VIEWPOINT

Insurance in a Climate of Change

Evan Mills*

Catastrophe insurance provides peace of mind and financial security. Climate change can have adverse impacts on insurance affordability and availability, potentially slowing the growth of the industry and shifting more of the burden to governments and individuals. Most forms of insurance are vulnerable, including property, liability, health, and life. It is incumbent on insurers, their regulators, and the policy community to develop a better grasp of the physical and business risks. Insurers are well positioned to participate in public-private initiatives to monitor loss trends, improve catastrophe modeling, address the causes of climate change, and prepare for and adapt to the impacts.

Business and science meet in the wake of disasters. The insurance sector is a lightning rod, serving as global integrator of impacts across all sectors of the economy, and messenger of these impacts through the terms and price signals it projects to its customers (*1*). As the world's largest industry [it would be the third largest country if its $3.2 trillion in yearly revenues were compared with national gross domestic products (GDPs)], the implications of rising disaster losses on insurers are as important as defining the industry's role in furthering understanding of the problem and advancing loss-prevention solutions.

The insurance "industry" is nonmonolithic, with considerable regional variations in coverages, hazard exposure, and regulation within and among countries. Insurance penetration averages 9% of GDP ($2750/capita) in industrialized countries and 5% of GDP ($25/capita) in developing countries and economies in transition (*2*). Although 12% of premiums today come from this latter market, at current growth rates it will constitute half of the global market within a few decades. Insurance payouts for weather-related disasters in the developing world are today three times the amount provided by international aid (*3*).

Insurance is part of a broader public-private patchwork for spreading risks across time, over large geographical areas, and among diverse social and commercial communities. Not all natural hazards are insured. In some cases (e.g., flood, crop), public and private agencies share the risk. The growing repository of insurance loss data—considered among the best sources of disaster statistics (*4*)—augments geophysical observing systems with trends in economic impacts.

The availability and affordability of insurance are grist for economic development and the financial cohesion of society, as well as security and peace of mind in a world where the knowledge of hazards lags their evolution. Unanticipated changes in the nature, scale, or location of hazards are among the most important threats to the insurance system. History has shown that society in general, and insurers in particular, are often caught unprepared for ostensibly "inconceivable" disasters. This reflects, in part, the recurring social miscalculation of using the past to predict the future while underinvesting in disaster preparedness. Be it the attacks of "9/11" or Hurricane Andrew, expectations based on past experience led to complacency and dramatic underestimation of exposure. An eye-opening insurance industry report from the mid-1980s (*5*) highlighted the importance of anticipating multiple large events in a single year, yet exposures are still often expressed in terms of probable maximum losses for single events rather than for entire insurance "seasons." The limitations of this approach were evident in the 2004 U.S. hurricane season and its $60 billion in economic losses (of which half were insured).

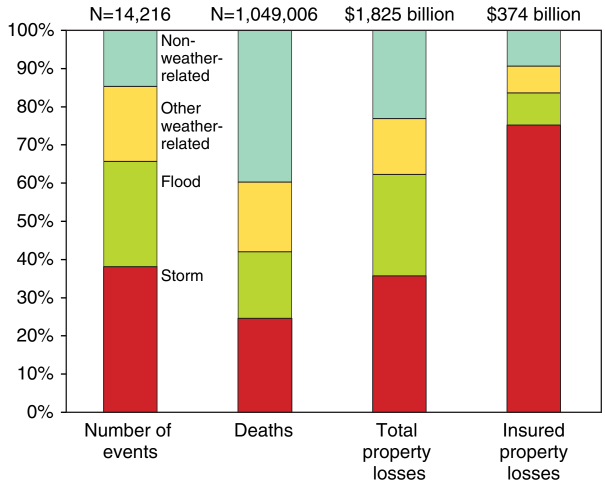

Fig. 1. Global impacts of natural disasters from 1980 to 2004. Insured property losses are dominated by storm events due to risk-selection preferences of insurers and coverage of flood and crop exposures by public entities, and low penetration of earthquake insurance. Economic values are inflation-adjusted to 2004 levels. [Source: Munich Re, NatCatSERVICE]

The weather-dependent share of global insured catastrophe losses (~90%) is greater than that experienced by the economy as a whole (~75%) (Fig. 1). This, coupled with the increase in the number, cost, and variability of such losses (Fig. 2), has brought some insurers, reinsurers, and their trade associations to view climate change as a strategic factor in their future (*6*–*8*).

Virtually all segments of the industry have a degree of vulnerability to the likely impacts of climate change, including those covering damages to property (structures, automobiles, marine vessels, aircraft); crops and livestock; pollution-related liabilities; business interruptions, supply-chain disruptions, or loss of utility service; equipment breakdown arising from extreme temperature events; data loss from power surges or outages; and a spectrum of life and health consequences (*1*).

Specific technical risks include the following: (i) Shortening times between loss events. (ii) Changing absolute and relative variability of losses. (iii) Changing structure of types of events. (iv) Shifting spatial distribution of events. (v) Damage functions that increase exponentially with weather intensity (e.g., wind damages rise with the cube of the speed). (vi) Abrupt or nonlinear changes in losses. (vii) Widespread geographical simultaneity of losses (e.g., from tidal surges arising from a broad die-off of protective coral reefs or disease outbreaks on multiple continents). (viii) More single events with multiple, correlated consequences. This was well evidenced in the pan-European heat catastrophe of 2003—where temperatures were six standard deviations from the norm (*9*). Immediate or delayed impacts included extensive human morbidity and mortality, wildfire, massive crop losses, and the curtailment of electric power plants owing to the high temperature or lack of cooling water. (ix) More hybrid events with multiple consequences [e.g., El Niño–Southern Oscillation (ENSO)–related rain, ice storms, floods, mudslides, droughts, and wildfires].

Specific market-based risks include the following: (i) Historically based premiums that

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lag behind actual losses (especially for life insurers, where premiums may be fixed over long periods). (ii) Failing to foresee and keep up with changing customer needs arising from the consequences of climate change. (iii) Unanticipated changes in patterns of claims, and associated difficulty in adjusting pricing and reserve practices to maintain profitability. (iv) Responses of insurance regulators (*10*). (v) Reputational risks falling on insurers who do not, in the eyes of consumers, do enough to prevent losses arising from climate change. (vi) Stresses unrelated to weather but conspiring with climate change impacts to amplify the net adverse impact. These include drawdowns of reserves due to earthquakes or terrorist attacks and increased competition from self-insurance or other competing methods of risk-spreading (especially if relatively low-risk customers shift to those products).

Observed Trends

It is widely recognized that the costs of weather-related natural disasters have been rising. The impacts include an elevated need for assistance from outside impacted areas (*11*) and a shrinking gap between insurance premiums and losses (Fig. 3).

From 1980 through 2004, the global economic costs of such events totaled US$1.4 trillion ($2004), of which $340 billion were insured. To put the burden of these costs on insurers in perspective, recent average annual losses surpass those experienced in the aftermath of the 9/11 attacks in the United States. These costs are substantial for insurers and their customers, leading to industry-wide unprofitability in the worst years (even including investment gains), abrupt price increases, and isolated bankruptcies. Although headline-catching catastrophic events are the most visible, the average aggregate insured cost of smaller events is 60% of the total (*1*).

The insured share of total economic losses from weather-related catastrophes is rising, increasing from a negligible fraction in the 1950s to 25% in the last decade. The ratio has climbed more quickly in the United States, with more than 40% of the total disaster losses insured in the 1990s (*12*).

For several reasons, the cited magnitude of losses systematically underestimates actual costs to insurers and the broader economy because, although large in aggregate, small events are rarely captured in these statistics (especially in the developing world). For example, the Property Claims Services (PCS), which compiles data for U.S. insurers, includes only those events with costs above a threshold of US$25 million. Among the types of events often excluded, power outages in the United States alone are estimated to result in a cost of US$80 billion per year (*13*) [and weather-related events account for 60% of the customers affected by disturbances on the bulk power grid (*14*)], and lightning strikes cause billions of dollars of losses each year, as do damages from soil subsidence (*1*), the melting of permafrost (*15*), and wildfire (*16*). No winter storms were included in the PCS statistics for the 46-year period from 1949 to 1974, and few were included thereafter (*17*). Similarly, aggregate weather-related vehicle accidents are typically not tracked. Furthermore, trends toward increasing deductibles and decreasing insured limits, as well as a strong shift toward self-insurance, lower year-to-year insurance payouts for like events. Finally, the figures cited above largely exclude weather-related life and health costs; restrictions on trade, travel, and tourism; disaster preparedness; and evacuations, energy price increases, and other second-order market impacts of severe weather.

Attribution

Socioeconomic and demographic trends clearly play important—and likely dominant—roles in the observed upward loss trends (*18*). As recognized by insurers and others, migration of populations to flood- and fire-prone areas, increasing reliance on vulnerable electric power grids, and rising material wealth are among the many drivers. Changes in the incidence and impacts of extreme weather events and sea-level rise can also be observed (*19–22*).

Global weather-related losses in recent years have been trending upward much faster than population, inflation, or insurance penetration, and faster than non–weather-related events (Fig. 2D). By some estimates, losses have increased by a factor of 2, after accounting for these factors plus increased density of insured values (*23*, *24*). The Association of British Insurers states that changes in weather could already be driving UK property losses up 2 to 4% per year (*7*) owing to increasing extreme weather events. Specific event types have increased far more quickly than the averages. For example, damages from U.S. storms grew 60-fold to US$6 billion/year between the 1950s and the 1990s (*21*).

According to the latest Intergovernmental Panel on Climate Change (IPCC) assessment, climate change has played a role in the rising costs of natural disasters (*1*). As an illustration of the linkages, the distribution and frequency of lightning strikes is expected to shift under climate change (*25*), and insurers indeed observe a notable increase in losses during periods of elevated temperatures (Fig. 4) (*6*).

Many human activities mask losses that would otherwise manifest in the trend data. These include improved building codes, early-warning systems, flood control, electric load-shedding to avoid blackouts during heatwaves, disaster preparedness and response, and land-use planning. Insurer actions to reduce their exposures produce a dampening effect on ob-

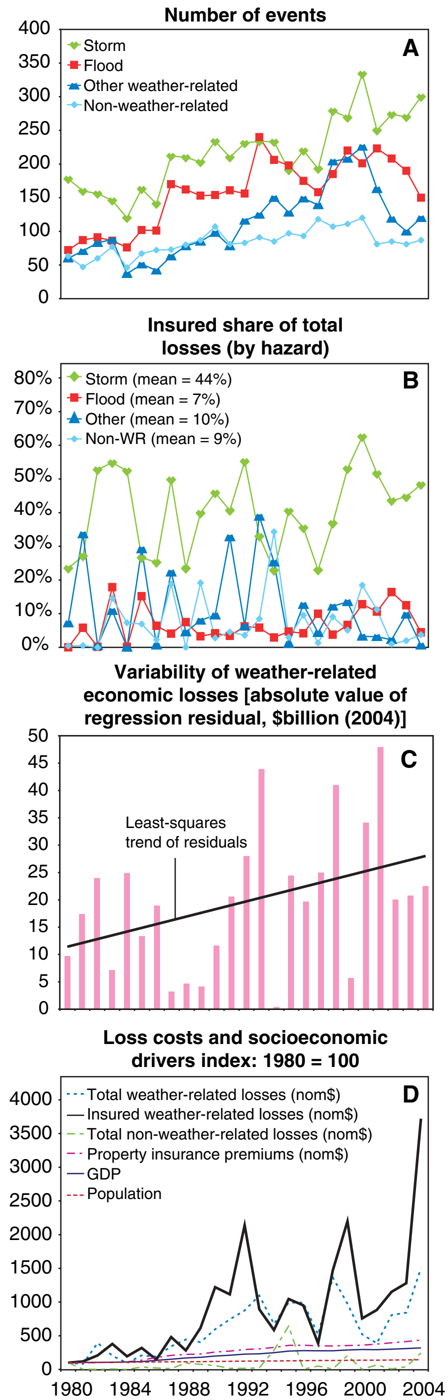

Fig. 2. (A to D) Trends in (A) global numbers of weather-related events, (B) insured share, (C) variability of total losses, and (D) economic impacts and demographic drivers. Insured and total property losses ($45 billion and $107 billion in 2004, respectively) are rising faster than premiums, population, or economic growth. Data exclude health and life insurance premiums and losses. Non-inflation–adjusted economic data are shown in relation to GDP. Inflation-adjusted economic losses from catastrophic events rose by 8-fold between the 1960s and 1990s and insured losses by 17-fold (*11*). [Sources: Natural hazard statistics and losses from Munich Re, NatCatSERVICE; Premiums from Swiss Re, *Sigma*]

served insured costs. Untangling these offsetting factors is a necessary part of any comprehensive attribution analysis and has not been dealt with satisfactorily in the literature.

In any event, the consequences of future climate change will be amplified by economic development and the tendency of populations to move into harm's way. Regardless of the relative weights of anthropogenic climate change and increased exposure (quantification is premature), rising uncertainty would complicate the fundamental actuarial and pricing processes that underlie well-functioning insurance markets.

The Globalization of Risk: One View of the Future

Most scenarios of climate change impacts are cast from the vantage point of the natural sciences with minimal examination of economic implications. Moreover, analysts often take an understandably simplified "stovepipe" approach by examining a specific type of event in isolation from the real-world mosaic of interrelated causes, vulnerabilities, and impacts.

The following business scenario—based on current socioeconomic trends and insurance market dynamics—explores an ensemble of events and impacts occurring simultaneously. The triggering events arise from the consequences of gradual anthropogenic climate change. Abrupt changes also anticipated in the longer term by many in the scientific community (*26*) are not included. The result is a plausible—and certainly neither a worst- nor best-case—rendition of what the future could bring.

In this scenario, weather-related property losses and business interruptions continue to rise at rates observed through the latter 20th century. The insured share increases, and underwriting becomes more problematic. Corporations face more environmentally related litigation (and associated insurance payouts), both as emitters of greenhouse gases and from noncompliance with new regulations (*27*).

A new class of losses emerges within the life and health branches of the insurance industry (*28*). These are driven by thermal extremes, reduced water quality and availability, elevated rates of vector-borne disease, air pollution, food poisoning, and injuries and mortalities from disasters and their associated mental health impacts (*11*, *29*, *30*). Other health consequences manifest in natural systems that directly or indirectly affect human systems, including coral-reef bleaching, agricultural diseases or other events that hamper food production, animal and livestock diseases, and pests such as pine beetle superinfestations. Mobilization of dust, smoke, and CO_2-linked aeroallergens (e.g., pollen and molds) exacerbates already high rates of asthma and other forms of respiratory disease.

The combined effect of increased losses, pressure on reserves, inflation of construction costs following natural disasters, and rising costs of risk capital result in a gradual increase in the number of years in which the industry is not profitable. A compounding effect arises from the continued destructive industry practice of underpricing risk and routinely allowing the core business to operate at a loss, relying instead on profits from their investments (also known as "cash-flow underwriting"). As occurred following the European windstorms of the 1990s (*7*), insurers periodically encounter liquidity problems when paying claims, forcing the sale of large blocks of securities, which, in turn, creates undesirable "knock-on" impacts in the broader financial markets. Outcomes are particularly bad in years when large catastrophe losses coincide with broader market downturns.

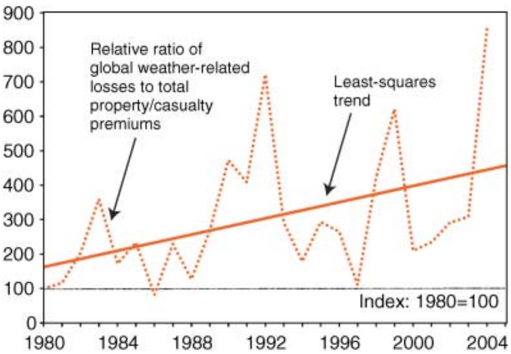

Fig. 3. Declining insurance industry capacity to absorb weather-related natural disasters. Curves show ratio of global weather-related property losses to total property/casualty premiums over the past quarter-century, indexed to average 1980 levels. [Sources as in Fig. 2]

Insurance operations in the developing world and economies in transition (the primary growth markets for insurance, already generating nearly $400 billion/year in premiums) are the most markedly affected. This arises from a combination of inferior disaster preparedness and recovery, more vulnerable infrastructure due to the lack or nonenforcement of building codes, high dependency on coastal and agricultural economic activities, and lack of funds to invest in disaster-resilient adaptation projects (*3*). Insurers also experience rising losses under political risk policies in these regions, as civil unrest and conflicts over food, water resources, and refugees manifest in the wake of natural disasters (*31*). Insurers from industrialized countries share these losses through their growing expansion into these emerging markets.

As insurability declines, insurers use traditional methods to reduce their exposures: increased premiums and deductibles, lowered limits, nonrenewals, and new exclusions. Although consumer demand for insurance increases at first, it evolves into reduced willingness to pay, and some shift from the use of insurance to alternatives such as weather derivatives.

As warned by the U.S. Government Accountability Office (*32*), private insurers encounter increasing difficulty in handling extreme weather events. As commercial insurability declines, demands emerge to expand existing government-provided insurance for flood and crop, and to assume new risks (e.g., wildfire and windstorm). Cash-strapped governments, however, find that claims interfere with balancing their budgets (*4*) and, in turn, limit their coverage (*33*), with the result that more ultimate losses are shifted back to the individuals and businesses affected by climate change. Compounding the problem, international aid for natural disasters continues its current decline as a percentage of donor-country GDP (*3*).

The impacts of climate change accelerate several forms of unrelated adverse structural change already under way in the insurance industry. This manifests as a rise in competition among insurers, consolidation due to the reduced viability of small firms, increased risk exposure by way of globalization, and a growing proportion of competing self-insurance and alternative risk transfer mechanisms. Better prepared for the impacts of climate change, European and Asian insurers capture market share from the United States.

Although the industry is not bankrupt, as some have suggested, an increasing number of firms do succumb to these losses, especially where solvency regulation is weak. In the United States, at least 7% of insurer bankruptcies are currently attributed to catastrophes (*34*). As the globe warms, climate change puts a chill on the insurance market. Insurance ceases to be the world's largest industry.

Policy Considerations

With human-induced climate change, the locus of Garrett Hardin's "tragedy of the commons" (*35*) as conceived in the 1960s has mushroomed from pastoral grazing lands to the global atmosphere. While his treatise was written before the issue was widely recognized, in a reprise three decades later Hardin reflected: "On the global scale, nations are abandoning not only the freedom of the seas, but the freedom of the atmosphere, which acts as a common sink for aerial garbage" (*36*). The relevance for insurers is twofold. They will inevitably experience some of the impacts and mirror back to society (through their selection and pricing of risk) some of the costs of externalities imposed on the climate commons. They may also become more proactive in formalizing social solidarity to prevent and, when necessary, endure and adapt to extreme events that individuals cannot manage independently, keeping the commons livable and sustainable and the insurance business viable. This is the highest form of insurance, with roots in its centuries-old tradition of loss prevention. What happens in practice remains to be seen.

Insurance is a form of adaptive capacity for the impacts of climate change, although the sector itself must adapt in order to remain viable. It is incumbent on insurers, their regulators, and the policy community to develop a better grasp of the physical and business risks. A key issue is whether the meeting of commercial interests with the expectation that insurance serves a basic social function results in market failures under climate change. Related questions concern the nature and desirability of loss prevention, universal coverage, and profit-driven decisions to exclude coverage for certain individuals or hazards.

Can insurers extend their self-chosen historical role in addressing root causes (as founders of the first fire departments, building codes, and auto safety testing protocols) to one of preventing losses at a much larger scale, namely, the global climate? Should insurance regulators take a more active role in fulfilling their obligation to maintain insurance availability and affordability? How can the public be more effectively enlisted in loss prevention? What is government's role, and will it serve as "insurer of last resort"?

Although insurers first expressed concern about climate change more than three decades ago (*37*), fewer than one in a hundred appear to have seriously examined the business implications (*38*), and fewer still present their analyses in the open literature (*7*, *8*, *11*, *39*–*41*). This state of affairs heightens the likelihood of unanticipated adverse outcomes.

Disjointed modeling traditions and inconclusive attribution analyses hamper the industry's ability to assess weather-related risks and regulators' ability to safeguard both insurers and consumers (*1*). Insurers' weather-related loss models focus primarily on catastrophic events (to the exclusion of a broader array of small-scale events that have larger aggregate impacts), are predicated on extrapolating historical trends, and largely neglect life and health impacts. In contrast, the climate change community's models are future-focused, yield results not easily applied to business decision-making, and underestimate the physical and economic impacts of abrupt climate changes (*26*). These communities operate largely in isolation (*42*). An effort to bridge the gap, in the case of windstorms under climate change (*40*), yielded striking results. Predicted losses, technical prices (risk premiums), and capital requirements under a low-emissions scenario [525 parts per million by volume (ppmv) atmospheric CO_2 concentration by 2080] were one-fifth to one-eighth those under a high-emissions case (810 ppmv CO_2). The value of improved data and modeling is central, as evidenced by a shift in the industry (thanks in part to better models) toward accepting flood risks where they previously had been viewed as uninsurable (*43*).

Certain measures that integrate climate change mitigation and adaptation can simultaneously reduce insurance losses (*44*). Examples include protection of mangroves, reefs, and wetlands that buffer storm surge and wave risks. A host of energy-efficiency technologies also provide insurance loss-prevention benefits (*45*, *46*). A few insurers have sought to lead by example, e.g., Swiss Re has committed to becoming carbon-neutral in its operations and asset management, and a growing number have initiated enterprise-wide sustainability programs.

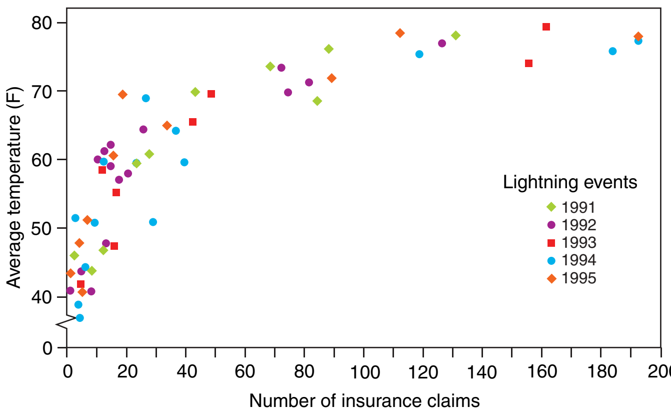

Fig. 4. Lightning-related insurance losses increase with temperature (*6*). Each symbol represents monthly losses in the continental United States.

Public-private partnerships are clearly essential (*11*, *43*, *47*). Insurers and governments have devised innovative means of spreading financial risk while fostering loss-prevention practices (*3*, *48*). Government's role can include research, education, emissions reductions, land-use planning, disaster preparedness, and provision of backstop reinsurance. Joint efforts to develop innovations such as microinsurance and microcredit can better serve the uninsured and fund disaster preparedness in the developing world. Such efforts should be coupled with a more prevention-oriented paradigm within the development and disaster relief communities.

Insurers will also find business opportunities in responding to climate change (*7*, *39*, *47*). These include new risk-management products for emissions reductions and loss-prevention technologies, analysis and advisory services, participation in adaptation activities, and increased demand for insurance itself.

Are insurers simply fomenting fear about climate change in order to sell more of their product or raise prices? This is doubtful. An industry thus motivated would be sounding a much louder alarm. Moreover, insurance regulators rarely allow price increases or expansion of reserves based on projected losses, and price competition is stiff. The prospects of forced reductions in coverage, loss of market share, periodic bankruptcies, eroded reputations, and regulator rejection of requests to withdraw from markets are material business risks that merit concern. Moreover, insurers hold major investments that may be vulnerable to climate change. A few insurers will no doubt be inappropriately opportunistic—and should be called to task for doing so—but those who have expressed concern are actively supporting climate change adaptation and mitigation, which will ultimately curb price increases.

The future role of insurance in helping society to cope with climate change is uncertain. Insurers may rise to the occasion and become more proactive players in improving the science and crafting responses. Or, they may retreat from oncoming risks, thereby shifting a greater burden to governments and individuals.

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VIEWPOINT

Refocusing Disaster Aid

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With new modeling techniques for estimating and pricing the risks of natural disasters, the donor community is now in a position to help the poor cope with the economic repercussions of disasters by assisting before they happen. Such assistance is possible with the advent of novel insurance instruments for transferring catastrophe risks to the global financial markets. Donor-supported risk-transfer programs not only would leverage limited disaster-aid budgets but also would free recipient countries from depending on the vagaries of postdisaster assistance. Both donors and recipients stand to gain, especially because the instruments can be closely coupled with preventive measures.

Postdisaster assistance for emergency relief and reconstruction, although important for humanitarian reasons, has failed to meet the needs of developing countries in reducing their exposure to disaster risks and ensuring sufficient funds to governments and individuals for financing the recovery process. Disasters continue to impose substantial human and economic losses on the developing world. In a sample of large natural disasters over the period 1980 to 2004, fatalities per event were higher by orders of magnitude in low- and middle-income countries compared with high-income countries; similarly, losses as a percentage of gross national income (GNI) were highly negatively correlated with per capita income (Fig. 1) (*1*). Despite evidence of large returns on investments in preventive measures (*2*), most assistance arrives after the disaster. Moreover, postdisaster aid discourages prevention because of the associated moral hazard: Governments and individuals, expecting support, have little incentive to invest in precautionary measures.

The donor community—financial institutions, international agencies, nongovernmental organizations, and donor governments—is recognizing the need to place more emphasis on programs that prevent disaster losses. There is less recognition, however, of the need to support risk-pooling and risk-transfer programs that assure readily available postdisaster funds for relief and reconstruction. Lacking sufficient funds, the follow-on costs of disasters can be extensive. For example, 4 years after the devastation of Hurricane Mitch in 1998, the gross domestic product (GDP) of Honduras was 6% below predisaster projections (*3*). Donor pledges of US$2.7 billion were considered exceptionally high but amounted to only about half of the estimated total reconstruction costs (*4*).

Governments, households, and businesses in poor countries cannot easily afford commercial insurance to cover their disaster risks. Whereas low-cost microinsurance for independent risks, such as funeral expenses, is now widely available in countries like Bangladesh and India, this is not the case for dependent risks that affect many communities at the same time. The cost of catastrophe insurance is usually substantially higher than the pure risk premium, mainly because of the insurer's cost of backup capital to cover dependent claims. Consequently, people can pay more for disaster insurance than their anticipated losses over the long term. For example, in the Caribbean region, catastrophe insurance

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