

International Social Protection for Climate-Related Disasters

Joanne Linnerooth-Bayer
IIASA

Paper prepared for
“The Irrational Economist” Conference
and Book Writing in honor of Howard Kunreuther

December 4-5, 2008

Chapter to appear in
The Irrational Economist: Future Directions in Behavioral Economics and Risk Management
E. Michel-Kerjan and P. Slovic (eds.) *Public Affairs Press*. (forthcoming 2009)

Nov. 19, 2008
DRAFT
Comments very welcome

International social protection for climate-related disasters ¹

Joanne Linnerooth-Bayer
IIASA

Abstract

This paper explores the role of the international support in providing insurance as a form of social protection to low-income individuals and governments in developing countries in the context of growing losses from natural disasters, and particularly climate-related extreme events. The discussion addresses two fundamental questions: whether insurance and other pre-disaster financial instruments should be supported by the international development and climate-change communities, and if so, what mechanisms of support are appropriate? The conclusion is that there is a promising and legitimate role for pro-poor insurance mechanisms on the part of development organizations and within the emerging climate adaptation architecture. This conclusion is drawn in full recognition that insurance is not appropriate in all contexts and that it must be designed to minimize price-distorting subsidies that lead to misplaced incentives and maladaptation. The discussion draws heavily on work by Howard Kunreuther and his Wharton colleagues, who address similar issues of efficiency and equity in providing comprehensive insurance in the US. The global challenge and opportunity becomes how to support insurance programs for very low-income households, businesses and governments in a way that both assures affordability and provides incentives for reducing risk exposure and vulnerability. In meeting this challenge, this paper discusses a proposal on the part of the Munich Climate Insurance Initiative for a two-pillar (prevention and insurance) international risk-management strategy as part of an adaptation regime.

1. Introduction

Confronting economic and political insecurity in interwar Europe, John Maynard Keynes called for “new policies and new instruments to adapt and control the workings of economic forces, so that they do not intolerably interfere with contemporary ideas as to what is fit and proper in the interests of social stability and social justice”.² Those words resonate just as strongly today as unregulated financial markets threaten economic livelihoods across the world economy, as food insecurity leads to political discontent, and as climate change imposes the threat of greater local environmental damage and increasingly destructive natural disasters. As the threats become global, so too does

¹ This discussion draws heavily on Linnerooth-Bayer, et al. (forthcoming).

² As quoted in United Nations, 2008, p. xxiii.

responsibility for providing security to protect against them. According to UN Under Secretary General for Economic and Social Affairs, Shu Zukang:

The responsibility for the choice and mix of policies required to guarantee prosperity, stability and justice, remains, of course, with national institutions and constituencies, but in an increasingly interdependent world and on a fragile planet, building a more secure home is a truly international endeavour. (UN WESS, “Overcoming Economic Insecurity” 2008)

By calling for a *truly international endeavour*, Shu Zukang’s words set the stage for this discussion, which explores the role of the international community in providing social protection to low-income individuals and governments in the context of growing losses from natural disasters, and particularly climate-related extreme events. Development organizations, humanitarian groups and international financial institutions are already re-thinking the concept of security for disaster-prone developing countries, and considering a switch from post-disaster aid to pre-disaster financial assistance, such as supporting insurance and alternative-insurance instruments. Insurance is also highly topical in climate debates. The climate convention and more recently the Bali Action Plan specifically call for consideration of risk sharing and transfer mechanisms, such as insurance, as a means to adapt to droughts, floods, tropical cyclones and other weather-related loss and damage in developing countries particularly vulnerable to climate change.

Zukang also calls upon national institutions to choose a mix of policies that *guarantee prosperity, stability and justice*. This guarantee, however, raises the “big tradeoff” between efficiency and equity, a tradeoff that is fundamental to providing security against natural disasters and particularly in examining the case for supporting or subsidizing insurance in developing countries. Howard Kunreuther and his colleagues at Wharton have addressed this tradeoff by proposing two principles that, they argue, should guide the development of insurance programs in the US – “efficiency”, by calling for risk-based premiums to ensure loss-prevention incentives, and “equity”, by assuring the affordability of insurance to low-income individuals (Wharton Risk Management and Decision Processes Center, 2008). An analogous issue is how this tradeoff can be addressed in the global security debate.

This paper examines the case for an international effort in providing social protection against climate extremes by addressing two fundamental questions: whether insurance and other pre-disaster financial instruments should be supported by the international development and climate communities, and if so, what mechanisms of support are appropriate? After presenting background on the relationship between climate extremes and poverty in the next section, in Section 3 we discuss insurance programs that are recently being piloted in developing countries. These pilot programs show that there are compelling benefits, but also costs and challenges to providing insurance in the developing world, which we briefly discuss in Section 4. In Sections 5 and 6, the discussion turns to issues of efficiency and equity in making these programs affordable to the poor. In summary, we argue that there is a case for international intervention in

providing insurance against climate extreme in developing countries and mechanisms that satisfy principles of efficiency and equity.

2. Climate extremes and poverty

As pictured in Figure 1 the developing world (low- and middle-income countries) suffer a disproportionate share of the economic and human burdens from all natural disaster events. In fact, no high-income country has been ranked in the top 100 for most costly disasters relative to GDP; over half of the 20 most costly disasters occurred in predominantly agrarian economies; 4 impacted the least developed countries, and 3 occurred among the heavily indebted poor countries (UNWESS, p. 83). Developing countries are more vulnerable to climate extremes for many reasons. They employ a greater number of people in climate-sensitive sectors, primarily agriculture (Antle, 1995). For example, in sub-Saharan Africa, 90% of the population rely on rain-fed agriculture for their basic food needs (FAO, 2000). Moreover, the losses from climate and other disasters in low-income countries are not simply economic, but often existential (Ribot et al., 1996).

More than three-quarters of recent past losses can be attributed to windstorms, floods, droughts and other weather-related hazards (UNISDR, 2007), and these losses are increasing. In the two decades from 1987 to 1998, the annual number of disasters triggered by adverse weather averaged 195; from 2000-2006 they averaged 365, representing an increase of 87 percent (reported in Wharton RMDSC, 2007). Although growing and shifting population and wealth remain the main factors in explaining increasing losses, the Intergovernmental Panel on Climate Change (IPCC) has predicted that extreme event impacts are 'very likely' to change because of increasing weather variability (Solomon, Qin, et al., 2007). As a result insurers are taking a close look at their exposures. Europe's largest insurer, Allianz, has stated that "climate change stands to increase insured losses from extreme events in an average year by 37 per cent within just a decade while losses in a bad year could top €1 trillion" (Mills, 2007). There is even mounting evidence of a current "climate signal" with the IPCC (2007) reporting observations of widespread changes in temperature, wind patterns and aspects of extreme weather, including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. Insurers are

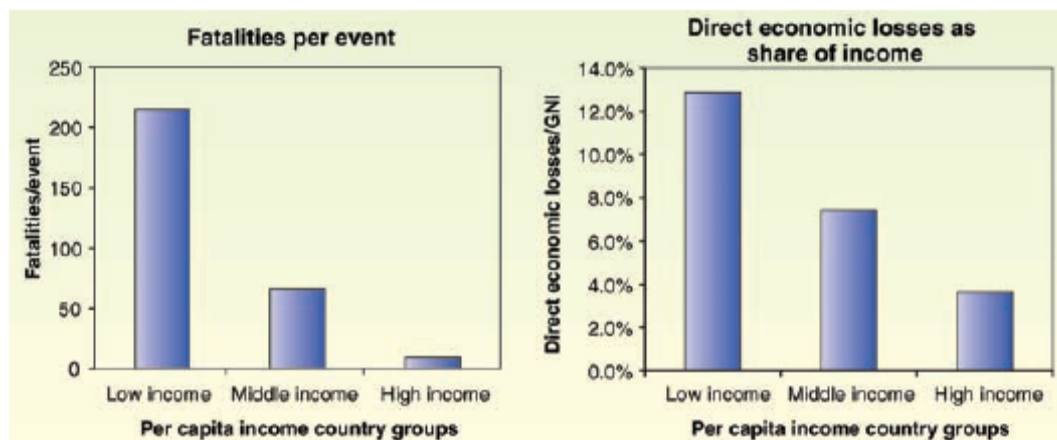


Fig. 1. Fatalities per event and direct economic losses as a share of national per capita income over the period 1980 to 2004. Country income groups according to World Bank classification using GNI per capita. Lower-middle and upper-middle income groups were combined.

The data pictured in Figure 1, however, do not include the long-term consequences of disasters on economic development, which can greatly amplify both the economic and human losses. Due to limited tax bases, high indebtedness and low uptake of insurance, many highly exposed developing countries cannot fully recover from disasters by simply relying on limited external donor aid (Mechler, 2004). In turn, external investors are wary of the risk of catastrophic infrastructure losses, and small firms and farmers cannot receive the credit necessary for investing in higher yield/higher risk activities. This leads to slowed economic recovery resulting in further human and economic losses.

Climate disasters thus exacerbate poverty in at least two ways. They destroy human and physical assets, livelihoods and public infrastructure, thus setting back gains from development. Additionally, households, businesses and farmers with high uninsured risk exposure often adopt low-risk, low-return strategies (e.g., placing relatives in low-paid but secure employment or planting low-yield drought-resistant seeds). This reduces their ability to accumulate the assets needed to escape poverty through savings and investment. In the words of agricultural insurance experts:

...those with few assets may accurately perceive that time is not an ally in their daily struggle to climb out of poverty... (those with assets may) suffer uninsured asset losses that suddenly cast them into poverty and possibly onto a downward spiral from which they have a difficult time re-emerging. These themes from the emerging literature on poverty traps underscore the relation between risk and persistent poverty, as well as the opportunities afforded by innovations in risk management. (Barnett, et al., forthcoming).

Innovations in risk management include cost-effective ways of reducing exposure and vulnerability as well as instruments for sharing and transferring the remaining risks. A cornerstone of risk management must be increased investments in private and collective measures that limit exposure, increase preparedness and reduce vulnerability. It is estimated that only about 2 percent of disaster management expenditures by bilateral and

multilateral donors are spent on disaster risk reduction, whereas estimates show that the benefits are many times the expenditures (Mechler, 2005). Risks, of course, will remain, and risk-sharing and -transfer mechanisms are increasingly viewed as an essential component of risk management. These instruments include conventional insurance, and also informal kinship and community pooling and hedging arrangements, as well as contingent post-disaster credit. Additionally, novel micro- and sovereign- insurance programs are coming on line for households, businesses and governments. These are described below.

3. Financial instruments as security against weather disasters

Insurance and related financial instruments that protect assets and livelihoods against climate disasters and other catastrophic shocks are playing an increasingly visible role in developing countries (Linnerooth-Bayer and Mechler, 2004, 2007a). Novel programs are demonstrating their potential to pool economic losses and smooth incomes of the poor facing weather variability and climate extremes, as well as transfer risks to the global capital markets. They provide insurance to (1) farmers, property owners and small businesses, (2) to donor agencies charged with providing disaster relief, as well as to (3) governments by transferring their risks to the global capital markets. A few examples of donor-supported pilot programs serve to illustrate:

- In *Malawi*, smallholder farmers can purchase affordable index-based drought insurance. Unlike traditional claims-based insurance, indemnity is based on an index of rainfall measured at a local weather station. By making farmers more creditworthy, this pilot loan/insurance scheme enables farmers to purchase hybrid seeds, and thus greatly increase their productivity. (Suarez, et al., 2007; Hess and Syroka, 2005a);
- Similarly, herders in *Mongolia* can purchase an index-based insurance policy to protect them against livestock loss due to extreme winter weather or *dzuds*. Herders retain small losses that do not affect the viability of their business (self-insurance), while larger losses are transferred to the private insurance industry (market-based insurance) and only the final layer of catastrophic losses is borne by the government with backing from the World Bank (social insurance) (Skees, et al., 2008; Skees and Enkh-Amgalan, 2002);

The potential for scaling up these types of insurance programs is huge. Over 40% of farmers in the developing world face weather-related threats to their livelihood (World Bank, 2005), and yet those benefiting directly from micro-insurance systems number in the thousands. For the most part, however farmers and herders do not belong to group referred to as the “poorest of the poor”, who, lacking assets, are probably best served by post-disaster government relief. Here too, pre-disaster financial instruments can provide needed security by insuring the providers of relief.

- The *World Food Programme* issued a bid for transferring Ethiopian drought risk to assure sufficient funds to the government to protect the livelihoods of Ethiopia’s vulnerable drought-exposed populations. US AID paid most of the premium. This insurance instrument holds large promise for supporting institutions that have traditionally provided humanitarian assistance (Hess and Syroka, 2005b).

Ethiopia and many other highly exposed governments not only face financial gaps in providing relief to the poor, but also have uninsured infrastructure portfolios. A well-known theorem by Arrow and Lind (1970) states that governments should not insure if their portfolio is sufficiently diversified and if they can spread their risks across a large taxpayer base. These conditions do not hold for many small and highly exposed developing countries (Mechler, 2004). Moreover, funds promised by donors consistently fall short of the desired level, for instance in 2007, only 72 per cent of requested funds through consolidated and flash appeals by the UN materialized, leaving a shortfall of \$1.4 billion. (UN Office for the Coordination of Humanitarian Affairs, 2008). Already governments are covering potential post-disaster financing gaps by pre-disaster arrangements that transfer their risks to the global markets, as the following examples illustrate:

- The *Mexican government* was the first developing country to issue a catastrophe bond to insure its catastrophe fund and thus reduce its risk of a large fiscal deficit following hurricane and earthquake disasters. (Cardenas, et al. 2007);
- The *Caribbean island states* have recently formed the world's first multi-country catastrophe insurance pool to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes. Technical and other support for this pool was provided by the World Bank, and international development organizations committed funds, for example, to Haiti, to assure wide participation (Ghesquiere, 2006)..

Again, the possibilities for similar arrangements is significant given the largely untapped potential for pooling uncorrelated risks of country governments ill prepared to respond to disasters with their own means.

4. Benefits, costs and challenges of insurance instruments

The benefits of insurance against the threat of weather disasters in developing countries are substantial. Not only do insurance instruments provide security against the loss of assets, livelihoods and even lives in the post-disaster period, but they also can set incentives for reducing exposure and vulnerability. For many in the developing world an insurance contract is preferred to humanitarian assistance. In the words of an insurance expert in India:

“Communities value disaster insurance not because it rewards them or makes them richer after a disaster. They value insurance because they see it as an instrument of dignity. Financial support to recover from a disaster becomes their right without sacrificing their self respect. It is far more dignified to claim your right for recovery than to find yourself dependent on the *ad hoc* generosity of donors” (Hari Krishna, 2007).

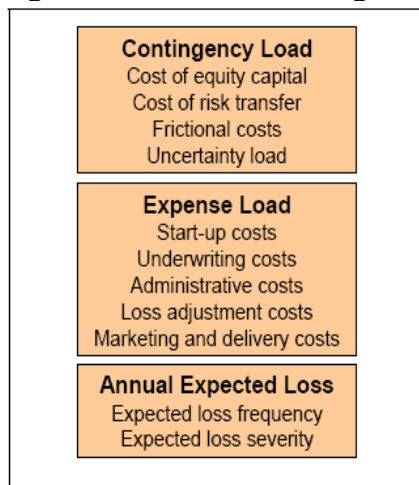
prevention; and not least, spurring economic development.; changing the way development organizations provide disaster assistance and, at the same time, engaging the private sector in vast markets; ensuring reliable and dignified post-disaster relief; setting

Moreover, and importantly, insurance provides the security necessary to take high risk and high payoff investments that are essential for spurring economic development and escaping poverty traps. This is true for both individuals and governments. With insurance, they will rely less on debt financing and international donations, while assurances of the timely repair of critical infrastructure will attract foreign investment.

Switching from post-disaster humanitarian assistance to supporting insurance contracts, especially if they are integrated into a comprehensive risk management program, can also be attractive for international financial and donor organizations (Linnerooth-Bayer, et al., 2005). If coupled with incentives for preventing disaster losses, insurance programs can ultimately reduce the human and economic toll that disasters take on the poor. This means that switching to pre-disaster assistance for insurance, even at extra cost, can be an efficient, long-term strategy because of its potential ultimately to reduce the need for post-disaster humanitarian assistance.

While the benefits of insurance are largely uncontested, it must be emphasized that they are paid for in high associated costs. As shown in Figure 5.1, premiums for catastrophe cover are inflated above the annual expected loss by an expense load, which reflects the costs of doing business, and a contingency load, which includes the cost of holding capital, of assuming uncertain contracts and frictional costs (World Bank, 2008). Frictional costs include expenses resulting from informational asymmetries between capital markets and the insurer's management.

Figure 2: Costs contributing to catastrophe insurance premium (World Bank, 2008)



The contingency load distinguishes catastrophe insurance from other types of insurance prevalent in developing countries. On account of the high capital requirements for insuring co-variant risks, the contingency load is far higher with catastrophe insurance than insurance for health, life and other non-covariant risks, and for this reason catastrophe insurance cannot be easily compared with other types of micro-insurance programs proliferating in the developing world.

The high costs of insurance, coupled with its benefits in reducing poverty, present a major challenge and opportunity to the international community in assuring insurance affordability to poor households, businesses and governments. Development organizations, international financial institutions and NGOs are already supporting insurance in the developing world. In fact, the pilot programs in Malawi and Mongolia, the Ethiopian drought program, as well as the risk transfer and pooling programs in Mexico and the Caribbean, respectively, have all received outside support in the form of technical assistance, reinsurance facilitation and, in some cases, direct subsidies.

Another challenge is assuring that systems avoid moral hazard. Poorly designed insurance contracts can discourage investments in loss prevention or even encourage negligent behaviour, commonly referred to as moral hazard or maladaptation. Insurers guard against moral hazard by requiring deductibles or co-insurance, such that the insured incur part of their losses. Index-based contracts, by decoupling losses and claims, avoid moral hazard altogether. In fact, index-based and well-designed insurance can provide strong incentives for physical interventions and lifestyle changes that reduce disaster risks. Our earlier examples illustrate this: in Malawi, farmers can only gain by planting more drought-resistant crops since insurance payouts are based on precipitation; in Mongolia, farmers who insure their livestock will face increasing premiums as climate change worsens weather conditions – giving them an added incentive to change livelihoods if animal husbandry becomes unproductive; in Mexican, government officials will face higher interest on their catastrophe bonds if they do not take measures to reduce risks to public infrastructure. This is the power of risk-based insurance premiums.

5. Efficiency and international support for insurance

Critics rightly argue that outside support for insurance, especially in the form of premium subsidies, can distort incentives and discourage efficient adaptation actions. If premiums do not fully reflect risks, they may perpetuate vulnerability by discouraging investments in disaster prevention and making it possible to remain in high-risk livelihoods or locations. As a case in point, subsidized crop insurance in the US has weakened incentives to plant more robust crop varieties, or to move away from farming in high drought or flood risk areas. In the words of Jerry Skees, a US insurance expert:

If the intent is to improve the well-being of farmers, it may be preferable to give them direct monetary transfers than to subsidize insurance premiums. A particularly ‘bad’ subsidy is one that is proportional to the premium since the disincentive to change crop practices becomes greater as the risk (and premium) increases. (Jerry Skees, 2007).

The same message is voiced by Howard Kunreuther and his colleagues at Wharton, who call for two principles, reflecting efficiency and equity, which they argue should guide hurricane insurance provision in the U.S.

- Insurance premiums should be based on risk in order to provide signals to individuals as to the hazards they face, and to encourage them to engage in cost-

- effective mitigation measures to reduce their vulnerability to catastrophes;
- Any special treatment given to homeowners currently residing in hazard prone areas should come from general public funding and not through insurance premium subsidies (Wharton Risk Management and Decision Processes Center, 2008,p. ii).

General public funding, which in the development context might take the form of direct cash transfers to low-income households and business, is an intriguing and possibly more efficient alternative to providing subsidies or backup capital to insurance systems. In fact, many development experts are pointing to money transfers as a preferred alternative to development assistance projects. In Mexico, as a case in point, the *Progresa* program provides cash to four million poor mothers conditional on them sending their children to school and health visits (de Janvry and Sadoulet, 2004). These programs have been hailed as being among the most significant innovations in promoting social development in recent years. According to the president of the Center of Global Development, “I think these programs are as close as you can come to a magic bullet in development...Every decade or so, we see something that can really make a difference, and this is one of those things” (quoted in de Janvry and Sadoulet, 2004).

In considering this alternative to subsidized insurance, the question arises whether vulnerable households would allocate an “efficient” part of their added cash for purchasing disaster insurance, or, rather, continue to rely on post-disaster humanitarian assistance. If the latter, the interests of the state might call for making cash transfers conditional on purchasing insurance in the same way cash transfers in Mexico are conditional on child education and health care. Something along these lines has been suggested by the Wharton researchers, who suggest insurance vouchers for those who cannot afford the full risk-based premium (Wharton Risk Management and Decision Sciences Center, 2008). In terms of the price signal, a voucher would be preferable to subsidies, unless subsidies are designed to reward risk reducing behaviour (e.g., by a fixed and not percentage premium reduction). Both are preferable to full reliance on ad hoc, post-disaster aid, and both address the equity concerns by relieving poor persons from paying their full risk load.

Moreover, vouchers, subsidies and other forms of support can be justified by failures of the market to provide the right price signals. This is the case in Mongolia, where government support for the syndicate pooling arrangement takes the form of absorbing losses from very infrequent extreme events (over 30% animal mortality), and the government can call upon a World Bank contingent debt arrangement to back this commitment (Skees, et. al., 2008). The designers of this program argue that subsidizing the “upper layer” is less price-distorting than subsidizing lower layers of risk because the market may fail to provide insurance for this upper layer. On the demand side, most people tend to be myopic and underestimate very low probability events (Kunreuther and Michel-Kerjan, 2008); on the supply side, insurers tend to charge premiums above the market price because of their contingency load.

This latter point deserves special attention since a large part of the contingency load is compensating insurers for taking on uncertain and ambiguous risks. In pioneering research, Kunreuther, et al. (1995) have shown that underwriters appear to be risk averse, and, moreover, they do not follow what might be viewed as the rational paradigm of expected utility maximization in underwriting insurance. Experimental evidence shows that insurers are not indifferent to ambiguity or uncertainty in the probability estimates. In situations with high uncertainty and ill-defined probability estimates, insurers will load the insurance premium to account both for risk aversion and ambiguity. This means that developing country clients will transfer premium to insurers above and beyond the insurer's operating and capital costs. In other words, the price of insurance can be significantly greater than the "real risk premium" (expected losses) plus the real costs facing insurers (operating and capital).

To eliminate this "risk aversion and ambiguity" load, one idea is to provide support for insurance schemes such that premiums reflect the *real risk price*, or expected loss, which arguably is the proper signal for the insured to reduce their vulnerability. For those unable to pay even the real risk premium, their contribution might be in terms of actively contributing to risk-reducing strategies, such as constructing safety hills or installing rain-collection devices (Bals, et al., 2007).

A related concern is that public or international involvement in the provision of insurance, even with "smart" subsidies, will impede the development of the private insurance market. Although private insurers and re-insurers are constrained in their ability to offer worldwide, catastrophe risk coverage, there is still concern that public assistance will crowd out private operations. While partnerships like the Caribbean insurance pool actually create an opportunity for the private market to carry out business, deep premium subsidies or ill-conceived public-private partnerships can prevent private companies from entering the market. This issue underlines the importance of carefully designing international support instruments.

6. Equity and international support for insurance

There are at least two compelling reasons why international organizations, financial institutions, governments and NGOs in the developed world should consider supporting insurance systems and other pre-disaster financial instruments in developing countries. The first is an efficiency argument. Since insurance can provide incentives for reducing risks and ultimately humanitarian assistance, pro-active support for post-disaster financing can be a win-win proposition for both donors and recipients. In addition, by sharing responsibility with individuals and the state, donors leverage their limited humanitarian budgets and substitute a calculable annual commitment for the unpredictable granting of post-disaster aid.

A second reason has to do with global equity. The UN World Economic and Social Survey 2008 argues that security against disasters cannot be left to individual responsibility and market forces:

Transferring the responsibility for sufficient protection against disasters to individuals by merely ensuring that risk transfer and risk pooling, such as insurance, are *available* can therefore not be the primary pillar for addressing the insecurity challenge (UN Department of Economic and Social Affairs, 2008, p. 110)

The case for shifting more responsibility to the developed world is greatly strengthened by recent evidence that greenhouse gas (GHG) emissions are contributing to increased weather variability and the risks of extreme events, and disproportionately burdening vulnerable developing countries. According to the wording of the UNFCCC, the principle of ‘common but differentiated responsibilities and respective capabilities’, means industrialized countries are obligated to absorb a portion of this burden. The question is how best to take on this responsibility.

The climate convention and the recent Bali Action Plan specifically call for the consideration of risk-management and risk-reduction strategies, including risk-sharing and transfer mechanisms such as insurance, as a means to address loss and damage in developing countries particularly vulnerable to climate change (Decision 1/CP.13, Bali Action Plan). Although numerous proposals for insurance instruments have been put forward, and even tabled in the climate negotiation process, their precise role in an adaptation regime is still largely undetermined (Linnerooth-Bayer and Mechler, 2007b). To help define this role, the Munich Climate Insurance Initiative (MCII) has put forward a proposal to include insurance instruments in a post-Kyoto adaptation regime (MCII, 2008). A risk-management financing mechanism would include two pillars: *prevention* and *insurance*, which would act together to reduce the human and economic burdens on developing countries. The insurance pillar would include a global solidarity facility for compensating losses from high-level risks as well as a facility for providing technical support and possibly subsidies for fledgling insurance systems that serve the poor. The pillars would be fully financed by a post-Kyoto adaptation fund.

7. Summary

The benefits of providing affordable access to insurance against the threat of weather disasters are clear: providing security against the wholesale loss of assets, livelihoods and even lives in the post-disaster period; changing the way development organizations provide disaster assistance and, at the same time, engaging the private sector in vast markets; ensuring reliable and dignified post-disaster relief; setting powerful incentives for prevention; and not least, spurring economic development. There are also many challenges: assuring sustainability and affordability in light of covariant risks; defining an appropriate role for donors in light of the inefficiencies of subsidies; and, assuring that systems avoid moral hazard and contribute to productive investments.

While the benefits and challenges of insurance for providing security to the poor are uncontested, the role of outside assistance for insurance instruments is highly controversial. Opponents rightly argue that support in the form of subsidies can distort the price signal and encourage maladaptation; support in the form of reinsurance can crowd out the role of the private market. Yet, most experts agree that even subsidized

insurance systems are in this regard preferable to post-disaster aid, and the reinsurance market is not yet prepared to commit sufficient and affordable capital to markets serving the poor. Moreover, the case for intervention is strengthened by the failure of the market to provide the correct price incentives, and by recent evidence that GHG emissions are contributing to increased weather variability and risks of extreme events. According to the Climate Convention's principle of 'common but differentiated responsibilities and respective capabilities', industrialized countries have some obligation to address this burden.

A practical way forward is to include a risk management mechanism in the post-Kyoto adaptation architecture. A proposal for such a mechanism has been recently put forward by the Munich Climate Insurance Initiative, and calls for two pillars on prevention and insurance, both of which would be fully financed by a post-Kyoto adaptation fund (MCII, 2008).

References

- Antle, J.M. (1995). Climate Change and Agriculture in Developing Countries. *American Journal of Agricultural Economics*. **77**:741-746.
- Arrow, K. J. and R.C. Lind (1970). Uncertainty and the Evaluation of Public Investment Decisions. *The American Economic Review* **60**: 364-378
- Bals, C., S. Butzengeiger and K. Werner (2007), "Insuring the Uninsurable: Design Options for a Climate Change Funding Mechanism", in *Climate Policy*, E. Gurenko, ed. Special Issue on Insurance and Climate Change.
- Barnett, B., C. Barrett and J.R. Skees (forthcoming). Poverty Traps and Index-based Risk Transfer Products. Working Paper, Department of Agriculture and Applied Economics, University of Georgia.
- Cardenas, V., Hochrainer, S., Mechler, R., Pflug, G., and Linnerooth-Bayer, J. (2007). Sovereign Financial Disaster Risk Management: The Case of Mexico. *Environmental Hazards* 7 (2007), 40-53.
- de Janvry, A. and E. Sadoulet (2004). Conditional Cash Transfer Programs: Are they really Magic Bullets? Department of Agricultural and Resource Economics, University of California at Berkeley. <http://are.berkeley.edu/~sadoulet/papers/ARE-CCTPrograms.pdf>
- FAO (2000). Public Assistance and Agricultural Development in Africa, Twenty-first FAO regional conference for Africa, Yaounde, Cameroon.
- Ghesquiere, F., Mahul, O., Forni, M., Gartley, R. (2006). Caribbean Catastrophe Risk Insurance Facility: A solution to the short-term liquidity needs of small island states in the aftermath of natural disasters, www.aidandtrade.org, IAT03-13/3
- Hess, U. and Syroka J. (2005a). Weather-based Insurance in Southern Africa: The Case of Malawi, Agriculture and Rural Development Discussion Paper 13, Washington DC, The World Bank.
- Hess, U. and Syroka, J. (2005b). Risk, Vulnerability and Development. Presentation at BASIX Quarterly Review & Insurance Meeting, Hyderabad, 21st October.
- Intergovernmental Panel on Climate Change (IPCC) (2007). Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability Summary for Policymakers. Cambridge University Press, Cambridge.
- Krishna, H. (2007). Presentation discussion. Expert workshop on Insurance Instruments for Adaptation to Climate Risks, International Institute for Applied Systems Analysis (IIASA), Munich Re, the German Agency for Technical Cooperation (GTZ) and World Bank, and as part of the activities of the EU Integrated Project on Adaptation and Mitigation (ADAM), Laxenburg, Austria, Sept. 24-5.

- Kunreuther, H. and E. Michel-Kerjan (2008). A Framework for Reducing Vulnerability to Natural Disasters: Ex Ante and Ex Post Considerations, Draft paper, Wharton Risk Management and Decision Processes Center, The Wharton School, University of Pennsylvania, Philadelphia.
- Kunreuther, H., J. Meszaros, R. Hogarth and M. Spranca (1995). Ambiguity and underwriter decision processes, *Journal of Economic behavior and Organization*, 26:337-352.
- Linnerooth-Bayer, J. and Mechler, R. (2004), Financing Disaster Risks in Developing and Emerging-Economy Countries, Paper presented at the OECD conference, "Catastrophic Risks and Insurance", Paris, November 22, 2004.
- Linnerooth-Bayer, J., Mechler, R., Pflug, G. (2005). Refocusing Disaster Aid. *Science*, 309, 1044–1046.
- Linnerooth-Bayer, J. and Mechler, R. (2007a). Disaster Safety Nets for Developing Countries: Extending public-private partnerships, *Environmental Hazards* 7 (2007), 54-61.
- Linnerooth-Bayer, J. and R. Mechler (2007b). "Insurance for Assisting Adaptation to Climate Change in Developing Countries: A Proposed Strategy." in *Climate Policy*, E. Gurenko, Ed. Special Issue on Insurance and Climate Change.
- Linnerooth-Bayer, J., C. Bals and R. Mechler (forthcoming). Climate Insurance as part of a post-Kyoto Adaptation Strategy, Paper to appear in *Climate Change: Strategies for Europe*, Cambridge University Press: Cambridge.
- Mechler, R. (2004). Natural Disaster Risk Management and Financing Disaster Losses in Developing Countries, Verlag für Versicherungswirtschaft, Karlsruhe.
- Mechler, R. (2005). Cost-benefit analysis of natural disaster risk management in developing countries. Working paper. Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ), Eschborn.
- Mills, E. (2005). Insurance in a Climate of Change. *Science*, 309, 1040-1044.
- Munich Re (2005). NatCatSERVICE, Natural disasters according to country income groups 1980-2004. Munich Re, Munich.
- Munich Climate Insurance Initiative (MCII) (2008). Insurance Instruments for Adapting to Climate Risks: A proposal for the Bali Action Plan, Submission to the 4th session of the Ad Hoc Working Group on Long-Term Cooperative Action under the Convention (AWG-LCA 3). Poznan 1-13 December, 2008.
- Okun, Arthur (1975). *Equality and Efficiency, the Big Tradeoff*. Washington, D.C.: Brookings Institution.
- Ribot, J.C., Magalhaes, A. and Panagides, S. (Eds) (1996). Climate Variability, Climate Change, and Social Vulnerability in the Semi-Arid Tropics. Cambridge University Press, Cambridge.
- Skees, J. R., B. J. Barnett, and A. G. Murphy (2008). Creating Insurance Markets for Natural Disaster Risk in Lower Income Countries: The Potential Role for Securitization. *Agricultural Finance Review* 68: 151–157.

Skees, J. R. (2001). The Bad Harvest: More Crop Insurance Reform: A Good Idea Gone Awry. *Regulation: The CATO Review of Business and Government* 24, 16-21.

Skees, J. R. and A. Enkh-Amgalan (2002). Examining the feasibility of livestock insurance in Mongolia.. World Bank Working Paper 2886, September 17.

Skees, J.R. (2007). Presentation discussion, Expert workshop on Insurance Instruments for Adaptation to Climate Risks, International Institute for Applied Systems Analysis (IIASA), Munich Re, the German Agency for Technical Cooperation (GTZ) and World Bank, and as part of the activities of the EU Integrated Project on Adaptation and Mitigation (ADAM), Laxenburg, Austria, Sept. 24-5.

Solomon, S., Qin, D., Manning, M., Alley, R.B., Berntsen, T., Bindoff, N.L., Chen, Z., Chidthaisong, A., Gregory, J.M., Hegerl, G.C., Heimann, M., Hewitson, B., Hoskins, B.J., Joos, F., Jouzel, J., Kattsov, V., Lohmann, U., Matsuno, T., Molina, M., Nicholls, N., Overpeck, J., Raga, G., Ramaswamy, V., Ren, J., Rusticucci, M., Somerville, R., Stocker, T.F., Whetton, P., Wood, R.A. and D. Wratt (2007) Technical Summary. In: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M. Averyt, K.B., Tignor, M. and H.L. Miller (eds.). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge.

Suarez, P., Linnerooth-Bayer, J., Mechler, R. (2007). *The Feasibility of Risk Financing Schemes for Climate Adaptation: The case of Malawi*, DEC-Research Group, Infrastructure and Environment Unit, The World Bank, Washington DC.

United Nations International Strategy for Disaster Reduction (UNISDR) (2007). <http://www.unisdr.org/disaster-statistics/impact-economic.htm>

United Nations Office for the Coordination of Humanitarian Affairs, Consolidated and Flash Appeals 2007, Global requirements and funding per sector as of 27 March 2008. Available from http://ocha.unog.ch/fts/reports/daily/ocha_R21_Y2007_o8030307.pdf

United Nations Department of Economic and Social Affairs, World Economic and Social Survey 2008, *Overcoming Economic Insecurity*, E/2008/50/Rev.1, ST/ESA/317. Available at <http://www.un.org/esa/policy/wess/wess2008files/wess08/wess2008.pdf>

Wharton Risk Management and Decision Processes Center (2008) *Managing Large-scale Risks in a New Era of Catastrophes: Insuring, Mitigating and Financing Recovery from Natural Disasters in the United States*, Wharton: University of Pennsylvania.