The Economics of Natural Disasters
- Implications and Challenges for Food Security -

Hartwig de Haen and Günter Hemrich, Rome

Plenary paper prepared for presentation at the 26th Conference of the International Association of Agricultural Economists, Brisbane, 12 - 18 August 2006

Abstract

A large and growing share of the world's poor lives under conditions in which high hazard risk coincides with high vulnerability. In the last decade, natural disasters claimed 79,000 lives each year and affected more than 200 million people, with damages amounting to almost US $ 70 billion annually. Experts predict that disasters will become even more frequent and their impact more severe, expecting a five-fold global cost increase over the next fifty years, mainly due to climate change and a further concentration of the world's population in vulnerable habitats.

The paper argues that in order to mitigate disaster impact on poor population groups, development policy and disaster management need to become mutually supportive. Focusing on challenges disasters pose to food security, it proposes that in disaster-prone locations measures to improve disaster resilience should be an integral part of food security policies and strategies. It expands the twin-track approach to hunger reduction to a "triple track approach", giving due attention to cross-cutting disaster risk management measures. Practical areas requiring more attention include risk information and analysis; land use planning; upgrading physical infrastructures; diversification and risk transfer mechanisms.

Investments in reducing disaster risk will be most needed where both hazard risk and vulnerability are high. As agriculture is particularly vulnerable to disaster risk, measures to reduce this vulnerability, i. e. protecting agricultural lands, water and other assets, should get greater weight in development strategies and food security policies. Investing in disaster resilience involves trade-offs. Identifying the costs, benefits and trade-offs involved will be a prominent task of agricultural economists.

"Reducing disaster vulnerability in developing countries may very well be the most critical challenge facing development in the new millennium." (Wolfensohn and Cherpitel 2002)

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1 Introduction

Natural disasters have been affecting people and their livelihoods throughout the history of humankind, causing enormous losses of human lives and material destruction. The tsunami of December 2004, though extreme in terms of numbers of lives lost, was only one of many types of natural hazards, which continue to occur in various parts of the world, often without sufficient early warning. Besides earthquakes, the list includes cyclones, floods, hurricanes, droughts, fires, volcanic eruptions and land slides.

Particularly worrisome is the fact that during the last decades, natural disasters have become more frequent, more intense and more costly (Freeman et al., 2003a). In the past decade alone, 79,000 people died and 200 million people were directly affected by natural disasters on average per year. Damages are estimated at US $ 67 billion per annum. Both the number of natural hazard events and the number of affected people has been growing rapidly. The costs associated with natural disasters are difficult to estimate. However, there is sufficient evidence that they have increased several-fold since the 1950s and strong indications that this trend will continue. Scientific predictions point to a further increase in the frequency and intensity of hazards, with a five-fold global cost increase over the next fifty years, mainly due

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to climate change and to further concentration of the world's population in vulnerable habitats.

Equally troublesome is the fact that natural disasters hit the poor disproportionately. Not only do most disasters affect almost systematically the tropics and hence mostly developing countries--the exception being geological disasters which are more equally shared between tropical and temperate zone regions. Within developing countries, poor communities, households and individuals carry the greatest burden. It is not simply by chance that more than 95 percent of the death toll of natural disasters in recent years was in developing countries and that the cost of the physical damages as a share of GDP was far higher in developing countries than in industrialised countries.

The combination of rising costs and disproportionate losses and damages amongst the poor makes it urgent to integrate disaster preparedness, mitigation and prevention into development strategies. A paradigm shift is needed. For too long, disaster management and development policy have been pursued in parallel. Building resilience in the broadest sense-- physical, social and institutional-- needs to become a component of investment in development.

This paper seeks to identify key principles and measures of natural disaster risk management which need to become part of development strategies. As natural disasters hit the poor more than the better-off, the impact on food security, both short and long term, is often detrimental. The focus of the paper is therefore on related economic choices regarding food security in developing countries.

2 Natural disasters: A product of hazard and vulnerability

To better understand the underlying forces of natural disasters, it is important to recall that these are the product of natural hazard and vulnerability (see Figure 1). The extent of a

disaster depends on both the intensity of the hazardous event and on the degree of vulnerability of the society it affects. What is particularly alarming is the fact that in recent decades, both probabilities are showing a rising trend in many parts of the world.

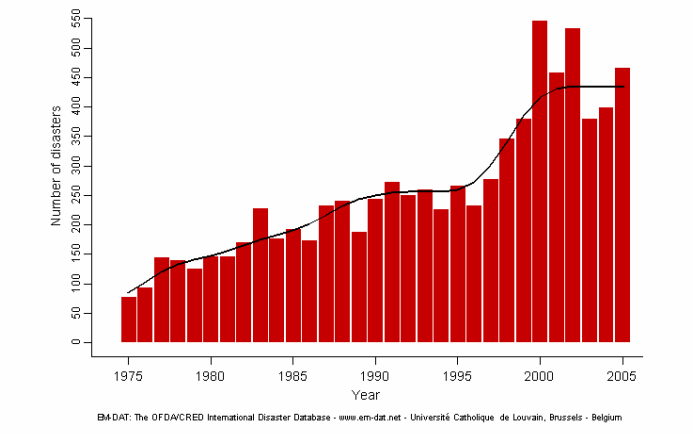
Figure 1: Hazard Risk, Vulnerability and Disaster Risk

Hazard risk Probability of an event with sufficient intensity to cause damage	**X**	**Vulnerability** Degree of exposure and fragility – Probability of damage in case of a hazard occurring	=	**Disaster risk** Combined probability of hazard and damage.

Source: Adapted from CEPAL, BID, 2000 p. 6.

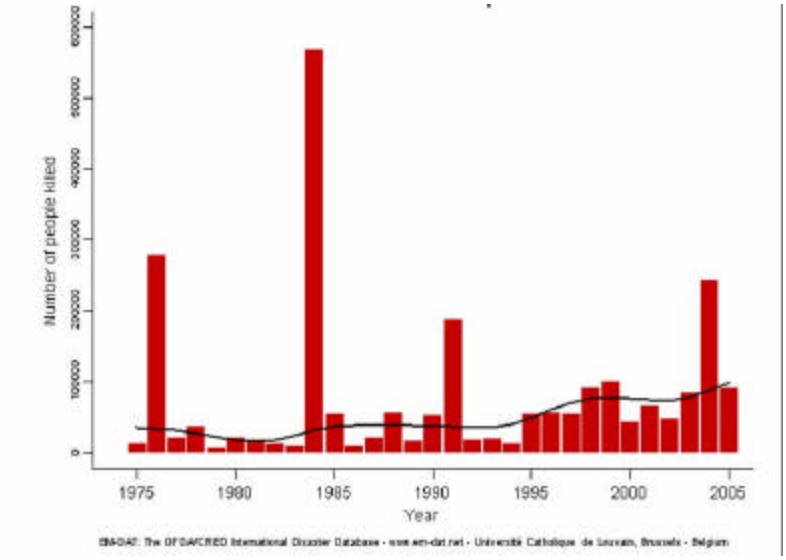
As regards the intensity of natural hazards, there are strong indications that climate change will continue to have an increasing impact in the decades to come (Intergovernmental Panel on Climate Change, 2001). Average surface temperatures continue to rise, leading to higher water absorption in the atmosphere. In turn, this results in more frequent and more intense windstorms, rains and floods in some regions and droughts in others, or even alternations of both in the same locations (Figure 2).

Figure 2: Long-term Trends in the Number of Natural Disasters, 1975-2005.



The number of recorded fatalities shows an increasing trend over the period 1975 – 2005, although only a few major deadly disaster events strongly influence the overall picture[2] (Figure 3).

Figure 3: Fatalities in Natural Disasters, 1975-2005



A large and growing share of the world's population lives under conditions in which high hazard risk coincides with high vulnerability. They live in hazard prone areas and have no or little chance to prevent the impact of hazards (such as floods or droughts), access risk insurance or benefit from investments in mitigation. Vulnerability is particularly high in urban areas, where an event of a given intensity affects many more people than in areas with lower population density. The exposure of urban people to risk is further accentuated by the fact that a high share of them (13 of the world's 19 megacities) is located in coastal areas, which are particularly exposed to floods, and in future potentially to sea level rises. Since most of the future global population growth is expected in the urban areas of developing countries, the proportion of people who will be particularly vulnerable to natural disasters will rise further.

[2] The disasters with exceptionally high casualties include the 1976 earthquake in Tangshan, China (estimates range from 240,000 to 650,000) people killed, the 1984 famine in Ethiopia where drought and economic collapse combined killed more than one million people, the 1991 cyclone in Bangladesh claiming the lives of more than 138,000 people and the 2004 Indian Ocean tsunami with a death toll exceeding 217,000 people.

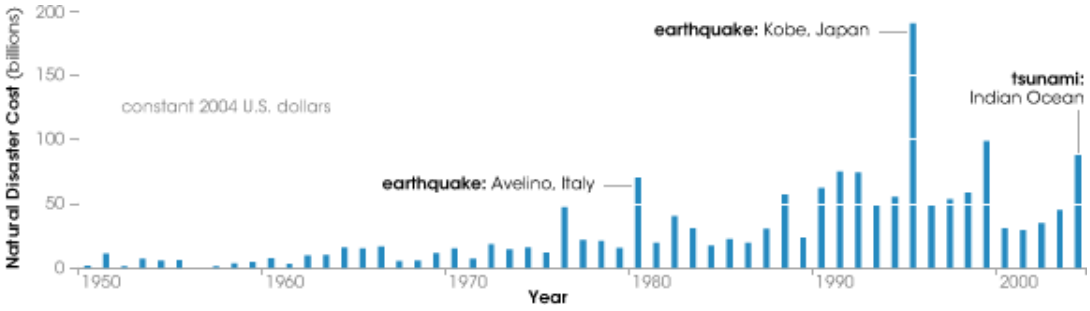
3 Impacts and costs of natural disasters

The combined effect of more frequent and more intense hazards and the on-going population concentration in vulnerable zones results in enormous costs of global damages caused by natural disasters. The economic impacts of disasters can be grouped into direct and indirect impacts. Direct losses only describe the physical impacts on infrastructure, buildings, machinery and agricultural assets and can be considered roughly as equal to stock impacts. In addition, disasters may change the flow of goods and services, thereby leading to indirect losses. These indirect effects are often not fully accounted for in damage assessments.

Direct Impacts

The direct impact of natural disasters, especially floods, storms and droughts, has risen steeply since the early 1960s. Figure 4 shows estimated damages in the past 50 years.

Figure 4: Estimates Damage, 1950-2005*



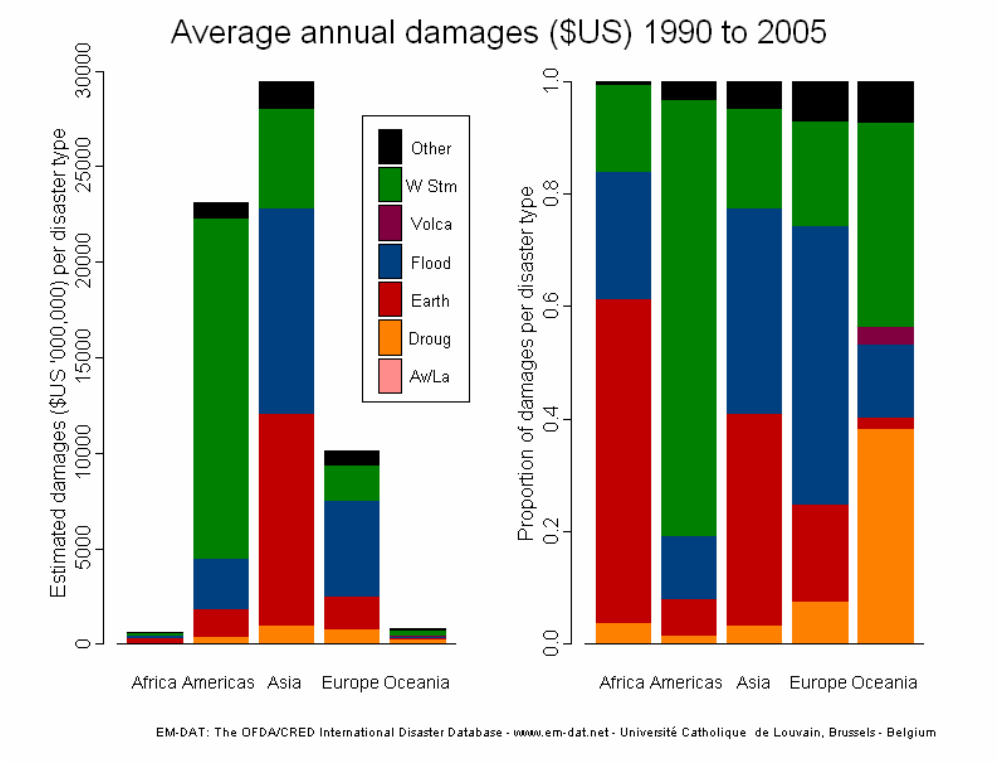
* In constant 2004 US$. Source: Riebek (2005)

Exact and complete cost estimates and comparisons over longer periods are particularly difficult to obtain (Riebeck, 2005. Guha-Sapir et al., 2004). According to some estimates, total economic costs associated with natural disasters have risen 14-fold since the 1950s and amounted to US$ 70 billion a year during the last decade (IFRC, 2001. OECD, 2001. Guha-Sapir et al., 2004, p 13.Yates et al., 2002). In the past decade, 79,000 people died and 200 million people were directly affected by natural disasters on average per year. Moreover, as a

consequence of disasters, a number of infectious diseases, some of which were long thought to have been conquered, are staging a comeback, and new ones are emerging with devastating effects in some parts of the world (Kirch et al., 2005). Experts of the Munich Reinsurance Company have estimated that the cost of natural disasters may rise fourfold to US$ 300 billion by the year 2050 (Freeman et al., 2003a, p. 8).

The relative contribution of different hazards to the average annual damages differ considerably by continent, as is shown in Figure 5. Over the past 15 years, absolute damages were highest in Asia and the Americas. While in Asia most of the damages were caused by flood and earthquakes, in the Americas they resulted from windstorms.

Figure 5: Average Annual Damages of Natural Disasters



Macroeconomic impacts

Depending on the scale and type of disaster, the macroeconomic implications of natural disasters can be far-reaching and of long duration, not only due to the destruction of

countries' production capacity, but also due to the destabilisation of public finance and the deterioration of their trade position (Mechler, 2003 p. 11). Statistical indicators can only give a rather abstract and incomplete impression of the scale of destruction. Nevertheless, the dimensions of the damage can be approximated by recording the costs in percent of GDP that resulted from some major disasters during the last decade. These costs have in many cases had orders of magnitude that amounted to several percent of GDP. For example, during the 1990s Nicaragua suffered average damages of 15.6 percent of GDP, and even for China the damage has been estimated at 2.5 percent in that period. Individual events can be even more devastating: In Honduras, Hurricane Mitch caused losses equal to 41 percent of GDP (The World Bank, 2004).

Impact on the poor

The effects of natural disasters are particularly adverse for the poor. This is primarily the result of three factors. Firstly, most low-income countries are located in regions that happen to be at far higher risk of natural hazard than those in the Northern hemisphere, including the impact of climate change. Many countries in Latin America and parts of Asia are at particularly high risk of hazards. Secondly, within countries, as Blaikie et al. (2004) have shown, the poor are normally affected much more than others due to economic and social factors, including race, class, gender and ethnicity. The majority of the poor cannot afford to live in locations with lower risk of disaster. Typically, they live in houses that are ill-protected against destruction by earthquakes or wind storms, or they live in low lands that are the first to be covered by floods or else they farm on dry lands without sufficient water storage and irrigation to sustain periods of drought. Women and children are often hit the hardest, bearing the brunt of economic, food security and nutrition impacts. Thirdly, there may be a perpetuation or even worsening of initial inequities, if the public sector (due to other needs for public funds) discontinues previously existing social programmes or discriminates against the poor (especially the homeless, tenants and women) in the distribution of compensation

programmes. The owners of smaller property will typically also have inadequate insurance coverage.

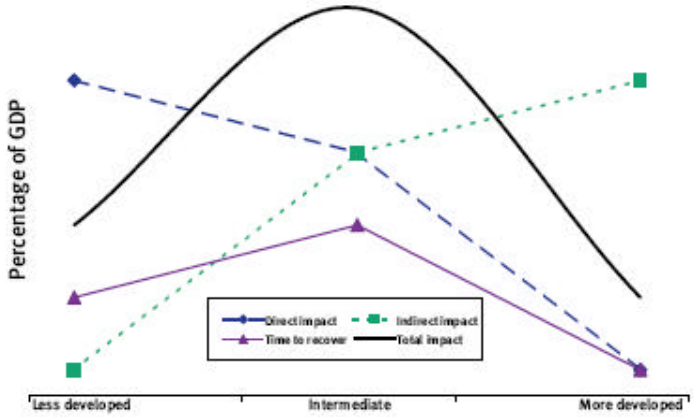
The statistics speak for themselves (Freeman et al., 2003a). During the 1990s, more than 90 percent of all major natural disasters occurred in developing countries. Half of the 49 Least Developed Countries (LDCs) are classified as being at 'high-level disaster risk'. More than half of the 25 countries most prone to disasters are Small Island Developing States (SIDS), which are at particular risk, due to sea-level rises and the increasing intensity of cyclones. During the 1990s, 96 percent of all deaths from natural disasters were in developing countries[3].

Countries at intermediate development level are particularly vulnerable

There are indications that countries at intermediate level of economic development (middle income countries) are particularly vulnerable to natural disasters. This may be because the relationship between the level of development and the relative impact of natural disasters in terms percent of GDP has the form of an inverted U, implying the shape of a 'Kuznets curve'. While the underlying hypothesis needs further empirical research, it follows the argument that, typically, the physical, institutional and social changes that accompany economic development may render economies initially more vulnerable. Possible reasons for this include the breakdown of traditional mechanisms of risk aversion and coping, movements of people into new, mostly urban, and often more hazard-prone settlements, and low priority on setting adequate risk-adverse standards for land use, buildings and infrastructure. If returns to national investments and to external development assistance are not to be lost, mainstreaming disaster risk management into development policy and strategy is thus particularly important for this group of countries. At higher levels of economic development, the costs of the damages caused by disasters, though high in absolute terms, are mostly lower relative to the

overall GDP. Typically, developed countries, if situated in disaster-prone regions, have established more rigorous rules and have invested more in early warning and awareness, preparedness and mitigation (ODI, 2005).

Figure 6: Inverted U relationship between economic development and disaster vulnerability



Source: ODI (2005)

Environmental degradation increases natural hazard risk

History provides many examples which show that there is a close positive link between the state of degradation of natural resources and the risk from natural hazards. Over thousands of years, humans have accumulated vast experience in protecting the natural resource base in order to achieve adequate resilience against the risk of damage from extreme weather events, earthquakes, hurricanes, floods, droughts or influx of transboundary pests and diseases. These experiences have allowed local people to be good caretakers of a well-balanced ecosystem, e.g. by maintaining a sufficient forest cover, especially on slopes and in semi-arid or arid zones, or by protecting the water systems of rivers and lakes and the surrounding lands against floods, over-use and pollution. With increasing population density and rising demand for land and energy that accompany economic development, these traditional mechanisms have either been replaced by new technologies and practices which are less environment–

[3] Between 1992 and 2001, 96% of deaths from natural disasters were in countries classified by the UN Development Programme (UNDP) as medium and low human development. See also Twigg (2004).

friendly or elsewhere people continue with traditional practices or seek to adopt new, but sustainable practices, they are affected by the externalities caused elsewhere. Global warming is only one, though a most worrisome, example of such developments.

Long-term implications

The implications of natural disasters can be long lasting. People who lose their houses, personal effects and livelihood are bound to change their patterns of behaviour, communication and income earning, all of which takes years of adaptation. Investments in rehabilitation and reconstruction are made at the cost of abandoning or postponing previous plans for investment in productive or social capital and thus result in a slowdown of economic growth. Finally, there may be longer term effects on some sectors due to the lengthy duration of rehabilitation. Examples are to be found in particular in agriculture, forestry and fisheries, where the reforestation, replanting of perennials and repopulation of fish stocks can take decades. In the meantime, affected people are forced to seek alternative sources of income, to migrate or, lacking such opportunities, are driven into deeper poverty.

4 Building resilience to disasters into food security strategies – a triple track approach

The aim of disaster risk management measures is to reduce the natural disaster risk and thus build resilience [4]. Resilience is the ability of a system, community or society to adapt to shocks in order to maintain an acceptable level in functioning (Institute for Catastrophic Loss Reduction, 2004). The key economic question is whether to take the hazard risk as a given and to invest more in adaptation and resilience, or to seek to reduce the risk and invest in mitigation or even in prevention where the latter is possible. In most cases, prevention is out of reach and the possibilities of mitigation are limited. In any case, investing in resilience needs to be seriously considered and the benefits and costs assessed. Resilience requires

social, institutional and informational resources that enable a community to respond effectively to a hazard impact. It also entails early warning systems and institutions for enhanced coping and adaptation (DFID, 2004).

This paper argues that food security strategies are a particularly appropriate framework for measures to build resilience against risks of natural disasters. This is because:

1. Given the range and intensity of the impact of natural disasters, it is evident that these can greatly affect all dimensions of food security: economic and physical access to food, availability and stability of supplies and nutritional status. The specific implications for food security depend mainly on whether a disaster affects primarily people's physical and economic access to food or the availability of food or, in the worst cases, both. The extent to which shortfalls in local food production results in reduced food availability depends on people's access to local food reserves, imports or food aid. Experience has shown that under most circumstances, international emergency aid arrives rather promptly. Nevertheless, people in remote areas and those for whom physical access has been interrupted through the disaster event often suffer significant shortfalls in food intake.
2. Success stories in poverty reduction show clearly that, as a prerequisite, people must have immediate and direct access to food. Hungry people cannot make use of the opportunities which pro-poor investments offer. Hunger compromises their health, learning ability and productivity. Therefore, disaster risk management should aim to ensure that access to food (e. g. school feeding, food for work) is maintained as one of the essential basic social services, even under disaster conditions.
3. Agricultural growth is critical for reducing poverty in developing countries. About two-thirds of the poor in developing countries live in rural areas and depend directly or indirectly on agriculture for their livelihood. As agriculture is also particularly vulnerable

[4] For example, the key role of food security is explicitly recognised in the Hyogo Framework for Action 2005 –

to disaster risk, measures to reduce this vulnerability, i. e. protecting agricultural lands, water and other assets, are vital for maintaining food security.

4. Appropriate agricultural technologies can play a key role in poverty reduction. Therefore, practices of land use for agriculture, livestock and forestry, including the management of related natural resources (such as water and biodiversity), need to be adapted to make them less vulnerable to extreme weather events.
5. Finally, the past decade has shown that public investments (national as well as international), have increasingly neglected agriculture and rural areas of developing countries, in spite of the sector's key importance for the poor and for the entire economies of most of these countries (de Haen, 2005. Pingali et al., 2006). Given the current nascent political will to step up such investment, the occasion should be seized to explicitly include investments in greater disaster resilience in development plans.

To integrate natural disaster risk management into food security strategies, a **triple track approach** is suggested. Such an approach would expand the so-called `twin-track approach' first presented jointly by FAO, IFAD and WFP in 2002 (FAO, IFAD and WFP, 2002) and later elaborated in FAO's proposal of an Anti-Hunger Programme (FAO, 2003a). The twin-track approach builds on the fact that hunger is both the result and a cause of poverty. Consequently it proposes to combine investment in productivity growth for the poor, focusing especially on small-holder agriculture and rural infrastructure (track One), with the creation of social safety nets to ensure direct and immediate access to food for the neediest (track Two). Most countries which aresuccessful in reducing poverty have indeed followed such twin-track strategies.

Depending on the specific circumstances, the measures foreseen under the two tracks must be focussed on the particular needs and constraints of the food insecure people concerned. For

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2015. See ISDR (2005).

countries that are vulnerable to natural disasters, it is proposed that the twin-track approach be expanded to include a third track of longer-term measures that address the disaster vulnerability of people and their assets so as to build greater resilience against the vagaries of natural factors that cause disasters. Such resilience measures would in principle need to be applied to all four elements of food security: availability, access, stability and utilization Table 2 provides a schematic overview of the triple track approach.

Table 2: A Triple-track Approach to Food Security in Disaster-Prone Countries

Track	Availability	Access	Stability	Utilisation
One Rural Development and Productivity Enhancement	Improving productivity and production capacity, esp. of low-income farmers Investing in infrastructure Improving the functioning of input and output markets	Promoting income earning opportunities Enhancing access to assets Facilitating the creation of rural enterprises Improving the functioning of rural financial systems and labour markets	Facilitating diversification Reducing production variability (irrigation, water harvesting, pest control etc) Monitoring production and consumption shortfalls Improving access to credit and saving services	Food handling and storage infrastructure Food safety regulation and institutions Safe drinking water and sanitation
Two Direct and Immediate Access to Food	Food aid Market information Transport and communication	Cash transfers School meals Food for work programmes Community and extended family structures	Safety nets	Nutrition intervention, health and education programmes
Three Building greater resilience against natural disasters	Risk information, analysis and early warning Legislation; Settlement and land use planning Upgrading physical infrastructures Diversification Risk transfer mechanisms (insurance and capital markets) Improving transition and sequencing of emergency rehabilitation-development efforts			

Source: Adapted from FAO (2003 c)

5 Some practical entry points

There are various concrete entry points for interventions to build resilience against natural disasters for countries, communities or households as a third track of food security policies. These include: risk information and analysis, settlement and land use planning, upgrading physical infrastructures, diversification of economic activities away from disaster risk and risk transfer mechanisms. Some entry points are not necessarily distinct from those of the second track (agricultural and rural development). However, as they are being designed to reduce disaster risk, related investments are likely to be more costly.

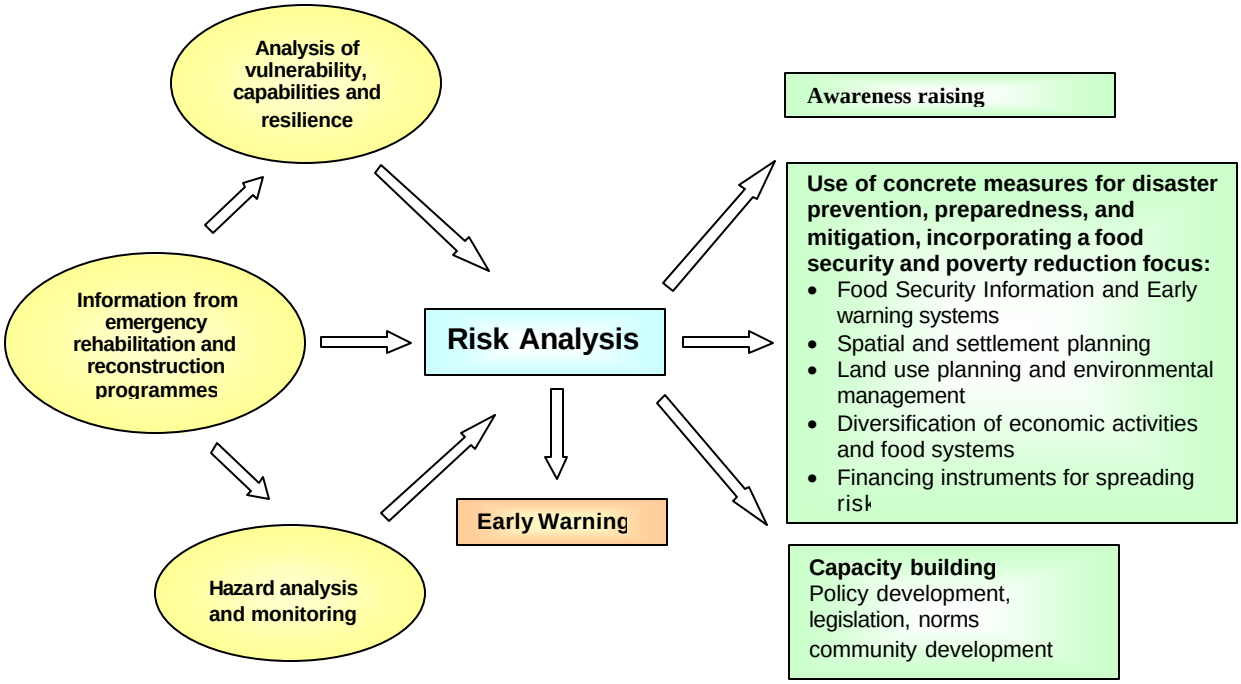
Risk Information and Analysis

A prerequisite for enhanced resilience and effective disaster risk management is improved risk awareness. It is only when people know about the possible risks inherent in their particular environment and are informed about how they can protect themselves against these risks that they may be able to avert, or at least reduce, the effects of natural disasters when these strike. A recent, noteworthy case of the need for greater awareness is Hurricane Katrina in 2005. It caused the death of more than 1300 people and billions of dollars in damages in spite of the fact that it occurred in a country with highly sophisticated early warning systems.

Risk analysis encompasses hazard as well as vulnerability and resilience analysis that identifies potential protective and adaptive capabilities (see Figure 7). Its objective is to assess the probability of occurrence and the potential adverse effects of natural disasters. The "Disaster Risk Hotspots project", initiated by the World Bank and Columbia University constitutes an example of a global disaster risk assessment. It evaluates global risks of disaster-related mortality and economic losses associated with cyclones, drought, earthquakes, floods, landslides and volcanoes. Such initiatives may help identify and support global early warning and disaster mitigation efforts (see Dilley et al., 2005).

Risk analysis can also contribute to strategic mitigation measures at regional, national and local levels. They can further support regional watershed management initiatives, help integrate disaster mitigation in national sector policies and identify vulnerable areas and population groups at sub-national levels.[5]

Figure 7: Inputs and Outputs of Risk Analysis:



Source: Adapted from GTZ (20

There is also a need to analyse concrete examples of effective resilience. For example, in the case of the tsunami, some indigenous ethnic groups, such as the Moken of Thailand, abandoned their villages before the tsunami hit, thanks to traditional lore which prompted them to head to the hills when sea levels receded, in anticipation of a natural disaster ("How a tribe of Thai animists listened to the sea, and survived", International Herald Tribune, 24 January 2005). This points to the significance of the contribution of indigenous knowledge to resilience as a factor in reducing risk and vulnerability.

[5] For a detailed list of mitigation measures enhancing the resilience of farming systems to storm-related disasters See FAO (2001).

Settlement and Land Use Planning

Disaster risk is commonly being associated with geographic location: Sub-saharan Africa with drought, Central America with earthquakes, and the Pacific and Caribbean islands with tropical cyclones (UNDP, 2004 p. 25). However, it is not location alone that generates disaster risk. Human settlement and land use patterns are important determinants of vulnerability and resilience. It is therefore critical that measures to reduce food insecurity and enhance resilience become an integral part of settlement and land use planning strategies.

Settlements along seismic fault lines, in coastal regions subject to storm damage and along rivers subject to frequent floods, are highly prone to disaster impact. Urban expansion may generate and create new hazard patterns. Today, some 50 to 60 percent of residents in Bogota, Bombay, Delhi, Buenos Aires and Lusaka live in informal settlements; 60 to 70 percent in Dar-es-Salaam and Kinshasa, and more than 70 percent in Addis Ababa, Cairo and Luanda (UNDP, 2004 p. 59). The size and vulnerability of informal settlements, generally built in unstable areas such as coastal zones, flood-prone planes and ravines, and geologically unstable slopes, greatly increase their susceptibility to risk (Bigio, 2003).

Hazard mapping, land-use planning, building codes and other disaster management standards, as well as training of rural and urban developers are critical to ensuring that settlements are made more disaster-resilient. National policies, programmes and the interplay of institutions may make a big difference as to whether a hazard will cause a disaster. Given the magnitude of the risk in some locations, remedial measures must not only include safeguards to protect the poor (and in particular environmental refugees), from risk of food insecurity and loss of livelihood. More serious consideration must also be given to banning construction in larger high risk locations (along seismic fault lines, in vulnerable coastal regions, and on river shorelines).

For men and women living in poor and informal settlements, the opportunities of vacating disaster-vulnerable areas in exchange for safer ones will, to a large extent, depend on the degree to which they are able to meet their food security and livelihood needs. Where there is a need to relocate populations and economic activities to less vulnerable areas, it will be important to examine how measures and investments to reduce poverty and improve food security and resettlement, and land use policies can reinforce one another.

Upgrading Physical Infrastructure

It has been estimated that investments of US $40 billion in disaster preparedness, prevention, and mitigation would have reduced global economic losses in the 1990s by US $280 billion (Freeman et al., 2003b). The net benefits of investments in greater resilience may even justify public funding in cases where the incentives for private investment are insufficient. Three categories of investments are classic examples of action to be taken:

- adoption of standards and building codes that ensure adequate levels of robustness of houses and bridges as protection against earthquakes and hurricanes;
- large scale engineering investments in dams, dikes to control floods, seawalls to break storm surges; rerouting rivers and building canals; and
- irrigation, water harvesting and water storage to prepare for drought.

The implications of investments in such activities for the various components of food systems need to be examined as part of a triple-track food security strategy.

Diversification Away from Disaster Risk

Diversification of economic structures is another well-established strategy of risk aversion and a typical response to risk and uncertainty in market economies. Livelihood diversification in the form of multiple sources of income is central to poor people's coping strategies. The long-term implications of economic structure are, however, frequently

overlooked in disaster mitigation programmes. Diversification for disaster reduction can take many forms and measures can be devised at different levels of aggregation.

At a macro level, **trade liberalisation and the promotion of market links** can be seen as diversifying the risk of a national hazard's impact on food supplies. For example, Del Ninno et al. argue that the liberalization of trade between Bangladesh and India prior to the 1998 floods prevented a steep hike in prices. Massive rice imports, in particular from India, helped to stabilize domestic prices. If they had risen by 50%, as was the case during the 1974 famine, severe food insecurity for millions of people may have ensued. [6]

Diversifying agricultural systems is another key entry point to reducing vulnerability. There are a number of measures through which cropping systems can be made more resistant to extreme weather-related hazards, be it wind, water or drought. For example, Bangladesh's long-term agricultural and investment policies in the 1980s fostered the development of winter--or "boro"—rice, which contributed to limiting the food security impacts of the 1998 floods. The substantial increase in the proportion of winter rice over the years meant that the devastating impact of the 1998 floods on the monsoon "aman" crop did not lead to disastrous food security effects. This is only one example of lessons learnt from the effects of frequent floods which Bangladesh has been using to invest in greater resilience for the future.

Water efficiency and drought resistance needs to be improved in drought prone areas and salt resistance in areas susceptible to the risk of sea water intrusion. Perennials at high risk of destruction by winds and hurricanes, e. g. bananas, may need to be replaced by other perennials or else be better protected. Investment in water storage and expanded irrigation systems is advisable in areas likely to be affected by more frequent droughts (see FAO, 1992, and FAO, 2001). An example from the Pacific Islands illustrates how short-term profit considerations can result in cropping systems which are not resilient against natural disasters.

In response to unprecedented high prices for *kava* in 1998, farmers in some of the four *kava* exporting countries (Vanuatu, Fiji, Tonga and Samoa) increased by a factor of ten the planting density of this crop. Given the high frequency of cyclones in these countries, there is now a reasonable probability that one will affect an intensive *kava* plantation once in a five-year production cycle (McGregor, 1999 pp. 21-23). To ensure resilience, consideration may need to be given to appropriate extension or even regulatory measures.

There are numerous other mechanisms through which diversification of economic activities can reduce vulnerability to disaster risk. One example is the category of so-called **social funds** which support measures to enhance human capital as a way of spreading risk. The rationale is that households with higher levels of education and better health status are more likely to cope with shocks, heed warnings and find alternative means of generating income. The most-studied case is perhaps Mexico's PROGRESA program.[7] Another example are **micro-finance institutions** addressing the consequences of disasters. They have the potential to help reduce vulnerability and support recovery through rescheduling of loans or stimulating pre-disaster measures through emergency funds and lending for specific disaster preparedness activities (Twigg, 2004 p. 227).

Strengthening Risk Transfer Mechanisms

No matter how much is invested into disaster prevention and mitigation, a significant risk of damage from natural disasters will remain in many hazard-prone areas. It is therefore appropriate that modern forms of risk transfer mechanisms have recently been created. The two basic tools for transferring the risk of disasters are insurance and instruments for spreading the risk directly to the capital market.

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[7] Skoufias and others argue that social funds, if in place before a disaster strikes, reduce significantly the start-up cost of disaster relief. See Skoufias et al. (2003), cited in: Dayton-Johnson (2004).

Insurance against certain forms of natural disasters plays an important role in developed countries. However, a number of specific characteristics of natural disaster risk pose challenges to insurability, particularly in developing countries (Mechler, 2003 pp. 58 – 59):

(1) Natural disasters are low frequency events with potentially large consequences. This type of risk requires a high amount of risk capital to back the underwritten policies, which is often not available in developing countries.

(2) Natural hazards like earthquakes, floods, and windstorms often impact entire developing regions. Thus, the risk portfolio is highly correlated, thus limiting the economic feasibility at national or regional level, unless globally operating reinsurance companies are available.

(3) Due to the low frequency of many types of natural disasters, the willingness of the private sector to take out insurances tends to be low. The reluctance to pay for insurance is further limited by the perception that governments and aid agencies will anyway provide assistance in the recovery effort.

(4) Additional difficulties in adopting insurance arise from traditional or ill-defined property rights, with individuals and even companies lacking formal titles to their holdings.

As a result of the above constraints, commercial insurance has been largely confined to richer countries and people. While in the United States more than 50 percent of the loss of catastrophes is insured, in countries with per capita income below US $ 10,000 insurance cover is less than 10 percent, and in countries with per capita income under US $ 760 it is about 1 percent. (Freeman et al., 2003a, p. 20).

New forms of insurance are needed in developing countries. To give just one example, a consortium of research institutions, including, inter alia, IFPRI and the World Bank, has developed the concept of a weather-based index insurance, which does not depend on costly

individual verification of damages, but uses location-specific trigger indicators (IFPRI 2001). A similar pilot initiative by the World Food Programme (WFP) has just been initiated. WFP has taken out a contract that will pay the agency should rainfall measures at 26 weather stations in Ethiopia fall below a certain level (see International Herald Tribune, 7 March 2006). The rationale is that response to a potential drought would not have to wait for the mobilisation of donor funds, but could commence promptly. In addition, the pilot aims also at exploring whether it would make sense for governments to take out their own insurance, and whether that would lead to a reduced impact of drought on the government's budget and the country's population.

Capital markets as mechanisms for risk transfer have emerged rapidly in recent years as new financial instruments for hedging against weather and natural disaster risks. These include the following:[8]

- *catastrophe bonds*, which charge a high interest rate premium, but are subject to default if a defined catastrophe occurs during the life of the bond;
- *catastrophe swaps*, which allow insurance portfolios with potential payment liability to be swapped for a security and its associated cash flow payment obligations;
- *weather derivatives*, which protect companies from climate variability under contracts that provide payouts in the event of a specified number of days with temperatures or rainfall above or below a specified trigger point;
- *contingent surplus notes*, which allow notes owners to issue debt to pre-specified buyers;
- *exchange-traded catastrophe options*, which provide options for payments if an index of property claims exceeds a threshold level; and
- *catastrophe equity puts*, which provide that the insurer can sell equity shares against an up-front fee after a disaster has occurred.

[8] See Freeman et al, 2003a.

The development of these new promising tools is partly a response to dramatic increases in the cost of insurance.

The alternative to insurance and capital market instruments is **contingent financing** in the form of public calamity funds, which is still the main financial tool used in developing countries. The source of those funds can be national budgets as well as international grants or concessional loans. While contingent financing can be released relatively quickly, especially when the source is an especially earmarked fund, it has a number of disadvantages, which need to be addressed by appropriate institutional provisions. One is the limited availability of public funds. The other issue is the moral hazard problem, sometimes referred to as the 'Samaritan's dilemma' (Freeman et al., 2003a p.17). Being aware and indeed expecting public assistance in the aftermath of a disaster, individuals, communities and the private sector in general have a limited incentive to take appropriate preventive and precautionary ex-ante action.

6 Policy Implications

This paper has reviewed evidence of rising damages caused by natural disasters, affecting the poor disproportionately and arresting development efforts in an increasing number of countries. It argues that development policy and disaster management strategies is would benefit from mutual integration of basic principles with a view to building resilience against disasters into all development efforts in hazard prone locations, focusing especially on the poor. In particular, the paper highlights that while natural hazards are mostly natural geo-dynamic and hydro-meteorological processes, the impact of the resulting disasters can often be reduced considerably, as, in many cases, these are manifestations of 'unresolved problems of development'[9].

[9] See Yodmani (no year).

Natural disasters can affect all dimensions of food security. To date, investment in disaster preparedness and resilience has too often fallen into the cracks between traditional food security policies on the one hand and humanitarian assistance on the other. The first, even if adequately focussed on rural poverty and undernourishment, has normally not been associated with the paradigm of 'direct life saving'. The latter, i. e. humanitarian assistance and disaster risk management, have not sought to promote an 'escape from poverty' as part of their strategy[10]. It is therefore critical to integrate disaster risk management into food security strategies as part of overall poverty reduction and development policies. For countries with high disaster risk, the proposed triple-track food security strategy could make a difference in reducing the vulnerability of the poor and in protecting development gains in agricultural and rural areas.

The challenge is how to translate the proposed paradigm shift into practice. This will require political will as well as difficult choices in allocating scarce resources to investments for immediate benefit versus those for reduced longer-term vulnerability and disaster resilience. In this context, identifying and drawing lessons from more practical examples of successful reduction of vulnerability, such as the case of Bangladesh, is an important task for the research community.

Political Commitment: Following recent disasters, political leaders have confirmed at the highest level that they are ready to mainstream disaster risk reduction in development strategies. The most prominent example is the 2005 Kobe Conference which called for a more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels. The returns of such an approach would be high in terms of disaster risk reduction, environmental protection and socio-economic benefit. As such, close follow-up is needed.

[10] Twigg (2004); Christopoulos et al. (2001) Disasters, 25 (3): pp.185-198.

Awareness and knowledge of the causes and implications of climate change and the resulting greater risk of land slides, floods and droughts is now clearly more widespread than it was one or two decades ago. This should be a motivation for industrialised countries to address their own contribution to the causes of climate change and to grant disaster risk management higher priority in international development assistance. Moreover, in a globalized world, the adverse effects of disasters may indirectly affect the geo-political, economic and security interests and concerns of all, including the developed countries.

Policy choices: Decisions regarding the level of investment in longer term disaster resilience will depend on the value attached to the discounted benefit of investing in prevention or reduction of a probable future damage, as compared to investment in short- and medium-term development. In the context of food security strategies, the choice relates to the allocation of scarce resources to productivity enhancement for the poor (track 1) and to the provision of food and safety nets with immediate benefits for the poor and needy (track 2) as compared to investments in disaster resilience (track 3). In terms of trade-offs between investments under tracks one and two versus those under track three, decisions should be the more in favour of investments in disaster resilience the higher the probability of the natural hazard concerned and the higher the likely loss it can create. As shown above, the frequency of extreme weather events as well as the vulnerability of developing countries, and in particular of the poor within these countries, is continuously rising. Therefore, building resilience should be given greater weight in development strategies, including food security policies. This would also contribute to the achievement of several Millennium Development Goals.

Public versus private responsibility: Even with more investment in early warning, mitigation and prevention, the nature, time and intensity of most types of natural disasters will remain unpredictable. Therefore, the public sector will face the continuing challenge of investing in

preparedness and proceed with rehabilitation when a disaster occurs. However, as has been pointed out, this can create moral hazard problem, which need to be addressed through appropriate institutional provisions. Governments need to share the burden of investing in resilience widely with the private sector. While the public sector definitely needs contingency plans and accept liabilities, state obligations must be kept to realistic levels. There are various ways to reduce a potential moral hazard through appropriate legislation, such as obligatory community level contingency funds or mandatory insurance coverage.

The chances of arriving at a political consensus for mainstreaming disaster risk management into food security policies and protecting agricultural lands, water and other assets of the poor are particularly good at this point in time. Not only does the political will exist on the part of the disaster management community. There is also a nascent political will and awareness at highest levels of government that efforts to achieve food security and hunger reduction must be key elements of any poverty reduction strategy and that the sustainability of poverty reduction strategies depends on increased investments in agriculture and rural areas. The moment should therefore be seized to bridge the two policy domains and include investments in greater disaster resilience in poverty and food security strategies in all disaster-prone locations. To facilitate decision making, agricultural economists have a prominent task in identifying and flagging the costs, benefits and trade-offs involved.

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