification for participation in the insurance pillar.

The insurance pillar covers two types of risk associated with adaptation: extraordinary risk and “middle level” risk. Extraordinary risks are risks that no single country can pay from its own resources. “Middle level” risks are risks which cannot be prevented but which a country should have adequate resources to cover. As envisioned, the extraordinary risks would be covered by a Climate Insurance Pool (CIP) which would indemnify developing country property and infrastructure (and potentially lives and livelihoods) against low-frequency, high-consequence events. This tier is financed by annual contributions from a post-Copenhagen multi-lateral adaptation fund, which itself will likely be financed by Annex 1 countries. Governments receiving the funding would be required to submit to risk-reduction measures.

The “middle level” risk would be covered by a Climate Insurance Assistance Facility (CIAP) that would provide support for risks not covered as extraordinary risk. It would provide support for the capacity building and technical support of disaster insurance systems but would not provide any insurance to individuals or governments.

**A. Role for Microinsurance in Climate Change Adaptation**

Implementing any of the ideas described above would be better than the current disaster funding situation for many countries. In terms of promoting climate change adaptive behavior and ensuring equity between high emitters and low emitters, the most attractive of these insurance ideas is a regional microinsurance approach. This section will describe the idea of microinsurance. The following section will review the

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165 The CIAP is based on a proposal by Linnerooth-Bayer and Mechler.
advantages and disadvantages of microinsurance and the final section proposes a regionally based carbon tax financed microinsurance scheme.

Microinsurance is an insurance tool for “the protection of low-income people against specific perils in exchange for regular premium payments proportionate to the likelihood and cost of the risk involved.” It is provided through various organizations such as credit unions and microfinance institutions. Depending on its constituency, it can be risk specific or priced at a flat-rate. It is often relied upon when government schemes cannot extend adequate social protection to the poor.

Microinsurance has the potential to alleviate some of the future stress from risks that are capable of being quantified. The development of climate change risk-specific microinsurances could become an extension of existing coping strategies. The first major challenge for microinsurance is developing an institutional framework. Currently, low-income sectors of society manage their risks by a combination of self-insuring through family/friends, saving for future expenses, and money lenders and informal welfare associations. Among low-income groups, formal insurance has only been introduced recently and is usually linked to microfinancing. Several groups require borrowers to

obtain life insurance as a condition of receiving a microfinance loan to ensure that a loan will be repaid in the event that a borrower dies.\textsuperscript{169}

A second major challenge faced by microinsurance markets is educating would-be insured parties about the value of “paying premiums for an intangible product with future benefits that may never be claimed.”\textsuperscript{170} For example, in field studies in Uganda, policyholders who received insurance linked to their microfinance loans did not know how much they were paying for the insurance, what was covered, or how to make a claim.\textsuperscript{171} Even where parties understand how to file a claim, the time for settlement of a claim may be lengthy because of institutional delays. For example, one microinsurer has seven persons processing each claim leading to claims being paid an average of 278 after the triggering event.\textsuperscript{172} This challenge of creating value in a product is particular acute in the case of developing a self-sustaining product to tackle the potential damages of climate change. This challenge is accentuated by how little is already insured in the developing world. In 2002, only 4.8 percent of losses in Asia and 1.1 percent of losses in Africa were insured against losses from natural disasters.\textsuperscript{173}

Even with these apparent market limitations, microinsurance may still be part of long-term adaptation for impacts associated with climate change. One of the most common types of microinsurance is index-based insurance also called weather

\textsuperscript{169} Id. at p. 35.
\textsuperscript{170} Churchill, supra note 166 at 20.
derivatives. This type of insurance is based on a particular event such as a heat wave occurring within a particular time range. If a given event against which insurance was purchased happens, an insured party will receive a certain negotiated payout irrespective of their actual losses. In lower-income countries without an insurance culture, index-based insurance is considered more attractive than traditional insurance because it reduces the degree of moral hazard and preserves the incentive to prevent and mitigate risks.

There are presently approximately thirty existing or proposed index-based insurance schemes that cover events such as drought, hurricanes, earthquakes, and flood. For drought-based products, the index measure is the amount of rainfall or the area yield production. For flooding the index measure is the amount of rainfall or the level of the river. These insurance schemes are targeted primarily at smallholder farmers and livestock breeders with a couple insurance products designed for state agricultural banks.

The technical challenge with index-based insurance is that unlike a mutual insurance companies where parties agree to see what will happen with future risks, the index-based insurers must calculate in advance what trigger will result in payments. This is challenging when historical records vacillate between different highs and lows. For example, for a hypothetical index-based insurance product for drought in the Sahel region of Africa, insurers would need to calculate a trigger. If they used rainfall as the trigger, they would be faced with arbitrarily choosing a trigger if they relied on historic data since

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the average rainfall depends over which historical period you measure. If you measure from 1900-1957, there was an average rainfall of 500 mm. Between 1960-1989, there was a precipitous decline in rainfall to an average of 310 mm. Since 1990, there has been a slow increase in rainfall for an average of 450 mm. If you set the trigger point too high, then no one will buy the product. If you set the trigger point too low, then the insurance will no longer be a viable product. The study authors concluded that index-based insurance tied to historical records would be difficult to administer and potentially “likely to delay adaptation.”  

Would-be insurers remain frustrated in their efforts to calculate adequate pricing models that will be dynamic enough to compensate for changes in weather patterns.

As part of their corporate citizenship initiatives, corporate foundations and insurance companies are financing products that address the need in developing countries for some degree of financial security in times of food insecurity. For example, in collaboration with the NGO Earth Institute and the Millennium Promise Alliance, Swiss Re created an index-based insurance to cover drought-related food shortages in three village clusters situated in Kenya, Mali, and Ethiopia. The payout of the derivatives depends are tied to satellite and weather data. If rainfall falls below the level needed for staple crop production, participants will receive compensation. Swiss Re also agreed in collaboration with the same partners to develop and implement climate risk indices for

175 Id. at pp. 100-103.
pre-selected groups of at-risk villages Ethiopia, Ghana, Kenya, Malawi, Mali, Nigeria, Rwanda, Senegal, Tanzania and Uganda.\textsuperscript{177}

Based on this information Swiss Re has participated in a number of anti-poverty initiatives. In 2008, Swiss Re agreed to provide coverage for the World Bank for its derivative program in Malawi linking rainfall and maize production indices. If maize production falls to 10\% below the historical average, farmers will receive the maximum payout for their crop.\textsuperscript{178} A similar project was initiated with Oxfam in Ethiopia.\textsuperscript{179}

Even while pilot projects based on index-insurance models are proliferating, there remains some reservations among agricultural economists that traditional crop insurance may be more effective than index-insurance in managing long-term risks.\textsuperscript{180} Since many of the index-insurance projects are quite new, the actual success of these projects in terms of compensating policyholders and encouraging climate change adaptive behavior remains to be measured.

\textsuperscript{178} Swiss Re enters into a weather derivative contract with the World Bank covering drought in Malawi, (October 20, 2008) http://www.swissre.com/pws/media%20centre/news/news%20releases%202008/mi_ida_20081020.html
B. Advantages and Disadvantages of Microinsurance

The primary advantage of microinsurance from the perspective of a victim is the victim’s ability to directly obtain relief from a private insurer who has made a binding commercial promise to pay for damages. In countries where either the government does not deliver expected services to its citizens or the government treats citizens groups differentially, there are obvious measured advantages in being able to collect claims from a trusted private entity rather than an indifferent or discriminatory government. The interests between poorer countries and poor people are not always allied. One scholar observes that “if the global poor are to adapt to global change, it will be critical to focus on poor people not on poorer countries.”\(^{181}\)

Self-insurance makes socio-cultural sense to groups throughout low coping capacity countries. To a certain extent, it is how people have always insured in countries where there is no government relief—people have instead relied on the solidarity of their families and kin groups to provide monetary relief in times of disaster. Microinsurance is an extension of existing self-insurance schemes.

Microinsurance is viable in low-capacity coping countries because the basis for return on an investment is based on volume of sales not on per unit profit. The more people who are protected by a product, the more closely microinsurance can adhere to the Law of Large Numbers which is essential for efficient risk-sharing.

As part of poverty alleviation and climate adaptation strategies, microinsurance faces certain challenges. How can premiums be kept affordable without subsidies? How can insurers avoid moral hazard among the most vulnerable members of the population?

so that insured parties do not engage in unnecessarily risky behavior? These challenges require certain ideological shifts. To address the disparity in premiums, the wealthiest of a nation may need to subsidize insurance contributions for the poorest. This may unpalatable in countries where the poor drastically outnumber the rich. To address moral hazard, the poor will need to approach risks as stakeholders in a larger solidarity movement. Insurance must not be considered a safety net for poor choices that party would not have otherwise made without insurance. This mindset may be difficult to achieve in conditions of poverty where parties are simply trying to survive.

In the specific context of compensating for climate change related damages, one additional disadvantage of current policies of microinsurance is that the insured party is expected to cover some or all of its own premiums as with traditional insurance policies. From an environmental equity perspective, microinsurance approaches including index-based insurance fail as fair compensation solutions because they ignore the fault of both domestic and international polluters in triggering long-term changes in food systems and weather patterns. When insured parties are expected to cover even some portion of their premiums, microinsurance results in the victim paying rather than the polluter paying.

The promotion of microinsurance as either self-insurance or NGO funded insurance avoids the difficult assignation of responsibility and accountability by shifting responsibility for consequences from the parties that have been the largest stressors on the climate to groups that have not contributed measurably to risk of climate change. NGOs should not be the largest subsidizers of the self-insurance projects. Instead polluting entities should be held responsible for the benefits that they have received from externalizing costs.
C. Regional Microinsurance

This subsection explores the logistics of developing a regional microinsurance for citizens of low-capacity states who are vulnerable to climate change impacts.

1. Regulations

To the extent that low coping capacity states lack the resources to provide adequate compensation after a climate-change induced catastrophe, low-capacity states may be able to rely on a market of microinsurance to supply compensation to individuals. To foster microinsurance networks, these states may need to develop additional regulatory frameworks to supervise microinsurers. Currently, many microinsurers operate informally outside of insurance laws which has the advantages of reducing transaction costs and allowing organizations to grow without having to meet difficult regulatory requirements such as minimum start-up capital reserves and licensing for insurance agents. As uncertified organizations, microinsurers, however, have no access to reinsurance as an additional level of risk-pooling.\(^\text{182}\) Some sort of balance needs to be struck between non-regulation and overregulation of the microinsurance industry.

A handful of countries have microinsurance regulations including India, Morocco, South Africa, Trinidad & Tobago, and the Philippines. For example, India’s 2005 regulation created a new legal entity called the microinsurance agent to create relationships between regulated commercial insurers and unregulated organizations.

offering microinsurance schemes.\textsuperscript{183} Under the regulations, the government designated minimum and maximum sums that could be insured under a microinsurance policy as well as maximum amounts of remuneration for microinsurance agents.\textsuperscript{184}

Microinsurance has an active market share in India because the state requires certified commercial insurance companies to offer programs that target low-income populations or pay penalties to the Insurance Regulatory and Development Authority.\textsuperscript{185}

In the Philippines, the Mutual Benefit Association Act governs microinsurers.\textsuperscript{186} The law requires each association to deposit a few hundred dollars as initial capital and then at least 10 percent of its assets. The primary product for these organizations is life insurance and all association members must participate. Associations must set aside half of the gross premiums for member equity to cover potential temporary loans to party whose insurance coverage has lapsed. The associations have different business rights and obligations from other commercial insurance companies. One unique feature of the associations is the requirement to refund all or part of insurance premiums paid after a party has been insured for several years with an interest payment. In the case of the Philippines, microinsurance becomes akin to a long-term investment for individuals.

2. Premiums

Self-insurance in low capacity coping countries might be equitable in the context of international environmental justice if someone beside the victimized farmer or homeowner pays the bulk of the premiums. In 2006, the Swiss Government began

\begin{footnotesize}
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\item \textsuperscript{183} Insurance Regulatory and Development Authority Microinsurance Regulation, Hyderabad, November 10, 2005, ADVT III/IV/161/2005/Exty.
\item \textsuperscript{184} \textit{Id.} at Schedule 1, Schedule 2 and Paragraph 12.
\item \textsuperscript{185} Wiedmaier-Pfister and Chatterjee, \textit{supra} note 182 at p. 502.
\item \textsuperscript{186} Chapter VII, Philippines Insurance Act, Section 390-409.
\end{itemize}
\end{footnotesize}
promoting a uniform global carbon tax of $2 on all fossil fuel emissions with an 
exemption of 1.5 tons of carbon dioxide per person.\textsuperscript{187} The money would be split between 
National Climate Change Funds and a Multilateral Adaptation Fund.\textsuperscript{188} In January 2009, 
the European Union circulated a draft paper describing its proposal to be formalized at 
the UNFCCC conference of parties in Copenhagen of raising 164 billion Euros ($213 
billion) through a carbon tax.\textsuperscript{189} For every ton of greenhouse emissions, countries would 
pay 1 euro per ton until 2013 and then 3 euros per ton until 2020. The funds raised would 
be generally spent on adaptation and mitigation in the developing world presumably 
through either a donation to UN funds or through EU aid.

Instead of going to large infrastructure projects, the bulk of the proposed Swiss or 
EU carbon taxes could be used to fund premiums for microinsurance policies that are 
available to protect vulnerable individuals and their subsistence property in those regions 
that are expected to experience the early consequences of climate change as listed in 
UNFCCC Article 4.8. Funding such microinsurance programs with carbon taxes would 
assure individuals in the most vulnerable areas that there will be some financial security 
in the case of a catastrophe beyond the social solidarity of villagers assisting each other.

Research indicates that existing microinsurance programs such as the Malawi 
index-based insurance for crop protection is highly vulnerable to climate variability. 
Without additional funding, existing insurance pools may be subject to climate change

\textsuperscript{187} Othmar Schwank, and Samuel Mauch (2008), Funding Scheme for Bali Action Plan 
A Swiss Proposal for global solidarity in financing adaptation, Bern, May 27, 2008, p. 5 
at www.bafu.admin.ch/klima/index.html?lang=en&download...pdf
\textsuperscript{188} \textit{Id.} at p. 7.
\textsuperscript{189} Communication from The European Commission to The Council, The European 
Parliament, The European Economic And Social Committeem And The Committee Of 
The Regions, “Towards a comprehensive climate change agreement in Copenhagen”, 
induced insolvency.\textsuperscript{190} This proposal of transferring wealth from carbon taxes to microinsurers is in line with certain types of existing microinsurance such as hunger insurance for Ethiopian farmers. This insurance is currently available because of earmarked donor subsidies through the World Food Program.\textsuperscript{191}

Using a microinsurance approach targeted at individuals rather than a macroinsurance approach targeted at funding government-run aid may prove more effective in delivering immediate direct compensation after an event to affected individuals. The microinsurance approach also has the added advantage of generating a new indigenous service industry that can promote long-term loss-prevention behavior such as requiring insured parties to raise their houses a certain distance of the ground in a flood-prone area or an area where sea level increase is expected. Subsidies from carbon taxes could be provided through the microinsurers to stimulate these adaptations.

3. Index-Based Insurance

If the focus is on distributing funds from the polluters to the vulnerable individuals and populations, microinsurers might be required to offer certain types of insurance. Given the difficulty of attributing a particular event to climate change, it makes sense for climate change microinsurance policies to have agreed upon “subsistence” triggers for coverage as is common with the index-based insurance and weather derivatives covered by the Global Insurance Index Facility. For example, where floodwaters reach a certain elevation or droughts last a certain length of time such as to

threaten basic subsistence needs, claims will be paid even if individuals do not experience actual losses in subsistence. This trigger-based component of the microinsurance is necessary to provide some incentive for individuals who experience multiple disaster events to remain where they are and collect insurance payments rather than become environmental refugees.

In order to avoid post-disaster opportunistic behavior, insureds will need to acquire policies before a disaster. In order to acquire a policy, they will need to provide some sort of record that what is being insured exists. Otherwise an insured may claim to have planted 5 acres for the subsistence needs of his 15 family members even though he only planted .5 acres for himself and his wife. Microinsurers have an incentive to make sure that any claims made are legitimate since any money paid on fraudulent claims is money lost by the insurer from its own revenue.

4. Analysis

Like the proposal made by Christoph Bals for Germanwatch, this insurance scheme has certain implementation challenges including the large amount of administration to ensure reliable transfers between the carbon tax collection agencies and the microinsurers and accountability on the part of microinsurers to their insured parties.

This proposal is similar to Joanne Linnerooth-Bayer and Reinhard Mechler’s First Tier proposal for a global insurance facility and the existing Global Insurance Index Fund. The major difference is that the focus of the regional program would be limited to ensuring the ability of microinsurance agencies to finance and cover specific damages tied to the subsistence needs for each insured regions. For example, one region may focus insurance products on livestock while another focuses on fisheries.
Critics may argue that continually subsidizing a micro-insurance program is no different than international aid assistance. In terms of wealth simply being redistributed from certain parties to certain recipients, this may be true. But when examined from the perspective of how the wealth is being redistributed, microinsurance is qualitatively different from standard government to government or government to intergovernmental organization aid. Unlike these other forms of aid, microinsurance gives the most vulnerable individuals access to a larger network of disaster relief including not just the microinsurers but also multiple reinsurers. Subsidized regional micro-insurance might be administered through an institution such as the recently created Global Insurance Index Facility. The focus with microinsurance becomes not the state but the individual in their local communities.

No public infrastructure or commercial business losses would be covered under this proposal. Instead, these losses could be covered by institutions such as the EU proposed multilateral insurance pool designed to provide a risk sharing mechanism to cover natural disaster losses in vulnerable countries.  

5. Microinsurance as Adaptation

Certain regions of the world will bear the brunt of impacts from climate change such as Bangladesh. Under an ordinary microinsurance scheme, the insured parties would receive payments each and every time a calamity occurs. This would mean that unless index trigger are ratcheted up after each calamity, certain insured parties will be able to make repeated. How can long-term adaptive behavior be encouraged at the individual level so that the microinsurance industry can also survive a series of calamities?

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One possibility is for insurers to provide *ex ante* funds to cover needed and inexpensive adaptation measures. For example in a flood prone area, funds could be given to raise a house further off the ground or to reforest denuded areas. Using these funds to undertake adaptation projects would be a condition precedent for any policyholder to receive any further insurance money in the case of a disaster. Because of the tremendous need for these types of funds across the low capacity coping groups, the distribution of funds would be ideally prioritized based on the vulnerability of a particular community to climate related impacts, the size of the population expected to be impacted, the predicted timing of impacts, and the capacity of a community microinsurer to insure that required adaptation measures are adequately implemented.

Providing incentives to vulnerable groups to stay in their existing communities and villages makes sense. Without any incentive to remain in risky areas, vulnerable groups will move away from areas that increase their vulnerability to climate change impact. Yet, any mass migration that redistributes populations has the potential of putting undue social stresses on other areas. Joanne Linnerooth-Bayer and Anna Vári observe in their research in one of the poorest regions in Europe, the Upper Tisza River basin in Hungary, that the option of moving large populations is not viable even among countries with a high coping capacity. Relocation of populations is impossible in a country where 50 percent of the territory is vulnerable to flooding leaving poor residents dependent on the charity of already stressed urban centers.\[^{193}\]

Much has been written about how best to cope with environmental refugee who are migrating due to unexpected effects of climate change. In March 2009, at a non-state international climate change conference convened by climate change researchers, the issue of mass migration was on the table for discussion. One researcher proposed that rich countries accommodate future climate refugees on their soil according to their historical share of greenhouse gas emissions. While fellow experts may have seen this as a good ethical choice for dealing with the impacts of climate change, states are likely to be far less sanguine about the political prospects of opening borders to some of the poorest people of the world. As noted earlier, countries like India who have been experienced positive economic growth over the last decade are busily erecting walls with its poorer neighbors rather than providing relief.

The proposal of *ex ante* funding for microinsurance policies for vulnerable groups addresses some of the ethical considerations that academics have identified as important in choosing adaptation strategies. In a paper on the social justice implications of adaptation, researchers identified an ethical adaptation strategy as one that avoids harms, reduces risks, reduces vulnerability, and supports human rights. Here an *ex ante* intervention prioritizes avoiding harm over simply compensating after the fact. To the extent that mitigation would be part of the insurance approach, climate change microinsurance should reduce risk rather than transfer the risk. *Ex ante* structural improvements coupled with evacuation plans should reduce vulnerability to certain types

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194 Jean-Marie Macabrey, Scientists are grim, economists more optimistic about climate change's effects, New York Times, March 13, 2009.
climate change induced risks while increasing the capacity of groups to cope with climate change impacts. Finally, microinsurance schemes unlike traditional government-distributed humanitarian aid have a greater potential to foster a more transparent dialogue between insured parties and local insurers about risk management practices.

Part 5- Mitigation and Adaptation in China

In the spectrum of mitigation and adaptation capabilities, what kind of country is China: a high-coping capacity country or a low-coping capacity country? The answer depends on where you are in China. Among the skyscrapers and office towers of Shanghai belonging to multinational financial giants, China appears to be a high coping capacity state. Among the communities of Sanbaihu village where the average farmer survives on less than $1 a day, China appears to be low coping capacity state. Given its size both physically and demographically, China is best characterized as a mixed coping capacity state. Like many other high capacity coping state, it thrives on the carbon economy and has functioning insurance schemes. Like many low capacity coping states, it has vulnerable populations who live outside the carbon economy and who lack any long-term strategies for adaptation.

What is China’s approach to climate change mitigation and adaptation? China, the smoking dragon, seems to have adopted a general climate risk policy of waiting and seeing what the future actually brings. This approach does not bode well for China or other states especially since the Chinese Academy of Sciences issued a sobering

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prediction: China’s carbon emissions may double in the next two decades.\textsuperscript{197} While China has established some targets, there is little apparent economy wide movement to achieve the targets.

What should China be doing if it won’t directly regulate its manufacturers emission and does not seem ready to implement a cap and trade system? In those parts of China that have succeeded in achieving the benefits of industrialization, China should respond domestically to climate change impacts through a government system such as those described in Part 3 which might include indemnification by private emitters who fail to make changes needed to achieve nationwide targets. If the worst-case climate scenarios come to pass, China will be confronted with large-scale damages and its citizens will look to the centralized government for disaster relief. China is no stranger to meteorological disasters and is cognizant of the impact of ongoing environmental degradation on its ability to respond effectively to disasters. Yet, the government has not allocated sufficient funds to meet ongoing disaster relief needs.\textsuperscript{198} Some government departments are beginning to explore possible synergies between large scale disaster relief and private insurance. The Deputy-General of the Chinese Department of Disaster and Social Relief observed in 2005 that “[I]t is an urgent…for the government and business society to form jointly an insurance mechanism to cope with disaster relief and recovery processes.”\textsuperscript{199}

\textsuperscript{198} Y. Zheng and J. Mu, Natural Disasters and Disaster Relief Policy in China, (OECD, ed.) \textit{CATASTROPHIC RISKS AND INSURANCE}, 2005, p. 377
\textsuperscript{199} \textit{Id.} at p. 379.
For those parts of China that have not shared in the success of globalization and wealth distribution, states should encourage the Chinese government to develop a microinsurance industry that could be funded either through revenue generated from carbon taxes or through international carbon fund. Given its role in perpetuating the carbon economy, Chinese industries making profit from the carbon economy should be required by their government to pay carbon taxes on their emissions that would be distributed within China to fund premiums for microinsurance funds.

Yet, at this juncture in history, the idea that Chinese industries might voluntarily participate in a nationwide disaster relief insurance scheme or in paying a carbon remains fanciful. In a country where the skies are black with particulate dust and the rivers are filled with colorful and noxious chemical byproducts, it is somewhat naïve to expect to be able to effectively implement the polluters pay principle for invisible carbon and other greenhouse gas emissions. Unlike in countries where the regulators have demanded accountability from polluters, China fosters a culture of non-enforcement because the private economic actors are far more vocal and powerful than the handful of national environmental actors attempting to implement laws and regulations requiring the polluter to pay.

Why should private industries in China submit to regulation? A March 2009 report from Maplecroft, a British risk management consultancy, sheds some light into the haze by announcing that China along with the United States, the world’s two largest greenhouse gas emitters, will have the largest economic losses associated with weather-related events that may be attributable to climate change. According to Maplecroft, the United States between 1980 and 2008 suffered economic losses of $18 billion due to
natural disasters, China suffered $10.7 billion over the same time period. Even though
many of China’s economic losses from the report can be attributed to earthquake
damages, a large amount of the damage was also the result of hurricanes, typhoons,
floods, landslides, forest fires and other weather-related phenomena. 200

What options do states have to pressure China to mitigate its rapidly exploding
emissions since the UNFCCC and Kyoto Protocol are currently toothless? The only real
option is to challenge China’s freedom to trade and for a coalition of states to
multilaterally reduce trade with China until China is able to demonstrate some effort to
reign in its greenhouse gas belching dragons.

What a trade challenge might look like is an interesting question and provides an
interesting subject outside the scope of this paper. A few observations of recent events
might provide a framework for thinking about a trade challenge. In January 2009, the
WTO decided that China must enact new and more effective laws to bring China into
compliance with its WTO and public international legal obligations. 201 Perhaps a similar
challenge could be made under the WTO or under a new multilateral environmental
agreement. Where two nations are both signatories to a multilateral environmental
agreement and the WTO, it may be possible to argue that environmental agreements
should operate as lex specialis to qualify a nation’s trade obligations. 202 China is a party
to the UNFCCC and the Kyoto Protocol and will likely become a party to whatever

200 Nathaniel Gronewold, U.S. and China most exposed to costs of climate-related
201 China Vows Copyright Cooperation after WTO case, January 27, 2009, available at
http://uk.reuters.com/article/mediaNews/idUKSHA9770420090127
202 See generally for discussion about the conflict between multilateral environmental
agreements and trade agreements Joost Pauwelyn, The Role of Public International Law
in the WTO: How Far Can We Go?, Vol. 95 American Journal of International Law 535
(2001)
agreement will be negotiated post-Kyoto. China’s obligation under these existing treaties and future treaties have the potential to trump conflicting free trade obligations under the WTO.

Whether a trade challenge would ever make policy sense depends on a number of factor since trade sanctions may impose high costs to efficiency and may inadvertently strengthen the domestic resistance to making needed changes. 203

Conclusion

What happens next? The IPCC observed in 2007 that “There is high confidence that neither adaptation nor mitigation alone can avoid all climate change impacts.”204

Some combination of the two is clearly necessary to change the business as usual world. The tool of insurance with its ability to pool risk and reduce losses addresses both mitigation and adaptation at meaningful levels of discourse. Compulsory insurance provides the incentive to mitigate business as usual emissions while providing adaptation funding. Microinsurance funded by high-capacity coping states addresses the need for local adaptation by providing security to the most vulnerable individuals who currently live outside of the world of risk management.

As noted throughout this paper, insurance is not a panacea. While implementing vast mandatory insurance networks may protect people, their property, and hopefully their livelihoods, insurance networks are far less likely to protect natural environments from long-term climate sensitivity. Some damages and losses may extend beyond the technical ability of human adaptation efforts such as reversing the predicted coral

204 IPCC AR4 Synthesis Report at 65.
bleaching from ocean acidification or reversing animal migrations.

While Munich Re is not Beowulf and Lloyds of London is not St. George single-handedly capable of slaying climate dragons, these businesses are still powerful social and economic actors with the potential to rally both political will and industry involvement. Even though naysayers may belittle market efforts to control carbon as just another get-rich quick scheme, the market has proven itself to more flexible, dynamic, and efficient than entrenched political systems in responding to certain types of environmental pressures. Since national and international political efforts to curb carbon continue to be sluggish at best, the insurance industry with its feet in both the regulatory world and the business world is in the unparalleled position to lead in both national and international mitigation and adaptation efforts.

This paper’s contribution to the emerging field of insurance and climate change is to propose two viable schemes: corporate catastrophe risk insurance for high-coping capacity states and regional microinsurance for low-coping capacity states. Working in tandem, these schemes have the potential to inject new life into the polluter pays principle and provide new direct means to achieve climate change equity.

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205 A number of large businesses have demonstrated the capacity to challenge and change business as usual practices. For example under pressure from NGOs, Home Depot limited its stocks of hardwoods to products grown in sustainable and certified forests. [http://corporate.homedepot.com/wps/portal/Wood_Purchasing](http://corporate.homedepot.com/wps/portal/Wood_Purchasing)
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