Infrastructure, Natural Disasters, and Poverty

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Introduction:

This paper discusses natural catastrophes and poverty. Measuring poverty is important to describe its relationship to natural catastrophes. A recent ODI Poverty Briefing articulates nine methods used to describe poverty (Maxwell,1999). As with most other complex issues, the definition of the problem invariably leads to conclusions about policy options. Here, the discussion is narrowed primarily to issues where risk transfer may play an important role. Risk transfer for natural disasters in the developed world is primarily directed at transferring the risk of damage to private real property to the insurance industry.. In the developing world, with its high concentration of publicly owned infrastructure, an equivalent problem is the vulnerability of infrastructure to the sudden impact of major natural catastrophes.

Risk transfer provides a safety net for economic loss to property. Just as governments provide safety nets to its people in times of need, risk transfer is the safety net for losses to property from unexpected events. For property damage, risk transfer provides resources to rebuild. Generally, rebuilding means restoring the damaged property. As a safety net, it reinforces original investment decisions, whether right or wrong.

The paper will proceed along the following lines. The first section will describe the worldwide economic costs of catastrophes, with the specific impacts on the developing world articulated. The relationship to poverty in the developing world from these natural catastrophe costs will then be examined. Finally, future directions of research will be discussed.

Worldwide Costs of Natural Catastrophes

Since the 1970's, the two largest reinsurance companies in the world, Munich Re and Swiss Re, maintain comprehensive records on the frequency and severity of natural catastrophes. For the past decade, each firm has published comprehensive annual reports on the worldwide costs of natural catastrophes. As well, Munich Re has published reports examining trends over the past 10 and 25 years, as well as a map describing all natural catastrophes during the prior decade. Swiss Re also publishes reports on natural catastrophes on at least an annual basis, with

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additional reports issued on specific issues. While the measurement tools used by each firm are different, the basic conclusions of their studies are quite similar. None of their reports specifically review the issues discussed in this paper. As a result, in some instances the statistics used in this paper are calculations based and data or ratios provided in the referenced reports

Over the past ten years, both the number and severity of natural catastrophes have been increasing. During the decade of the 1990's, the number of catastrophes has increased five-fold, and the damages have increased by a factor of nine, contrasted to the decade of the 1960's (Munich Re, 1999). During the decade of 1987-1997, the total direct economic loss from natural catastrophes was 700 billion USD, for an average loss of 70 billion USD. Catastrophes are a function of physical events impacting human settlement. Increasing concentrations of populations and fragile infrastructure in hazard prone areas is the main cause of the increased costs of catastrophes (Munich Re, 1998).

Natural catastrophes are generally defined in three main categories: windstorm, flood and hurricane. Windstorms, including hurricanes, and flooding each account for approximately 35 percent of the number of natural catastrophes and 30% of the annual damage caused by catastrophes. Earthquakes are responsible for 15% of the total number of events, and 30% of the total damage. The number of windstorms and flooding events have both increased in the past decade, while the number of earthquakes has remained relatively constant (Munich Re, 1998a).

Despite the concentration of capital assets in the developed versus the developing world, the economic impacts of catastrophes are relatively evenly split between these groups of countries. While windstorms and flooding each account for approximately 30% of the annual average direct damage from catastrophes, their impacts on the developed and developing countries are significantly different. Windstorms are responsible for 70% of the private property damage from natural catastrophes in the United States (Swiss Re, 1999). Floods primarily occur in Asia, which bears 70% of worldwide flooding damage (Munich Re, 1998a). Earthquake damage during the past few decades has been more evenly split between the developed and the developing world. Consequently, the developed world primarily bears the costs of windstorm, the developing world the cost of flooding, and they divide the cost of earthquake damage. In the end, the developing world bears approximately USD 35 billion in direct costs of natural catastrophes, the same as the developed world. Based on the enormous disparity in the GDP for the two regions of the world, the per capita cost of natural disasters in relation to GDP in the developing world is dramatically higher.

The damage variance between years is dramatic. During the past decade, the range has been between a high of USD 130 billion, and a low of 30 billion USD (Munich Re, 1998). In addition, the use of mean damage amounts may significantly discount the severity of events for limited geographical regions. For example, in 1998 the total worldwide economic losses are estimated to be approximately 65.5 billion USD (Swiss Re, 1999). Over half of those losses, 35 billion USD were Asian flooding losses, with 30 billion USD attributable to the losses in China from the immense flooding along the Yangtze River. The second largest single disaster was hurricane Mitch, with losses of 5 billion USD. As a result, 66% of 1998 losses were incurred by the developing world (Swiss Re, 1999).

Global Warming and Natural Catastrophes

Continuing a long-term trend, 1998 proved to be the warmest year on record in terms of mean temperature (Munich Re, 1998b). The implications and causes of the increase of worldwide temperatures are one of the important worldwide policy scientific debates of our time. In examining the implications of global warming, particular concern has arisen over the increase of windstorms and floods. Both windstorms and floods are atmospheric events and warmer surface and ocean temperature results in increased moisture absorption in the atmosphere. Increased moisture absorption leads to increased precipitation in the form of floods and windstorm events. As recently said in the New York Times, "experts have long said that one effect of global warming will be to alter precipitation patterns—increasing rainfall in some places while decreasing it in others. A warmer atmosphere, according to this view, causes more water to evaporate from the surface. Also, a warmer atmosphere holds more moisture, so that when a storm system comes through a given locality to make it rain, the rain is heavier. Data collected and analyzed by Federal scientists suggest that there is indeed a trend in that direction in the United States"(May 18, 1999). The statistics maintained by Munich Re suggest that worldwide more atmospheric events of increased severity are occurring. The impacts of natural catastrophes will be of increasing concern for the foreseeable future.

Relationship of Natural Catastrophes, Infrastructure and Poverty

A clear link of natural disasters to poverty is through infrastructure. The linkages can be described in at least three components: access to infrastructure is often a measure of poverty, infrastructure is a key component of economic growth, and the loss of infrastructure may have significant indirect and secondary costs that directly impact the poor. This portion of the paper will explore these linkages.

In the World Development Report 1994, the World Bank articulates the direct links of infrastructure to poverty. In fact, access to sanitation, electricity, and clean water, all supplied by infrastructure, are measures of poverty. As stated by the Bank, lack of access to infrastructure is a welfare issue. Further, access to infrastructure for the rural poor, primarily irrigation and transportation, increases income that enables the poor to manage risk

The maintenance of infrastructure is essential to maintain economic growth, the primary linchpin in reducing poverty. As it does every ten years, the World Bank in 1990 discussed its role in reducing poverty. In its report, the Bank outlined the principles for its strategy in the 1990's for reducing poverty. As the Bank reported:

> (R)apid and politically sustainable progress on poverty has been achieved by pursuing a strategy that has two equally important elements. The first element is to promote the productive use of the poor's most abundant asset-labor. The second is to provide basic social services to the poor. A comprehensive approach to poverty reduction, therefore, calls for a program of well-targeted transfers and safety nets as an essential complement to the basic strategy (World Bank, 1991).

These principles have guided the Bank's lending activity.

The report also specified particular characteristics of the poor that are also important to understand. These include the following:

1. One third of the total population of the developing world are poor and 18% of these are extremely poor;

2. Nearly half of the developing world's poor, and half of those in extreme poverty, live in South Asia;
3. Poverty is at its worst in rural areas; and
4. Agricultural is still the main source of income for the world's poor. The livelihood of rural poor are linked to farming, whether or not they earn their income directly from it.

These facts lead to a strategy to reduce poverty that increases the income of rural poor through farming.

Infrastructure development plays an essential role in reducing rural poverty. Infrastructure projects with a direct impact on rural agricultural production, primarily transportation, irrigation, and electricity, have a particularly direct impact on poverty reduction. In a study examining the role of infrastructure and agricultural production, the Bank reported that greater infrastructure development for agricultural development was associated with a one third increase in average household incomes, 24% increase in crop income, 92% increase in wage income, and income for livestock and fisheries increased by 78%. These changes associated with greater infrastructure development largely benefited the poor (World Bank, 1994). The Bank estimates that a one per cent increase in the stock of infrastructure translates to a one per cent increase in GDP. To reduce rural poverty, effective infrastructure projects related to agricultural have proven to be an essential policy tool.

Natural catastrophes destroy essential rural infrastructure. In Asia, which accounts for half the number of the natural catastrophes in the world, and 70% of all floods, the average annual costs of floods over the past decade is approximately 15 billion USD (Munich Re, 1998). A high proportion of losses from flooding is to infrastructure. By some estimates, infrastructure loss accounts for 65% of all flood loss (Swiss Re, 1997). For Asia, this would account for average annual infrastructure loss of approximately 12 billion USD for the past decade. As more infrastructures is developed in rural areas to combat poverty, and as the frequency and severity of natural disasters also increase, the impacts on the poor will become more critical.

The size of the loss to infrastructure can be compared to the worldwide lending activity of the World Bank. Over the past decade the Bank has annually loaned approximately 25 billion USD (Kreimer, 1998). The direct damage to infrastructure in Asia alone approximates nearly 50% of the total lending activity of the Bank.

Rural infrastructure loss in the developing world has impacted the activity of the world's international lending institutions. The World Bank has estimated that it has loaned 14 billion USD to developing countries in the last 20 years for damages from natural disasters. This is nearly 2.5 times the amount loaned by the Bank for relief from civil disturbances worldwide (Kreimer, 1998). The Asian Development Bank has estimated that between 1988-98, 5.6% of ADF loans were for disaster rehabilitation. In 1992, nearly 20% of the ADF loans were for rehabilitative assistance from natural disasters (Arriens, 1999). The World Bank has internally estimated during the past decade that in Mexico up to 35% of its lending earmarked for infrastructure has been diverted to pay for the costs of Mexican natural catastrophes.

The economic data generally available regarding the costs of catastrophes is primarily the direct economic costs. To date, little work has been done to measure the indirect impacts of natural catastrophes to developing countries. While measuring indirect impacts is much more difficult than measuring direct property loss, the implications of the indirect costs can be much

more severe. Some studies measuring the impacts of the loss of flows from infrastructure indicate that damage may be 2.5 times the cost of the direct losses (Shinozuka, 1998).

The current state of the art tends to measure the direct economic loss caused by catastrophes. In fact, almost all the data referenced in this paper is based on these data sources. This tendency tends to distort policy decision making as relates to disasters. For example, these types of analysis focus attention on disasters as single events. For most countries harmed by disasters, they are repeated events that may strike at random times but impact both the rate and pattern of development (Arriens, 1999). Without considering catastrophes as patterns of events with indirect and secondary effects, the costs of the events tend to be minimized. As such, policy options such as mitigation and risk transfer do not receive their proper due as tools to reduce the long-range cost of catastrophes.

A new initiative is underway between the World Bank, the International Institute of Applied Systems Analysis, and Swiss Re to better understand the indirect costs of catastrophes to the developing world.

Strategies to Deal with Natural Catastrophes

Knowing the costs of catastrophes is not enough. The critical risk management issue is what steps are possible to effectively deal with the costs of catastrophes. Generally, risk management falls in two broad categories: risk reduction and risk transfer.

Risk Reduction

On a worldwide policy level, the causes of climatic change must be pursued. While the scientific links between human activity and increased global mean temperature continue to be explored, the international community must take into account increasing loss burdens for developing countries from natural catastrophes. This increasing burden will be fed by the dual trends of increasing concentration of vulnerable assets in hazard prone regions, and the likelihood of increased severe natural atmospheric catastrophes.

Planning for catastrophe has a set of common tools employed in the developed world. The first tools deal with the reduction of risk prior to an event occurring. These tools are generally classified as mitigation activity, and are directed at either reducing exposure to catastrophe events or increasing the ability of structures to withstand the impact of the catastrophes. Land use planning attempts to reduce construction on seismic fault lines, coastal regions subject to windstorm or storm surge damage, and river shorelines subject to floods. While among the most effective of risk reduction measures, land use planning has proven to be difficult to implement (Kunreuther, 1998).

A second strategy reduces risk through engineering or ecological measures. These approaches attempt to reduce the impact of catastrophes by some form of engineering or ecological intervention. The creation of dams for flood control, dikes to reroute flood waters, reforestation activity or seawalls to break storm surges are examples of this approach.

An additional engineering approach reduces the impact of catastrophes on individual structures. The use of proper construction techniques can substantially reduce the loss of life from earthquakes and flooding. The use of these measures requires weighing the comparative cost of the mitigation measure with the benefits to be received.

Another planning tool combines pre disaster planning with immediate post disaster response. These activities fall within the general terminology of disaster emergency preparedness planning. The use of early warning system, evacuation of hazard prone regions, creation of temporary housing and life support systems, and other activities immediately around the disaster event are incorporated within this planning activity. This disaster planning activity can have a dramatic impact in reducing the lives lost and property damaged from catastrophes.

Risk Transfer

Risk transfer is an important policy tool in the developed world in dealing with the cost of natural catastrophes. The costs of natural catastrophes have increased for the developed world dramatically in the past decades as well. The increased concentration of populations and property values in the developed world, particularly the United States, has increased dramatically the economic costs of catastrophes to that part of the world. In the developed world, the economic costs of catastrophes have been spread through the use of risk transfer techniques.

The most common tool for spreading the risk associated with natural catastrophes is excess of loss insurance coverage. This coverage spreads the risk of catastrophe loss to the world reinsurance community and through them to the world capital markets. During the past five years, the amount of coverage purchased by the developing countries of the world has increased by 31%. The amount of catastrophe reinsurance purchased is approximately 53 billion USD, or 50% more than the average annual damage of USD 35 billion caused by catastrophes in the developed world. Through the use of insurance and reinsurance, a substantial portion of the losses from natural catastrophes is borne by others than the victims and governments in those countries. In the United States, nearly 70% of the catastrophe losses from natural disasters are from hurricanes. In the United States, 85% of the losses to private property from hurricanes are insured. On average, the insurance industry absorbs 60% of the private property losses from natural catastrophes in the U.S. By contrast, almost no insurance and reinsurance exists to absorb the cost of catastrophes in the developing world. In Asia, for example, less than 2% of the damage from natural catastrophe is insured As a result, nearly all the losses from floods in Asia are absorbed either by the governments or victims in those countries (Swiss Re, 1997).

The lack of insurance for catastrophe is in contrast to the use of insurance in the developing world for other risks. The developing world is responsible for 14% of the worldwide direct insurance business, and almost 19% of the demand for non-life reinsurance. The use of insurance, and especially reinsurance, is therefore not unknown to these regions of the world. The failure of any effective market for catastrophe insurance has meant that the risk spreading benefits and costs of catastrophe insurance have bypassed the developing world.

In addition to catastrophe reinsurance, there has developed in the past five years a new generation of risk transfer tools for catastrophe risk transfer. These tools capture the economic risk of catastrophe event and transfer them directly to the capital markets. Since 1996, 2.7 billion USD of these instruments have been used to transfer risk as varied as earthquake and typhoon exposure in Japan, to hurricane risk in the United States (ISO, 1999). To date, none of these innovative tools have been used for any risk in a developing country.

Risk transfer for natural disasters is primarily a tool to absorb cost of property damage. While some risk transfers for income replacement exists, crop insurance for example, it is does

not have wide application. Risk transfer tools also tend to be developed and defined for markets that exist for the products. Consequently, a deep market exists for hurricane protection and a much smaller market exists for flood risk. The market for earthquake coverage is between these two markets. Not suprisingly, the risks that impact the developed world are much more developed than the risks that primarily impact the developing world.

The tools to transfer catastrophe risk in the developed world are known. Flood risk is insurable, and programs now exist for flood protection in some countries (Swiss Re, 1998a, 1998b). Although technical issues exist for all insurance programs, those issues associated with flood programs in the developing world can be solved. Of course, no effort to solve those issues will occur unless demand for risk transfer in the developing world develops.

Future Directions

The first step is recognition of the impact of natural catastrophes on the effort to reduce poverty. The poverty debate now fails to account for the role of natural catastrophes as a development issue. Without this recognition, little progress can be made in dealing with the impacts of catastrophes.

Risk transfer in the developed world is based on complex models of catastrophic risk exposure. During the past decade, these models have been essential for pricing and accumulating catastrophe risk (Swiss Re, 1999). The outcomes of these models are compared to complex decision making models for both the sellers and buyers of risk to compare the benefit of risk transfer to its cost. In the developing world, the essential decision making tools to evaluate alternative policy options are missing. Key among those tools is a clear understanding of the total impact of catastrophes.

Currently, the costs of catastrophes in the developing world are borne by the victims and governments. When disaster occurs, governments currently generally rely on either reallocating domestic budgets, redirecting approved loans , aid and new loans to restore lost infrastructure. As long as the international community is willing to provide needed resources to the developing world, often at substantially reduced cost, to replace lost infrastructure, no change in current policy may be necessary. As the lending and aid community look at the options for more efficiently dealing with costs of catastrophes, the issue of risk transfer will become more important. In some cases, the use of risk transfer may be much more efficient than the use of ex post lending. As well, the equitable argument of allocating costs to activities may reduce the willingness of the international community to subsidize inefficient behavior. While risk transfer has proven to be an effective tool to deal with the costs of catastrophes in the developed world, its role in the developing world is still undefined. Even worse, the terms of the dialogue have not been subject to much discussion. Without developing the proper information, there can be no meaningful dialogue. At the same time, the range of policy options available will be dependant on the long term role the international lending and aid agencies are willing to play in financing the losses from catastrophes in the developing world. The role of privatization, financial sector reform, devolution, and other policy objectives will all influence this discussion. This dialogue will be essential to develop any policy options.

The tug between governmental subsidizes, direct or indirect, to support desired activity and the need to efficiently and fairly allocate capital so that it absorbs the real risk associated with its expenditure has been one of the great recent policy debates. The discussions of

environmental accounting and impact assessment are good examples of that debate. The increasing burdens of natural catastrophes on development may warrant its attention as an issue of comparable importance.

References:

Arriens, W.T.L & Charlotte Benson (1999) "Post Disaster Rehabilitation: The Experience of the Asian Development Bank" Paper before IDNR-ESCAP Regional Meeting for Asia: Risk Reduction and Society in the 21st Century, Bangkok, 23-26 February 1999.

Insurance Services Office (ISO)(1999) Financing Catastrophe Risk: Capital Market Solutions (New York, N.Y.: Insurance Services Office)

Kreimer, Alcira et al (1998) The World Bank's Experience with Post-Conflict Reconstruction Washington D.C.: The World Bank

Kunreuther, Howard & Richard J. Roth, ed. (1998) Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States Washington D.C.: Joseph Henry Press

Maxwell, Simon; (1999), "The Meaning and Measurement of Poverty", ODI Poverty Briefing, 3: February 1999.

Munich Re, (1999), "Climate Change and Increase in Loss Trend Persist", press release, March 15, 1999

Munich Re, (1998b), "Munich Re's Review of Natural Catastrophes in 1998", press release, December 29, 1998.

Munich Re, (1998a), World Map of Natural Hazards, Munich: Munich Re.

Munich Re, (1998), Topics: Annual Review of Natural Catastrophes 1997, Munich: Munich Re

New York Times, 1999, "New Focus of Climate Fears: Altered Air Currents", May 18, 1999.

Shinozuka, Howard & Richard J. Roth, ed. (1998) Engineering and Socioeconomic Impacts of Earthquakes: An Analysis of Electricity Lifeline Disruptions in the New Madrid Area, New York: Multidisciplinary Center for Earthquake Engineering Research.

Swiss Re, (1999), Natural catastrophes and man-made disasters 1998: Storms, hail and ice caused billion-dollar losses, *sigma* no. 1/1999, Zurich: Swiss Reinsurance Company.

Swiss Re, (1998a), Floods-an insurable risk? Zurich: Swiss Reinsurance Company

Swiss Re, (1998b), Floods an insurable risk? A market survey Zurich: Swiss Reinsurance Company

Swiss Re, (1997), Too little reinsurance of natural disasters in many markets, sigma no.7/ 1997, Zurich: Swiss Reinsurance Company.

Swiss Re, (1997a), Learning from Disaster: The floods in the Czech Republic, Poland and Germany in the summer of 1997, Zurich: Swiss Reinsurance Company.

The World Bank (1991) World Development Report 1990: Poverty Washington D.C.: Oxford University Press

The World Bank (1994) World Development Report 1994: Infrastructure for Development Washington D.C.: Oxford University Press