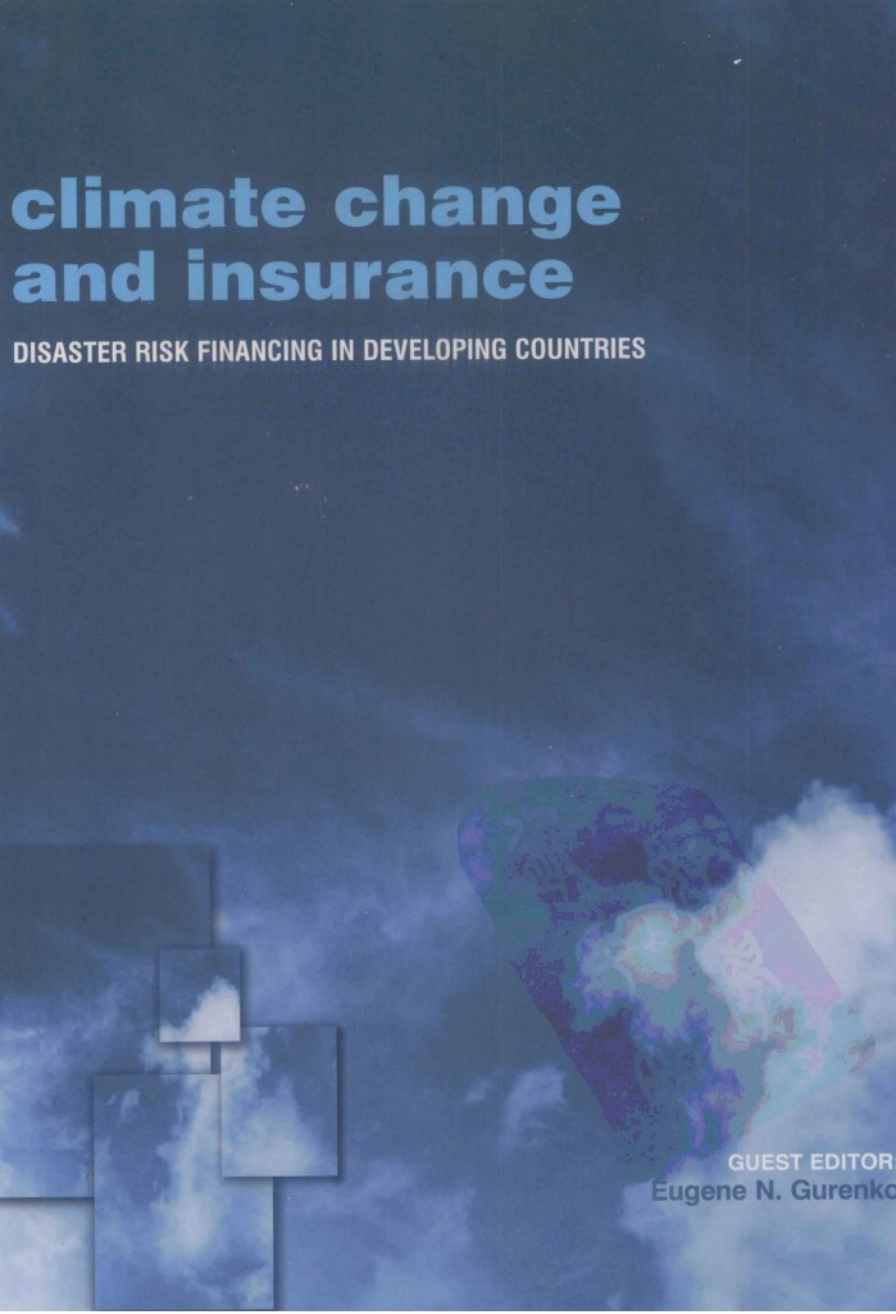
climate change and insurance

DISASTER RISK FINANCING IN DEVELOPING COUNTRIES



GUEST EDITOR
Eugene N. Gurenko

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Earthscan
8–12 Camden High Street
London, NW1 0JH, UK
Tel: +44 (0)20 7387 8558
Fax: +44 (0)20 7387 8998
Email: earthinfo@earthscan.co.uk
Web: www.earthscan.co.uk

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List of contributors

Christoph Bals is the Executive Director and the founding member of Germanwatch – a non-profit organization founded in 1991. He was among the initiators of the European Business Council for Sustainable Energy, the pro-Kyoto-campaign 'e-mission55', and the Initiative for Climate Conscious Flying Atmosphere. He has been a Board member of the Foundation for Sustainability since 1998. He has been one of the three NGO representatives in the German government's Working Group on Emission Trading (AGE) since 1998; and a member of the advisory group of the German Green Investment Index (NAI); in 2003 and 2004 he was on the National Advisory Committee for Renewables 2004. Christoph has headed several different successful environmental campaigns (Rio Konkret, Climate Responsibility Campaign). He studied theology, economics and philosophy at Munich, Belfast, Erfurt and Bamberg.

Joanne Linnerooth-Bayer is leader of the Risk and Vulnerability Programme at the International Institute of Applied Systems Analysis (IIASA) in Laxenburg, Austria. She is an economist by training, and has received a BS and PhD at Carnegie-Mellon University and the University of Maryland, respectively. Her current interest is global change and the vulnerability of developing countries to catastrophic events, and she is investigating options for improving the financial management of catastrophe risks on the part of households, farmers and governments in transition and developing countries. She has recently led research projects on this topic in the Tisza River region, Hungary, and the Dongting Lake region, China. Joanne is currently a leader of two work programmes on an integrated European Union project, which examines risk and vulnerability to weather-related extremes in Europe. She is an associate editor of the *Journal for Risk Research* and on the editorial board of *Risk Analysis* and *Risk Abstracts*. She has received the Distinguished Scientist Award from the European Society for Risk Analysis and the Scientific Excellence Award from the International Society for Risk Analysis.

Sonja Butzengeiger is an expert in Kyoto Mechanisms and EU Emissions Trading. She has been working on climate policy aspects since 1999. From 2000 to 2003 she worked on a research project on baseline standardization and accounting issues (PROBASE) for the EU. Besides the implementation of CDM and JI into business practice, her focus is company-level emissions trading schemes such as the EU-ETS. Since 2001, Sonja has been working for the German Emissions Trading Group (AGE) under the lead of the German Ministry for the Environment. She also has extensive experience with strategies for the allocation process from the business perspective, the establishment of CO_2-monitoring plans, and the identification of internal GHG reduction potential by innovative approaches. She holds an engineering degree in environmental sciences.

Andrew Dlugolecki is now a Visiting Research Fellow at the Climatic Research Unit, University of East Anglia, an Advisory Board member at the Tyndall Centre for Climate Change Research and the Carbon Disclosure Project, and advisor on climate change to the UNEP Finance Initiative. He worked for 27 years in the insurance group Aviva in various senior technical and operational posts, retiring from the position of Director of General Insurance Development in December 2000. He served as the chief author and later reviewer for the Intergovernmental Panel on Climate Change in its Second, Third and Fourth (due 2007) Assessment Reports, carried out similar duties for

official UK and EU reviews of climate change, and chaired two studies of climate change by the Chartered Insurance Institute (1994 and 2001). He is the author of numerous international publications on insurance and climate change. Andrew obtained a BSc (Hons) in pure mathematics at Edinburgh (1970), an MA in operational research at Lancaster (1971), and a PhD in technological economics at Stirling (1978), and is a Fellow of the Chartered Insurance Institute (1990), and a Fellow of the Royal Meteorological Society (1992).

Eugene N. Gurenko is a Lead Insurance Specialist at the Insurance Practice of the World Bank. During his career at the World Bank Group, which he joined in 1998, he designed and managed the World Bank programme of technical assistance and lending to the Turkish Catastrophe Insurance Pool (TCIP), currently one of the largest and most successful public–private partnerships in earthquake insurance in the world. His most recent projects include risk assessments and the design of catastrophe risk transfer solutions for Romania, Bulgaria, Iran, the Caribbean islands and India. In 2004–2006, Eugene was with Munich Re on a special staff exchange assignment, where he led the company's efforts to develop a group-wide terrorism risk management strategy. He is the author of numerous publications on catastrophe insurance. Eugene holds a PhD from Columbia University and professional designations of Chartered Property Casualty Underwriter (CPCU) and Associate in Reinsurance (ARe).

Erik Hoekstra is a member of and deputy to the head of the Innovative Solutions Team in Munich Re's Global Clients Division. After studying at the University of Groningen in the Netherlands, he held various positions within the Gerling Group in Cologne and Luxembourg and was an underwriter at Converium in Cologne. Before joining Munich Re in October 2002, Erik was an associate director in the Risk Markets Group at WestLB in Düsseldorf. He holds a MS degree in economics.

Peter Hoeppe is the Head of the Geo Risks Research and Environmental Management Department at Munich Re. He joined Munich Re in 2004 after a long and successful academic career. During his time at the university, he received PhD degrees in physics (1984) and human biology (1996) and was appointed Professor in 2003. Since 1984, he has held the positions of tenured Lecturer at the Institute of Bioclimatology and Applied Meteorology and the Institute of Occupational and Environmental Medicine at the Ludwig-Maximilians-University (LMU) in Munich, Germany. His main research fields have been health effects of weather and climate, as well as pollutants and the general assessment of environmental risks. On a couple of occasions, Peter has worked abroad in the USA, Austria, and Pakistan. He is a member of the International Society of Biometeorology, of which he was President in 1999–2002, and a member of the German Meteorological Society, where for many years he served on the Board.

Catherine Rose James has nearly 2 years of research/consulting experience in rural development projects, particularly those relating to the water and sanitation sector. Her key focus areas have been policy and institutional analysis and impact assessment of water resources projects, and her area of expertise includes social mobilization using participatory tools, microfinance and data analysis. Prior to being associated with TERI, she worked as a risk underwriter with State Bank of India Cards, where she undertook risk analysis and underwriting of SBI classic international credit cards and portfolio health assessments. Catherine is a graduate in economics from St Stephens College, Delhi, and holds a post-graduate diploma in rural management from Xavier Institute of Management, Bhubneshwar (2004).

Ulka Kelkar is an Associate Fellow with the Centre for Global Environment Research, The Energy and Resources Institute (TERI), India. She has a Masters degree in economics from the School of International Studies, Jawaharlal Nehru University, New Delhi. She has more than 6 years work experience in the fields of climate change negotiations and policy, clean development mechanism projects, and vulnerability and adaptation assessment. Her recent projects include a review of the preparedness of the Indian insurance industry to climate change, research on key negotiating issues for India, a national strategy study on CDM for India, and analysis of the role of emissions trading in climate policy.

Ritu Kumar is an environmental economist experienced in dealing with sustainable development issues, energy and climate change. She is Director of The Energy and Resources Institute (TERI) office in London. She is currently working on a number of practical projects aimed at enhancing the capacity of developing-country partners to participate in potential Kyoto Protocol mechanisms. One of these projects is looking at the future role of the Indian insurance industry in climate change. She has worked with the United Nations Industrial Development Organization (UNIDO) for 10 years, of which 2 years were spent in West Africa, and has developed and implemented projects relating to industry and environmental policy in several developing countries. Ritu is a postgraduate in economics from the Delhi School of Economics, India, and the London School of Economics.

Reinhard Mechler is a Research Scholar in the Risk and Vulnerability Programme at IIASA. He has been analysing the impacts and costs of natural disasters in developing countries, as well as strategies to reduce these costs; in particular, strategies related to risk financing. He has also studied the costs, impacts and benefits of reducing the effects of air pollution and climate change. He has worked as a consultant for the ProVention Consortium, the World Bank, the Inter-American Development Bank, and the Gesellschaft für Technische Zusammenarbeit (GTZ). Reinhard studied economics, mathematics and English. He holds a diploma in economics from the University of Heidelberg and a PhD in economics from the University of Karlsruhe in Germany.

Axel Michaelowa is the Head of the Research Group on International Climate Policy at Zurich University and has a 12-year background in the analysis of climate policy instruments. From 1999 to 2006 he headed the climate policy programme of the Hamburg Institute of International Economics. He is also CEO of the consultancy Perspectives Climate Change, which specializes in CDM and emissions trading. He is a member of the CDM Executive Board's Registration and Issuance Team and on the UNFCCC roster of experts on baseline methodologies, where he has reviewed ten proposed methodologies. Axel has written over 50 publications on the Kyoto Mechanisms, including a book on CDM's contribution to development. He is a lead author in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change and a member of the board of the Swiss Climate Cent Foundation.

Koko Warner is a senior scientific advisor at the United Nations University Institute for Environment and Human Security (UNU-EHS). She coordinates the Munich Re Foundation Chair on Social Vulnerability. Prior to joining the UNU, she was an economic research scholar at the Natural Hazards Department at the World Institute for Disaster Risk Management (DRM) in Davos, Switzerland. Koko has worked for the past 7 years on the economic and societal impacts of climate change and natural catastrophes in developing countries, with the major emphasis on the development of policy and financial instruments to reduce and transfer disaster risk. Koko received her doctoral degree in economics, and currently also serves as an Assistant Professor on the University of Richmond's Emergency Service Management graduate programme.

Foreword

Peter Hoeppe

Head of Geo Risks Research, Munich Re, Munich, Germany

Over the last few decades, both the frequency of large natural disasters as well as the amount of damage caused by them have increased significantly. 2005 was not only the second warmest year since 1856 but also a year of absolute records in number and intensity of hurricanes in the North Atlantic as well as in the global economic and insured losses caused by weather-related disasters. In recent years, science has provided more and more evidence that there is a high probability of a causal correlation between climate change and these trends in natural catastrophes. If the scientific global climate models are accurate, the present problems will be magnified in the near future. Changes in many atmospheric processes will profoundly impact upon the lives, health and property of millions of people.

The crucial question today is not when we will have the ultimate proof for anthropogenic climate change, but which strategies we should follow to mitigate and adapt to climate change. Insurance-related mechanisms can be an effective part of adaptation strategies. In particular, developing countries are very vulnerable to these changes as in these countries natural catastrophes can cost a large proportion of their GDP and consume large amounts of the money donated by developed countries that is then not available for investments in economic development.

In response to the growing realization that insurance solutions can play a role in adaptation to climate change, as suggested in paragraph 4.8 of the Framework Convention and Article 3.14 of the Kyoto Protocol, the Munich Climate Insurance Initiative (MCII) was founded in April 2005. The members of this initiative are representatives of the insurance and reinsurance industry, climate change and adaptation experts, NGOs, and policy researchers. MCII introduced and discussed its objectives for the first time in public at a special side-event of the COP-11 conference in Montreal in December 2005. This special issue of *Climate Policy* draws, by and large, on the results of the first year's work of MCII. The publication of these articles is intended to stimulate discussion on insurance-related mechanisms and how they can help in adapting to a changing climate and the corresponding risks.

Introduction and executive summary

Eugene N. Gurenko*

World Bank, Washington DC, US

1. Objectives of the publication

The increasing frequency and severity of extreme weather events (including heatwaves, droughts, bush fires, tropical and extratropical cyclones, tornadoes, hailstorms, floods and storm surges) and the historically unprecedented economic losses observed in 2004/5 have intensified the ongoing international debate about the possible adverse impact of climate change on global weather patterns. However, the adverse implications of climate change are likely to vary considerably from one country to another based on geographical location, effectiveness of climate adaptation strategies, level of insurance penetration, and the overall resilience of the economy to exogenous shocks. While the complexity of these atmospheric phenomena makes it difficult to accurately predict the impact of climate change on a given country, it is clear that disaster-prone developing countries are likely to be affected most severely due to their weaker economic base and the very limited use of risk transfer instruments in these societies.

Catastrophe risk transfer from disaster-prone countries to global reinsurance and capital markets represents one viable adaptation solution which has been gaining the support of international financial organizations. Article 4.8 of the United Nations Framework Convention on Climate Change (UNFCCC) and the supporting Article 3.14 of the Kyoto Protocol call upon developed countries to consider actions, including insurance, to meet the specific needs and concerns of developing countries in adapting to climate change. However, to date, there has been little understanding or agreement within the climate change community on the role that insurance-based mechanisms can play in assisting developing countries to adapt to climate change.

Responding to this low level of awareness of the role that can be played by insurance-related mechanisms in countries' climate change adaptation strategies, a group of NGOs, reinsurers, climate-change and insurance experts from international financial organizations, and policy researchers from academic think-tanks decided to form the Munich Climate Insurance Initiative (MCII). Founded in 2005, the organization provides an open forum for examining insurance-related options that can assist with adaptation to the risks posed by climate change. Among the most well known organizations that comprise the MCII membership are the World Bank, the United Nations, Munich Re, Germanwatch, IISA, the Potsdam Institute for Climate Impact Research (PIK) and the Swiss Federal Institute of Technology (SLF).

* Tel.: +1-202-458-5414; fax: +1-202-614-0920
E-mail address: egurenko@worldbank.org

This special issue of *Climate Policy* is the first collective publication by MCII members. It presents articles on the topic of insurance and climate change in developing countries. The issue aims to help communities at risk, governments, international organizations, the insurance industry and NGOs worldwide that are seeking solutions for preventing and adapting to the increasingly adverse economic impacts of climate change and weather-related disasters in developing countries.

The publication pursues two main objectives. First, it aims to shed light on the rationale and potential applications of catastrophe risk transfer mechanisms (insurance) for mitigating the adverse economic consequences of climate change on disaster-prone developing countries. Second, it attempts to engender an international debate on the role of insurance-based mechanisms in reducing global emissions and encouraging climate-friendly corporate behaviour.

The structure of the special issue is as follows. Hoeppe and Gurenko first discuss the scientific and economic rationale for a climate change insurance-based adaptation system. They examine the role of insurance in reducing the long-term vulnerability and mitigating the adverse financial effects of climate change on the economies of disaster-prone developing countries. They also describe the current global model of disaster risk financing and highlight its major drawbacks. Linnerooth-Bayer and Mechler provide a detailed overview of the existing public–private partnerships in catastrophe insurance and lay out an alternative design for a global climate risk financing vehicle. Bals, Warner and Butzengeiger introduce yet another alternative approach to the design of the climate change financing mechanism and discuss how it can be financed. Dlugolecki and Hoekstra present the perspective of the private sector on public–private partnerships in catastrophe risk management and describe how the competencies and resources of the global reinsurance industry can be best employed in support of such an undertaking. Kelkar, James and Kumar present a case study of traditional and innovative climate risk financing products in India, with extensive comments on their affordability and effectiveness. Michaelowa assesses the feasibility of applying insurance solutions to mitigate the negative impacts of global adaptation policies on the economies of oil exporting countries. The final article concludes and offers specific policy recommendations on how insurance-based mechanisms can be used to meet the needs and concerns of countries in adapting to climate change.

2. Executive summary

Peter Hoeppe and Eugene Gurenko offer the scientific and economic rationales for innovative climate insurance solutions in the context of global adaptation to climate change. The arguments presented in their article are twofold. On the one hand, drawing on the growing body of scientific evidence that climate change is already taking place, the authors point out that the increasing frequency and intensity of weather-related hazards makes the previous disaster-funding approaches obsolete. Indeed, according to the World Meteorological Organization (WMO), the last 5 years (2001–2005) were among the six warmest recorded worldwide since 1861, with 2005 being the second warmest. The year 2005 also set records for hurricanes in the North Atlantic: since records have been kept (1850) there have never been so many named tropical storms developing so early in the season (seven by the end of July), and the total number of 27 easily outstrips the old record of 21. Hurricane Wilma achieved the lowest recorded central pressure, and Hurricane Katrina was the most expensive ever. Already today, increasing losses from natural disasters make it more and

more difficult for disaster-prone nations to finance economic recovery from their own budget revenues or special government disaster funds. All these manifestations of increasing climate extremes make a good case for insurance-based climate risk financing mechanisms at the country level. For a fixed premium payment, countries can cap the amount of fiscal loss caused by natural disasters in the future. Hence, by adopting insurance-based funding solutions, countries can not only greatly reduce the uncertainty of national budgetary outcomes due to natural disasters but can also increase the speed of post-disaster economic recovery.

The authors point out that, due to limited tax bases, high indebtedness and low uptake of insurance, many highly exposed developing countries cannot fully recover from slow- and sudden-onset disasters by simply relying on external donor aid, which typically covers only a small fraction of total economic loss. A concern to donors and multilateral financial institutions, among others, is that the increasing share of aid spent on emergency relief and reconstruction stifles spending on social, health and infrastructure investments and distorts countries' incentives for engaging in *ex-ante* risk management. This means that as disasters continue to profoundly impact on the lives, health and property of millions of people, their devastating impacts will be felt most by the world's poor. To date, these vulnerable groups have also had the least access to affordable insurance. In the absence of new innovative global disaster risk financing mechanisms, which can address the increasing volatility and severity of losses sustained by these economies due to natural disasters, and which, at the same time, can provide appropriate incentives for *ex-ante* risk management for disaster-prone countries and their populations, the adverse impact of the global climate change is likely to become even more pronounced in the future.

Joanne Linnerooth-Bayer and Reinhard Mechler lay out their vision for an international public–private climate risk insurance fund. They suggest a two-tiered climate insurance strategy that would support developing country adaptation to the risks of climate variability and meet the intent of Article 4.8 of the United Nations Framework Convention on Climate Change (UNFCCC). The core of this strategy is the establishment of a climate insurance programme specializing in supporting developing country insurance-related initiatives for sudden- and slow-onset weather-related disasters. This programme could take many institutional forms, including an independent facility, a facility in partnership with other institutions of the donor community, or as part of a multi-purpose disaster management facility operated outside of the climate regime. Its main purpose would be to enable the establishment of public–private safety nets for climate-related shocks by assisting the development of (sometimes novel) insurance-related instruments that are affordable to the poor and coupled with actions and incentives for proactive preventative measures. A second tier could provide disaster relief contingent on countries making credible efforts to manage their risks. Since it would be based on precedents of donor-supported insurance systems in developing countries, one main advantage of this proposed climate insurance strategy is its demonstrated feasibility. Other advantages include its potential for linking with related donor initiatives, providing incentives for loss reduction, and targeting the most vulnerable. Although many details and issues are left unresolved, it is hoped that this suggested strategy will facilitate much-needed discussions on practical options for supporting adaptation to climate change in developing countries.

In their contribution, the authors draw extensively on their international experience in public–private partnerships in catastrophe risk transfer, which they use to illustrate the types of country-based risk financing programmes such as those that an international facility can support.

Christoph Bals, Koko Warner and Sonja Butzengeiger provide yet another interesting proposal for insuring the uninsurable. The proposed design features of the Climate Change Financing Mechanism (CCFM) aim to rectify numerous deficiencies of the existing model of disaster aid. One of the key problems with the current *ex-post* and *ad-hoc* form of international assistance is that it neither requires nor provides any incentives for effective risk reduction or climate adaptation measures on the part of aid-receiving countries. In the absence of effective risk reduction/adaptation measures, the increasing frequency and severity of natural disasters due to climate change is likely to claim even higher future tolls in terms of economic damage and lives lost in disaster-prone developing countries.

The authors propose the establishment of a clearly defined contractual arrangement between the insurance fund and the insured countries. The fund would provide catastrophe insurance cover to countries that are highly exposed to the risk of natural disasters on a parametric basis, although free of charge in order to make such coverage affordable. Instead of paying a monetary premium, countries would be required to make an in-kind contribution commensurate with the level of their imputed risk-based premium by investing in risk reduction and mitigation projects that over time will reduce their vulnerability to future natural disasters.

The extent of adaptation measures needed to qualify a country for the CCFM basic cover would depend on its risk profile as well as its financial capacity. By encouraging more risk-prone countries to invest relatively more in risk-reduction projects, the CCFM mechanism would be providing strong incentives for proactive risk reduction. Climate adaptation measures through investments in emission-reducing projects and technology would also count toward the country's in-kind premium contributions to the CCFM.

While the main objective of the CCFM mechanism is to provide coverage for the most extreme catastrophic natural events, it may also offer an additional insurance coverage that would cover damages below the level of attachment of the basic free-of-charge insurance coverage. Such extra coverage would be provided for an additional risk-based premium to be paid by countries directly to the fund.

Similarly to the IISA proposal, financial support from the international community would be required to either subsidize the countries' risk reduction projects and/or to provide risk capital for CCFM to reduce its costs of reinsurance and consequently the costs of CCFM's coverage. Among the possible sources of CCFM's financing, the authors see financial contributions by UNFCCC Parties and by international financial organizations committed to developing sustainable climate adaptation mechanisms in disaster-prone countries.

In conclusion, the authors emphasize that the proposal can be used by the UNFCCC Parties as the base for developing the legal and organizational framework for the post-2012 Kyoto Protocol negotiations.

Andrew Dlugolecki and Erik Hoekstra offer an insurance industry perspective on the role of the private sector in insuring climate-related hazards in the context of climate change. The authors begin with an overall discussion of the role of the private sector and the key actors in the global catastrophe risk market. The complexity of the insurance market necessitates the presence of many different players which, as well as insurers and reinsurers, includes brokers, risk modellers, loss adjustors, customer associations, banks and, more recently, investors.

Although many national insurance markets and the global reinsurance and capital markets are already active in providing cover against natural catastrophes, the overall insurance market appetite for catastrophic risk is limited by companies' internal risk management considerations. Hence,

commercial insurers are reluctant to provide cover for floods, windstorms and other potentially high-consequence climate events, if it involves risks with a considerable loss accumulation potential and for which hardly any historical data exist.

However, the main stumbling block to the expansion of catastrophe insurance coverage offered by the private markets is that often catastrophe insurance cover is not affordable or accessible to poor nations or individuals. This problem, however, can potentially be addressed by the creation of public–private partnerships (PPP) or through donor support for insurance-based risk financing mechanisms.

The authors then examine the type of arrangements that would provide the best fit for both public and private sector participation in catastrophe risk insurance. Their article briefly reviews a range of core and support functions essential for the successful operation of a catastrophe insurance entity before zooming in on the main competencies of the public and private sectors.

The authors point out that among the key public functions in catastrophe risk management are effective risk prevention and risk reduction, which can be achieved by the vigorous enforcement of construction codes and hazard-linked land zoning, based on thorough public risk assessment surveys. A breakdown in the implementation of these essential hazard risk management functions by governments creates additional uncertainty for private risk underwriters and results in higher risk premiums for insurance coverage.

Potentially, in a PPP, the private sector can fulfil some risk-bearing and many essential non-risk-bearing functions. In the case of the risk-bearing function, PPPs may find it advantageous from the risk management perspective to cede at least a part of their catastrophe risk peak accumulations to the global reinsurance or capital markets. Examples of such risk transfers from public–private insurance entities to the reinsurance markets are readily available around the globe. The non-risk-bearing functions of the private sector may include technical support for risk assessment, risk management, product design, distribution, marketing, loss handling and administration. A fruitful approach to explore is a PPP where the public sector sets a rigorous framework to control and reduce the physical risks, and also provides cover for severe but unlikely catastrophe events or for segments of the market which require high administration costs (due to the lack of the existing private insurance infrastructure, for example), while the private sector provides insurance services and coverage for less severe but more frequent events to the segments of economy that are more easily accessible.

The article then briefly comments on the feasibility of different PPP design approaches, including the type of insurance coverage to be provided by such entities and the level of risk aggregation (global versus regional versus local) at which they may operate. Having assessed potential design options for PPPs in catastrophe insurance, the authors conclude that the fundamental building block is the national (country) level, since risks must be consistently estimated and dealt with in their everyday context prior to their aggregation at supranational level within regional or global markets.

Ulka Kelkar, Catherine Rose James and Ritu Kumar present a case study of India's insurance industry in the context of climate change, which is typical of most other poor countries. The authors demonstrate that, given the country's history of disaster losses compounded by the growth in population concentrations and the burgeoning development in coastal and flood-prone areas, the potential impact of climate change on the Indian economy can be quite severe. These findings are driven home by the July 2005 floods in Mumbai, India's commercial capital, caused by a record level of 944 mm precipitation within 24 hours. The floods resulted in the record economic loss of US $5 billion and 1,130 people killed.

Yet, despite being the second most disaster-prone country in the world, India remains a country where insurance penetration for natural hazards is almost non-existent, less than 1%, which is abysmally low even when compared with countries with a similar level of GDP. In India, partly as a result of such a low level of insurance coverage, the government by and large remains the main financier of disaster relief, rescue, rehabilitation and reconstruction efforts.

The low insurance penetration in the country can be traced to a number of factors. On the demand side, the biggest hurdles are the lack of insurance awareness among the public and the very low income of the population. As a result, personal risk management is usually reactive and, in the case of natural catastrophes, episodic. The experience of major insurance companies shows that following a major catastrophe, first there is a rush to buy insurance cover, but this interest is short-lived and in most cases these policies are not renewed.

The scalability of successful insurance projects is further limited by the lack of incentives to purchase insurance on the part of consumers, as the government and other donor agencies often compensate losses on account of disasters. Such government assistance, however, is often insufficient or comes too late to make a real difference for the poor. As a result, as traditional risk-sharing strategies break down in the case of natural disasters that affect whole communities at once, the rural poor are forced to turn to moneylenders or sell their productive assets, which frequently undermines the very prospect of recovering their livelihoods.

Traditionally, due to the very limited insurance penetration, the insurance industry in India has played a very marginal role in dealing with the impacts of either climate variability or extreme events such as droughts, floods and cyclones. However, the recent partial liberalization of the Indian insurance market has opened the door for product innovation. Various innovative products, including those aimed at dealing with the risk of climate variability, have been introduced. Among these new products are index-based weather risk insurance contracts, which have emerged as a promising alternative to traditional crop insurance. These are linked to the underlying weather risk defined by an index based on historical data (e.g. for rainfall, temperature, snow, etc) rather than the extent of loss (e.g. crop yield loss). As the index is objectively measured and is the same for all farmers, the problem of moral hazard is minimized, the need to draw up and monitor individual contracts is avoided, and the administration costs are reduced. Weather-indexed insurance can help farmers avoid major downfalls in their overall income due to adverse weather-related events. This improves their risk profile and enhances access to bank credit, and hence reduces their overall vulnerability to climate variability. Unlike traditional crop insurance, where claim settlement may take up to a year, quick payouts in private weather insurance contracts can improve recovery times and thus enhance the farmers' coping capacity.

However, one of the main inherent disadvantages of weather derivatives is that, because of the way the index is defined, there may be a mismatch between payoffs and the actual farmer's losses; the problem also known as a basis risk. Despite many technical advantages of index-based weather risk derivatives, the presence of the basis risk makes buyers vulnerable to the possibility of not receiving compensation in spite of suffering a considerable loss, which makes these instruments ill-suited for small farmers. The problem of the basis risk, however, becomes less pronounced for commercial buyers of these instruments (such as large commercial farmers, agricultural lenders and farmers' cooperatives) due to the diversification effect afforded by their larger land-holdings and their higher risk retention capabilities.

The authors conclude that in achieving this goal the private insurance industry would benefit from joining forces with the government in the form of a PPP. Such an alliance could make disaster

insurance products more affordable, could create strong incentives for consumers to buy insurance products, and would discourage unsustainable economic activities in disaster-prone areas.

While the previous articles dealt with the issue of adaptation to the direct consequences of climate change through insurance-based mechanisms, Axel Michaelowa examines the feasibility of using insurance-based mechanisms for offsetting the negative impacts of countries' adaptation measures in response to climate change. The necessity to address negative impacts of the implementation of mitigation and adaptation policies ('response measures') is specified in Articles 4.8 and 4.9 of the UNFCCC and Article 3.14 of the Kyoto Protocol.

By using a series of hypothetical but highly illustrative examples, the author demonstrates how adaptation policies of one country can adversely affect other economies. One example of such an adverse impact is a foreseen reduction in the demand for fossil fuels due to global adaptation measures which are likely to result in reduced world market prices for these fuels, and which arguably would lead to lower revenues for fossil-fuel-exporting countries. Alarmed by the potential adverse impact of global adaptation measures on their economies, for a long time OPEC countries have argued in the international climate negotiations that they should receive compensation for reduced export revenues.

Michaelowa attempts to find a risk-management solution to this problem. He begins by examining the applicability of insurance-based mechanism to managing the risk of adverse implications of adaptation measures on the economies of fossil-producing countries. After a careful examination of the problem, he concludes that the insurability of this risk is highly questionable due to the wide range of parameters that influence energy markets, which make it impossible to unambiguously separate the price and quantity effect caused by adaptation measures. In addition, as the timing of the adverse impact of adaptation measures can be easily predicted and the insured losses from such measures would be impossible to diversify (due to their systemic effect), insurers would be unable to offer insurance cover for such a risk.

An alternative approach to mitigating the impact of mitigation measures on oil prices may lie with the traditional commodity markets, where long-term price hedging contracts can be bought by countries at risk. However, due to the impossibility of teasing out the effect of mitigation measures from other factors that may reduce the price, tradable oil price hedging contracts are universal (e.g. cover against any cause of price decrease) and therefore relatively expensive.

The author concludes that the best long-term risk management policy for countries exporting fossil fuels is to diversify away from commodities in order to reduce the systemic market risk. Funds for diversification could be raised through taxes on the production of fossil fuels. These revenues could be used for investments in diversification projects, such as renewable energy technologies, which these countries can then export to offset their declining oil export revenues. This conclusion seems to be particularly sound in light of the fact that many fossil-fuel-exporting countries have a good renewable energy resource base in both solar and wind energy. Nevertheless, fossil-fuel exporters so far have neither taken up the opportunities of the pilot phase of Activities Implemented Jointly nor have they made visible efforts in the Clean Development Mechanism area.

Drawing on the material presented in this special issue, Eugene Gurenko concludes by drawing policy recommendations on how insurance-based mechanisms can best be utilized in the context of global adaptation to climate change. One of the key recommendations that also underpins every article in this Special Issue is that the creation of public–private partnerships in catastrophe insurance, where technical and capital resources of the insurance industry are combined with government actions to prevent and mitigate the risk of natural disasters, may be the only viable climate-adaptation strategy of the future.

RESEARCH ARTICLE www.climatepolicy.com

Scientific and economic rationales for innovative climate insurance solutions

Peter Hoeppe[1*], Eugene N. Gurenko[2]

[1]*Munich Re, Munich, Germany*
[2]*World Bank, Washington DC, US*

Abstract

The scientific and economic rationales for climate insurance solutions are provided in the context of global adaptation to climate change. Drawing on the growing body of scientific evidence on the increasing frequency and severity of climate-related natural disasters, we argue that climate change is already taking place. The mounting and highly unpredictable losses from natural disasters make the traditional disaster-funding approaches obsolete, as even large economies have problems financing economic recovery from their own budget revenues or special government disaster funds. This is particularly the case in low-income developing countries, where limited tax bases and high indebtedness prevent them from relying on debt financing of reconstruction efforts. Using OECD and World Bank statistics, we demonstrate that despite the commonly held belief, disaster-related external donor aid to developing countries accounts for only a small fraction of the total economic loss caused by catastrophic events. According to our estimate, on average over 90% of the economic loss from natural disasters is borne by households, businesses and government. This suggests a need for insurance-based climate risk financing mechanisms at the country level. By paying a fixed insurance premium that can be a small fraction of the potential economic loss, countries can cap the amount of their fiscal loss, greatly reduce the uncertainty of national budgetary outcomes due to natural disasters, and increase the speed of their post-disaster economic recovery.

Keywords: Adaptation; Climate change; Insurance; Natural catastrophes; Risk financing; Developing countries

1. Impact of climate change on global economic development

Over the last decades the frequency of major natural disasters as well as losses, both total economic and insured, caused by them have increased significantly. In Figure 1, it can be seen that over the last half-century (1950–2005), the frequency of 'great natural disasters' caused by different natural perils has been on the rise – from a global mean level of about two per year in the 1950s to about seven in recent years.

* Corresponding author. Tel.: +49-89-3891-2678; fax: +49-89-3891-72678
E-mail address: phoeppe@munichre.com

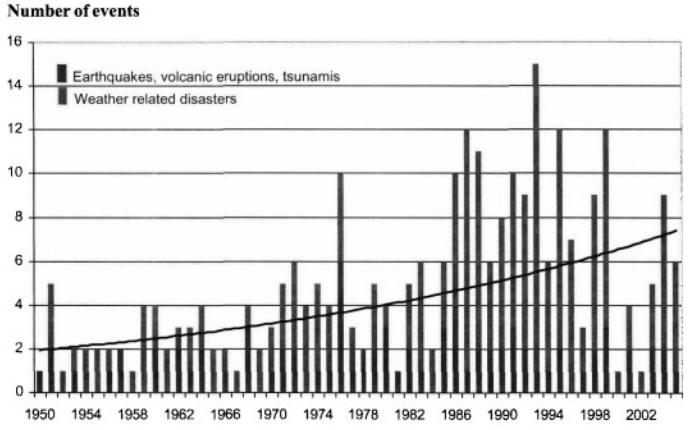

Figure 1. Great natural disasters, 1950–2005.

In this context, 'great natural disasters' are defined as events in which the affected region's ability to help itself is distinctly overtaxed. One or more of the following criteria apply:

- Interregional or international assistance is necessary
- Thousands are killed
- Hundreds of thousands are made homeless
- Substantial economic losses
- Considerable insured losses.

As great disasters are well documented in the newspapers and other media, there is little room for a reporting bias in these data. We are also quite convinced that the trend in the number of these great disasters, contrary to the level of economic damage caused by them, has no relevant confounding by population growth and increasing values. This means that a great disaster in 2004 would also have been a great disaster in 1950, even with less people involved and lower values affected in the latter case. Another interesting result from the data presented in Figure 1 is that there is no relevant trend for natural events of geophysical origin, such as earthquakes, volcanic eruptions or tsunamis (all represented by red bars). This means that the upward trend in the number of annual events is carried solely by weather-related events, which are inherently linked to climate change.

As can be seen from Figure 2, compared to the number of events, the trends in total economic and insured losses (all values already adjusted for inflation to values of 2005) are much more pronounced.

Figure 2 shows economic and insured losses only from great weather-related disasters. The economic losses in the last decade (1996–2005) have increased by a factor of seven as compared

