

Disasters, Climate Change and Economic Development in Sub-Saharan Africa: Lessons and Directions

Ajay Chhibber^{*,†} and Rachid Laajaj^{*,†}
Independent Evaluation Group, World Bank

This paper explores the links among natural disasters, climate change and economic development, and attempts to outline a framework for considering these links. The paper summarises the limited knowledge of the long-term economic impact of natural disasters. Drawing links among disasters, resource management, conflicts and other transmission channels is a necessary condition to develop an appropriate response. The paper argues that African governments along with their development partners need to develop a more robust adaptation and response capability to disasters as part of development planning. The paper makes the case for more market-based financing mechanisms than have been used hitherto and an emphasis on forecasting research. It also argues for more work on the links between climate change and disasters and a new way of looking at disaster resilience as a continuum to development strategy.

1. Introduction

1.1. The Increasing Costs of Natural Disasters

Worldwide, the risks linked to natural hazards have increased sharply during the last decades. In constant dollars, the costs of natural disasters between 1990 and 1999 reached over \$650 billion in material losses, which is more than 15 times higher than the

* Corresponding authors: Ajay Chhibber, E-mail: ajay.chhibber@undp.org or Rachid Laajaj, Email: laajaj@wisc.edu

† The authors are respectively Director and Consultant at the Independent Evaluation Group at the World Bank. The authors are grateful to Ronald Parker, Kristin Little and Kenneth Chomitz for thoughtful comments on this paper, and to Betty Bain and Yezena Yimer for their assistance in preparing this paper. The authors are also grateful for comments received from Dr Olu Ajakaiye and participants at the AERC plenary session.

cost from 1950 to 1959.¹ Over this period, some two billion people were affected by disasters in one way or another. Natural hazards are an increasing hindrance to the development of the many developing countries, especially but not exclusively in Sub-Saharan Africa, and need to be addressed. How much of the growing vulnerability to disasters is due to human actions and how much is due to nature have been subjects of some debate. This paper argues that hazards are created by nature but disasters are largely man-made and that development and disasters are closely inter-linked. Moreover, although much focus is placed on very visible cataclysmic events such as earthquakes, floods and tsunamis, we must become more aware that disasters are also often the slow buildup of human pressure on resources, which in turn is affected by choices made on strategies for economic development.

Before going forward with the analysis, the concept of vulnerability needs to be clarified. Vulnerability to natural hazards can be divided into two main components: the exposure to shocks, and resilience. The degree of exposure to shocks is a function of the frequency and size of natural hazards affecting the population and the proportion of population affected by the hazard, which in part is determined by choices made by people on where they live. The degree of exposure is therefore the result of the frequency and intensity of natural hazards, which are mainly exogenous, and of where people choose to live. In some cases, the choice is voluntary, e.g., people prefer to live in coastal areas or along river beds. In other cases, the choices are involuntary as when population pressure drives people to live in marginal areas. Resilience is the capacity to cope with natural disasters, including both preparedness (land and building codes, better forecasting) and response to disasters (such as financing mechanism, post-disaster relief). Therefore:

$$V = f(\text{NH}, P, R),$$

where V is vulnerability, NH is the number and intensity of natural hazards, P is the population exposed to disaster and R is the level of resilience. It is expected that NH and P increase vulnerability while R reduces it. Note that in this framework, climate change can affect

¹ Based on a report on Natural Disasters prepared by the World Bank's Independent Evaluation Group.

V by increasing the intensity and frequency of NH and by increasing the proportion of population that will be affected by disasters.

There is also growing evidence that there are links among conflict, security and disasters, with pressure on resources often leading to the increased probability of conflict. Although much focus has been on the scramble for natural assets, be they oil, diamonds, or forests as source of conflict, we have seen conflict and insecurity also arise from the slow build-up of disasters coming from lack of resources and sometimes from the increased vulnerability created following a disaster. This is evident in some of the conflicts in Central Africa and more recently in the Darfur region of the Sudan, where the rebellion began in the 1970s, right after Africa's greatest famine. This paper argues that we need to perceive a much more comprehensive link among disasters, security and economic development strategy in the long-term choices often made.

Finally, Africa is being affected by choices made by others on the nature of economic development, through their impact on climate change. Although Africa is not a major contributor to climate change, it is a major consumer of it and will be so in the future. There is now growing evidence of the link between climate change and disasters—although a subject of some debate. The Intergovernmental Panel on Climate Change (IPCC) has issued some of the most consistent reports on the evolution of climate. According to their predictions, despite considerable uncertainty, it is very likely that temperatures and sea level will continue to rise in the near future, thus increasing the frequency of extreme events.

The IPCC expects the following climate change impacts for Africa:

- Grain yields are projected to decrease.
- Major rivers should be affected: average runoff and water availability would decrease.
- Desertification would be exacerbated.
- The number of droughts, floods and other extreme events should increase.
- A significant extinction of plants and animal species is predicted.
- Coastal settlements would be affected by sea level rise through inundation and coastal erosion.

In a recent comprehensive review of the impact of climate change, Stern (2007) estimates a global impact on economic activity much higher than previously predicted, including by the IPCC. According to Stern, in the long run, 'business as usual' could result in a permanent reduction of global gross domestic product (GDP) by as much as 20%. Moreover, the review states that poorer regions in Sub-Saharan Africa and South Asia will be more severely affected. For Sub-Saharan Africa the review summarises the impact as follows:

Sub-Saharan Africa will be under severe pressure from climate change. Many vulnerable regions, embracing millions of people, are likely to be adversely affected by climate change, including the mixed arid-semiarid systems in the Sahel, arid-semiarid rangeland systems in parts of eastern Africa, the systems in the Great Lakes region of eastern Africa, the coastal regions of eastern Africa, and many of the drier zones of southern Africa.

The Stern Review is a subject of intense debate. Some critics argued that climate change and its links to human activity are subject to wide margins of error, and Stern has taken the most extreme scenarios and low discount rates to estimate high costs in the future and to increase the present value of very long term benefits; this debate will intensify in the coming years. Although the direct and incontrovertible link between the increase in disasters and climate change is still debated, the links between climate change and certain categories of disasters, particularly those that are hydro-meteorological, are getting much closer inspection. Even if we accept that the links between climate change and economic activity are subject to wide margins of error, we can observe that some of these changes in the increased intensity and number of disasters have already begun. A simple way to observe this is to pay attention to the increasing number of disasters in Sub-Saharan Africa (Figure 1). Disasters include the following events between 1975 and 2005: drought, earthquake, flood, insect infestation, slides, volcano, wave or surge, and wind storm. In order for a disaster to be entered into the database, at least one of the following criteria has to be fulfilled: 10 or more people reported killed; 100 people reported affected; a call for international assistance; or declaration of a state of emergency (Scheuren *et al.*, 2002). Some but not all of the increase may be due to better reporting.

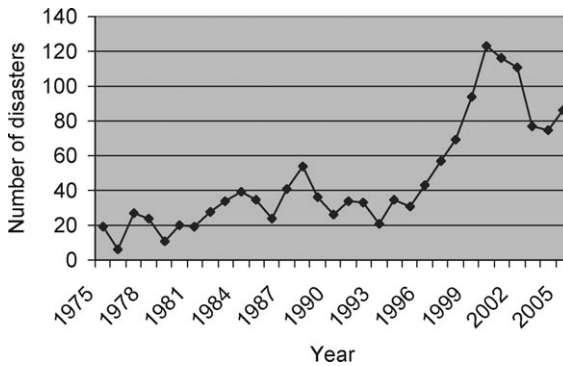


Figure 1: Number of Natural Disasters over Time in Sub-Saharan Africa since 1975.

The aim of this paper is to highlight the interactions between development and vulnerability to natural hazard in order to foster research that will improve future decision-making. Section 2 reveals the limited knowledge of the long-term economic impact of natural disasters. On the basis of recent theory, a number of scenarios that will need to be tested are proposed to represent the long-term impact of a disaster on GDP. Section 3 stresses the reciprocal influence of development and vulnerability, highlighting the possibility of a vicious circle: a highly vulnerable and poor country may suffer frequent disasters that prevent it from development and thus from improving its resilience. Section 4 relates three case studies, providing examples of either poorly, or well-managed, disasters. Section 5 provides growing evidence of the link between climate change and disasters. These cases, combined with theory and other evidence, lead to the discussion of the next section for better mechanisms for coping with natural disasters. The focus here is on better financial mechanisms, and on better measures for preparedness that are currently overlooked. Finally, we end with some ideas for further research on the topic. This research is needed both to develop better some of the linkages identified in this paper as well as country case studies to understand better how development choices have led to different levels of vulnerability.

2. The Long-Term Economic Impact of Natural Disasters

Several studies have evaluated the short-term cost of natural disasters. An exhaustive assessment of the short-term costs must include

both direct costs (damage to buildings, crops, social infrastructure) and indirect costs (lost output and investment, macroeconomic imbalances, increased indebtedness). The World Bank estimated that from 1990 to 2000, natural disasters have caused damage representing between 2% and 15% of an exposed country's annual GDP (World Bank, 2004). With such large costs—in many countries much larger than their aid budgets, and in some cases larger than the country's investment rate—it is important to focus more than has been the case so far, on the impact of natural disasters, their relationship to economic development priorities and strategy, and better coping mechanisms.

There is little doubt that most natural disasters have severe short-term consequences on the economy. But very few studies assess the long term-consequences of natural hazards. This chapter outlines the findings of the past studies, developing theoretical as well as empirical analysis of the long-term economic impact of natural disasters.

2.1. Theory and Alternate Scenarios

2.1.1. The Possibility of a Positive Impact on the Path of Growth

Because natural disasters are frequently succeeded by higher growth rates that seem to compensate for the economic impact of the disaster, one could expect that disasters are just a temporary disruption of the development process that has no impact on the long-term development of the country. Aghion and Howitt (1998) provide a theoretical explanation to this observation with a Schumpeterian model of endogenous growth. In the model, growth is generated by technological change that is favoured by the capital replacement needed after the disaster. As a result, a natural disaster can even lead to a positive overall impact on the economy.

Some authors have tried to model the long-term effects of disasters. Using arguments on economic linkage and substitution effects, Albala-Bertrand (1993a) constructed the first macroeconomic model of the economic impact of a natural disaster. In this model, a first step was to set an upper limit for the impact of a one-time disaster on output, assuming that all losses are on capital stocks, which is homogenous and irreplaceable in the short term. The result is basically that the reduction in the output is

proportional to the reduction in the stock of capital. The author then modifies some assumptions, considering, for example, that loss is split between capital and output, that capital loss is estimated at replacement cost and that capital is heterogeneous. As a result, the author finds a much smaller impact on the output and he considers this to be much more realistic than the first result. The implication is that a natural disaster is unlikely to have a long-term impact on growth. It explained why macroeconomic indicators improved during the years following the disaster and quickly returned to their normal level.

2.1.2. Arguments for a Negative Impact on the Path of Growth

Benson and Clay (2004) come to the opposite conclusion by arguing that resources used following a disaster are not necessarily additional and can have a high opportunity cost. They provide a number of channels through which natural hazard can influence the path of growth and development:

- The stock of capital and human resources can be damaged (through migration and death) or their productivity reduced by disruption of infrastructure and markets.
- Increase in spending can lead to higher fiscal deficits and cause inflation.
- Re-allocation of expenditures draws funds from planned investments.
- Even when funded by aid, this aid may not be entirely additional: donors tend to advance commitments within existing multiyear country programmes and budget envelopes. As a result, the amount of aid provided following the natural disaster is also diverted from development aid flows.
- Consecutive natural disasters create an atmosphere of uncertainty that discourages potential investors.

Another main channel deserves investigation and seems absent from most studies: the occurrence of a natural disaster increases the risk of civil war through its economic and social impact. Using a panel of 41 African countries from 1981 to 1999, Miguel *et al.* (2004) found that a negative growth shock of five percentage

points (instrumented by extreme rainfall variations) increases the likelihood of conflict by 50% the following year.

Some models have been developed, focusing specifically on one of these transmission channels. For example, the International Institute for Applied System Analysis modelled the potential impact of disaster on capital accumulation, whereas Cochrane (1994) explored the impact of disasters on a country's indebtedness. Using a recursive Keynesian growth model, the author assumes that the recovery costs are entirely funded by external borrowing and hence generate an increase in interest rates. The consequence is an increase in debt stock as well as a reduction of long-term investment and growth.

Nonetheless, all the studies mentioned have been subject to some criticism. Lavell (1999) points out that models such as those presented here should be submitted to an *a posteriori* analysis and evaluation in order to compare real with projected performance. Insufficient empirical work has been done on these issues.

2.1.3. Different Possible Scenarios

A common problem in preparing an economic assessment following a disaster is the confusion caused by mixing stock losses with changes in flows. A distinction is necessary between the impact of the disaster on stocks and flows. Physical and human capital and public debt are examples of such stocks; they can be hit directly (destruction of infrastructure, livestock) or indirectly—in this latter case, the variation of a flow causes the variation of the corresponding stock. An increase in the public deficit (a flow) would help add to the public debt; or a diversion of investments (a flow) to fund the relief costs would reduce the stock of physical capital. In return, annual flows are dependent on stocks: physical and human capital stocks are determinants of the GDP (a flow). These multiple and complex interactions need to be considered for an evaluation of the economic impact of a disaster.

Because of contradictory effects, theory does not provide clear-cut conclusions about the impact of natural disasters on the long-term growth rate. It may be useful to outline different scenarios that would then need to be tested:

Disasters reduce the stock of capital that leads to immediate losses in annual production. This short-term reduction of GDP

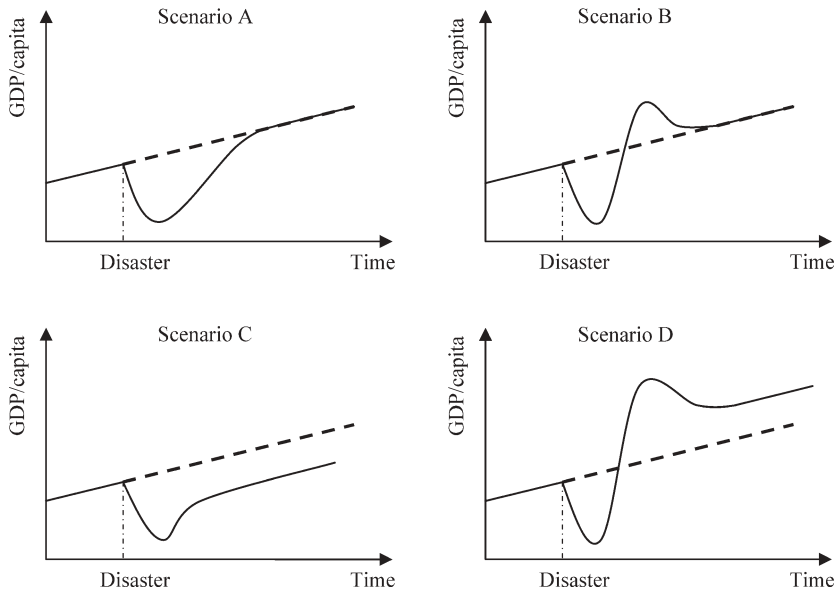


Figure 2: Possible Long-run Impact of a Disaster on GDP per Capita.

can also be direct, for example when a drought reduces agricultural production. If a negative impact is commonly observed in the short-term, the medium-term and long-term impact of disasters is still subject to debate. Scenarios A, B, C and D of Figure 2 are graphic representations of the possible predicted impact of a disaster on the long-term growth rate. In scenarios A and B, the disaster does not influence the long-run growth path of income: the shock has a negative impact on the GDP, eventually followed by an expansion during the reconstruction (in order to match the initial stock of capital), and the production level returns to its long-run state of equilibrium. In scenario C, because the disaster has permanently reduced the stock of capital, the new long-run equilibrium is established at a lower level of GDP. Finally, in scenario D, the restitution of capital brings with it technological change that enhances the long-run growth rate of the economy.²

It should be noted that different types of disasters could be associated with different scenarios. For example, an earthquake is more

² Post-war reconstruction has also seen this type of feature with the rapid recovery of countries devastated by the Second World War attributed to, among other factors, new capital stock embedded with better technology.

likely to be associated with scenario B or D because it is generally followed by considerable reconstruction that may trigger an expansion, and eventually technological change. Conversely Scenario A or C could correspond to a drought because when the loss is generally restricted to the annual production and the household's livelihood, it is unlikely to lead to greater production potential unless it leads to major investments in irrigation or other drought-reducing technologies. Empirical testing of these assertions would be useful.

2.2. *Empirical Evidence*

Because of considerable methodological difficulties, different studies have led to different findings and no consensus has emerged about the long-term consequences of natural hazard.

One of the first empirical evaluations of the long-term impact of disasters on the economy has been provided by Albala-Bertrand (1993b). In a statistical analysis of 28 disasters in 26 countries from 1960 to 1976, he found that the long-run growth rate and some other key variables were not affected by disasters. Benson and Clay (1998) have noted the lack of assessment of the non-agricultural or economy-wide macroeconomic impacts of droughts in Sub-Saharan Africa. Even if the direct impacts of droughts are the most easily observable, indirect and secondary impacts on the non-agricultural and macro-economy should not be neglected. They are often not examined as recurrent issues that could potentially affect the rate and pattern of development. Benson and Clay try to fill the gap despite the considerable methodological difficulties in establishing a non-drought counterfactual, in order to isolate the natural hazard's effect. They found that drought shocks have large economy-wide impact but that the extent of the impact varies tremendously according to a number of factors. According to their results, the level of complexity of the economy and increased intersectoral linkages are among the main factors that increase the risk that a disaster will affect not only the agricultural sector, but the whole economy.

Benson (2003), in a cross-sectional study including 115 countries, found that the average growth rate from 1960 to 1993 was lower in countries that experienced more natural disasters. A main criticism of this study was that the more developed countries have experienced less disaster and therefore the results might reflect Quah's (1993) finding of a polarisation towards a bimodal distribution. Indeed

Quah observed a long-term divergence of income between developed and developing countries, hence the lower long-term growth rate in countries with frequent disasters (mostly developing countries) is not sufficient to draw conclusions regarding the causality. It is generally difficult to isolate the impact of natural hazard from other factors that influence the path of growth and development, because countries with stronger institutions have higher growth and also are better able to handle natural hazards and therefore are better able to reduce the probability of huge disasters.

Given the difficulties faced in macroeconomic studies in trying to isolate the impact of natural disasters, microeconomic results can provide valuable insights concerning the long term consequences of natural disasters. Using a panel dataset from Zimbabwe, Alderman *et al.* (2004) found that children who were between 12 and 24 months of age during the 1982–4 drought had a higher probability of being stunted³ during preschool years, which is a manifestation of malnutrition. As a result, the cohort affected by the drought has been found to be 2.3 cm shorter and have 0.4 less grades of schooling attained 13 to 16 years later. This study highlights the long-term irreversible consequences of natural disasters on human capital in poor countries. Dercon (2007) explains that this situation suggests the existence of poverty traps linked to human capital, resulting in a permanent state of low human capital and earnings.

Another problem that has received insufficient attention is that different types of natural disasters have different consequences: for example, Benson and Clay (2004) note the need for a distinction between geological and hydro-meteorological disasters. While geological events, being less frequent but often more cataclysmic, are more likely to generate Schumpeterian innovation and stimulate a post-disaster growth, hydro-meteorological disasters are generally more frequent, creating an atmosphere of uncertainty that hurts the investment climate and requires adaptation costs. Indeed in the Albala-Bertrand's study mentioned earlier, most of the countries that were found to have achieved higher growth rates in the two years following a disaster as compared with the two preceding years, had experienced earthquakes. Other disaster events were mainly succeeded by a lower post-disaster growth rate.

³ A child is considered as stunting if its height given his age is two standard deviations below international norms (United Nations ACC/SCN, 2000).

Using simulation based econometric methods, in a growth model applied to panel data from rural Zimbabwe, Elbers and Gunning (2003) found that risks associated with disasters reduced the mean capital stock in the observed region by 46%. The most innovative part of their work comes from the distinction between ex-post (observed directly after the shock) and ex-ante effects of risk (the costly behavioural response to risk, such as a discouragement to invest). They show that the ex-ante effect represents two-thirds of the negative effects of risk, stressing the inadequacy of most of the existing studies, which focus on the ex-post effect of risk. This also explains how frequent disasters can generate effects significantly different from a one-time huge disaster (which would have no ex-ante effect).

When estimating the overall cost of natural hazards, too much attention has been paid to the major events. Lavell (1999) stresses the importance of smaller-scale disasters, much more frequent than the larger ones, but not registered in the statistical databases because they are small enough not to involve the central authorities and are typically handled by local governments. According to Lavell, 'the cumulative losses associated with the "smaller disasters" may be as significant as that attributed to large-scale disasters'.

Moreover, many 'progressive disasters' are observed around the world with little action taken to address the problem. This issue is different from vulnerability to natural disasters, but is also accentuated by climate change and human behaviour. Although different from vulnerability to natural disasters, land degradation and soil erosion are also accentuated by climate change and human behaviour, and have increasing consequences on the poor. In Uganda, for example, the exposure to natural hazards has led to land degradation and has accentuated the impact of climate variability on crop output. In the most affected districts (Kabal, Kisoro, Mbale), which are also the most densely populated with a density of more than 250 inhabitants per square kilometre, 80% to 90% of the area is estimated to be affected by soil erosion (National Environment Management Authority of Uganda, 2002). Land degradation is a worldwide issue: A World Bank (1997) report estimated that 80% of the poor in Latin America, 60% of the poor in Asia, and 50% of the poor in Africa lived on marginal lands characterised by poor productivity and high vulnerability to natural degradation and natural disaster.

Given the methodological difficulties linked to empirical analysis, let us see what is offered by studies that focus on qualitative evidence. Benson and Clay (2004) have provided a number of case studies, highlighting the long-term negative effects of disasters. For example, the Bangladesh government has recognised that ‘inadequate infrastructure to deal with floods have been a constraint on investment in productive activities as well as on utilisation of installed capacity’ (Ministry of Planning—Bangladesh, 2000). Similarly, the Philippines have met tremendous difficulties in improving the country’s transport system and meeting the social infrastructure needs of the population because of an extremely high exposure to natural hazards, mainly floods and wind storms. Dominica (1979) and Montserrat (1995–8) are examples of a considerable loss of human capital through emigration linked to natural disasters. Clearly more work, both qualitative and quantitative, is needed to further explore these issues.

3. The Interactions Between Development and Vulnerability

3.1. Development Strategies and Their Impact on Vulnerability to Disasters

Hewitt (1983) and Blaikie *et al.* (1994) have made major contributions to the recent study of natural disasters and development. They stress the role of social structures in shaping vulnerability. Besides, Sen (1981) and Drèze and Sen (1989) are among the pioneers in considering famine not just a natural disaster but an avoidable economic and political catastrophe. They show that the famines were caused not so much by lack of food, but by lack of entitlement to resources based on access to economic, social and political power. These works have strongly influenced the concept of prevention and management of famines in the developing world and the idea that disasters are man-made or policy induced.

To pursue the analysis, it is crucial to understand that a natural disaster is not a completely exogenous event. A natural disaster is used as shorthand for humanitarian disaster with a natural trigger; or as stated by Wisner in a more provocative way, a natural disaster is a failure of human development (Pelling, 2003). As we will see, natural disasters are the consequences of natural hazards, but also, to a large extent, the reflection of development flaws.

3.1.1. Determinants of Vulnerability to Natural Hazard

Economic development typically reduces the exposure to natural hazard. A reduction of the proportion of the population working in the agricultural sector increases the resilience of the country since the overall level of production becomes less sensitive to hydro-meteorological conditions. The intersectoral linkages are another determining factor of the resilience: countries with a high degree of dualism, with a large capital-intensive extractive sector are less sensitive to natural hazards. For example, droughts had limited effect on the macro-economy of Botswana, Namibia or Zambia, all of which draw most of their resources from the mining industry.

The Financial System. Development is generally linked to a better financial system, which allows a wider diffusion of the impact of the disaster, especially when it facilitates small-scale savings and transfers. In Zimbabwe for example, after the 1991–2 drought, a well-developed financial system facilitated transfers from urban to rural regions. Later we discuss the role and importance of micro-credit.

Trade Openness. More open economies have fewer exchange constraints. As a consequence, any increase in imports for relief and reconstruction will not displace normal imports. Moreover, local inflation can be contained more easily in a more open economy following a disaster. But again more study is needed on how openness to trade helps or hinders recovery from natural disasters.

Institutions. One of the most important factors that determine the resilience of a country is the willingness of the government to consider preparedness for natural hazards a priority. This includes a long-term commitment to mitigation and preparedness, even when no disaster has occurred during the preceding years. Along with this, transparency, better reporting of relevant expenditures, and post-disaster reallocations are essential, as well as the enforcement of appropriate land-use and building codes.

On the other hand, the coincidence of a natural disaster and political instability can have dramatic consequences. Such was the case during the violent independence struggle in Bangladesh during the mid-1970s or the war in Mozambique during the 1990s that

destabilised Malawi's transport system and provoked an arrival of refugees. A more recent example is the case of Zimbabwe in 2002. Angola, Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe have all suffered from food shortages after three years of drought combined with flooding in some areas. However, Zimbabwe, which was considered as the 'breadbasket' of southern Africa a few years ago, became the most vulnerable country of the region. Political violence, fueled by inflation, unemployment, racial tensions, land reform issues, and soaring rates of HIV/AIDS have greatly weakened the country's capacity to provide effective relief. The government took control over the distribution of mealie meal (basic food). The objective was to ensure that mealie meal is supplied only to the supporters of the ZANU-PF ruling party (Osborne, 2003). Sen was the first one to observe that famines are the result of human behaviour, stressing that they do not happen in democracies, where a free press and free speech create excellent early-warning systems. While Sen provided Zimbabwe as an example of a democracy that has successfully prevented famines despite sharp declines in food output, he acknowledged that Zimbabwe no longer qualified for the exemption he had earlier given it.

Public Awareness. Only a population informed and concerned by risks related to natural hazard can create the appropriate incentives for the government to invest sufficiently in preparedness and mitigation. In Turkey, public awareness was very low despite frequent events. The Marmara earthquake (1999) has created a new level of public awareness not only because of the unprecedented scale of the disaster, but also because it was mainly urban, making it difficult for the politicians, local municipalities, building contractors and civil engineers to ignore their responsibility (Özyaprak, 1999). Sen has also compared the response to droughts in India and China arguing that India avoided famines because of its free press, whereas China suffered a major famine in 1984 because of the ability of the system to withhold information on the drought, and its unwillingness to admit problems and seek assistance.

3.1.2. An Example of Vulnerability Due to Human Factors

In 1972–3, the Sahel experienced a catastrophic drought during which thousands of people and millions of animals died (de

Waal, 1997; Mortimore, 1998). This catastrophe was the result of both natural and human factors. The preceding droughts in the late 1960s and early 1970s increased people's vulnerability, especially in the rural areas, by depleting their stock of physical capital (savings, grains, animals) as well as human capital through health deterioration or rural to urban migration. Indeed rural communities were the most vulnerable due to a combination of socioeconomic factors: (i) isolation due to poor communication and transport links; (ii) an urban bias in policy-making resulting from poor rural representation; (iii) a focus on short-term stabilisation rather than long-term economic development; and (iv) an emphasis on industrial investment and the conversion of agriculture to cash crops at the expense of the production of food for local consumption (Baker, 1987; Shaw, 1987; Rau, 1991).

The relevance of those human factors is highlighted by the fact that subsequently, the Sahel endured many droughts comparable to those of the early 1970s, but none of them led to such a massive regional-scale famine (Mortimore, 2000). If natural hazard has increased the vulnerability in the short-term, in the long-run the population has developed many strategies to cope with drought, such as agricultural diversification and migration.

In this case, the emphasis on industrialisation, cash crops and export earnings in countries that are primarily rural, where most of the population cannot afford, or lacks access to, imported food-stuffs, has increased the vulnerability of the region. This example illustrates the existence of a local-level adaptive capacity and the danger inherent in a 'top-down' approach to development, especially when it is based on global economic paradigms disconnected from the rural communities' reality (Pelling, 2003).

3.2. The Complex Relationship between Vulnerability and Development

Considerable development effort can be wasted when vulnerability is not taken into consideration. In Honduras, after the hurricane Mitch (1998), President Carlos Flores stated that his country's development was set back 30–50 years. Indeed 70% to 80% of the transport infrastructure was destroyed, including almost all bridges and secondary roads. One-fifth of the population was left homeless, crops and animal losses led to food shortages, while

outbreaks of malaria, dengue fever and cholera resulted from the lack of sanitation (National Climatic Center, 2004).

Mohamed H.I. Dore and David Etkin (Pelling, 2003) point out the importance of adaptive capacity at an institutional level. They define the necessary conditions for adaptation by observing in what ways developed countries are responding to the current climate. The authors observed six conditions:

- Developed countries have the technical know-how to understand climate.
- They have resources to devote to research on climate and the related risks.
- They develop the necessary technology to cope with climate.
- They share risks through government disaster-assisted programmes and through the insurance market.
- The insurance market mediates moral hazard problems through mechanisms such as a deductible minimum, rebates for minimising damages, or premium reductions for making no claims.
- They invest resources in emergency responses at all levels of government.

The six conditions are generally costly and require high-quality institutions and human capital. It can be deduced that a country needs to be relatively developed to meet the necessary conditions for a high resilience to natural hazard. At the same time, a vulnerable country is highly exposed to disasters that would be harmful to its development process. Consequently there is a risk for poor countries to be locked in a vicious circle where they are vulnerable because of their low level of development, and this vulnerability regularly brings them back to their initial level of development through natural disasters. As represented in Figure 3(a), high vulnerability would result in frequent large-scale natural disasters. Even if one disaster would generally not have long-term effects (such as represented in scenario A of Figure 2, for example), the succession of disasters does not allow the country to reconstitute its capital and other productive capacities. The result is high instability but also disconnection from the path of growth that

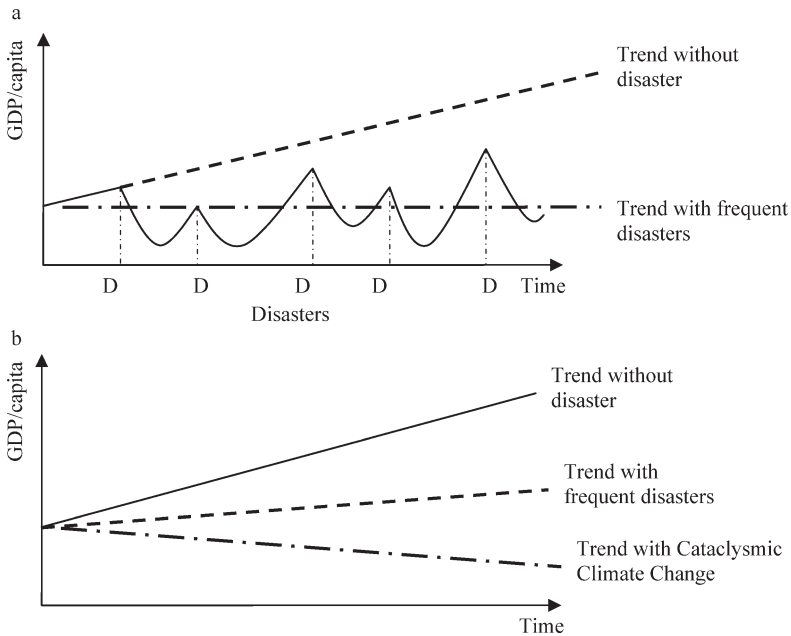


Figure 3: Possible Long-run Impacts on Income: (a) Possible Long-Run Impact of Successive Disasters on Income; (b) Possible Long-Run Impact of Severe Climate Change on Income.

would have been expected in the absence of disaster. This could be the story of Ethiopia, for example, which is particularly vulnerable since agriculture accounts for 41% of the GDP, 80% of the working force, and 80% of exports. Undoubtedly, vulnerability is only one of the numerous factors that can explain the stagnation of a least developed country, but its role should not be neglected, including its role through indirect channels such as discouraging private investments or increasing the risk of political instability. Further work on this vicious link between vulnerability and development would be valuable, although the establishment of a counterfactual would be difficult.

In order to emerge progressively from this situation, highly exposed countries need to incorporate how best to build resilience and reduce vulnerability very consciously into their development policy. Some authors, such as Katrina Allen (Pelling, 2003), go even further and argue that the distinction between resilience to natural hazards and development is mainly theoretical and has

more meaning for government bodies than for local communities. At a local level, both are strongly related to the lack of livelihood. Similarly, the humanitarian crises are extensively linked to the sociopolitical context. According to the author, isolating vulnerability from the wider social background risks treating symptoms rather than cause. The last case study of Section 4 illustrates how vulnerability and poverty can be tackled jointly.

If the projections made in Stern (2007), which incorporate the impact of more severe climate changes are correct, then we must also include the possibility of a sharp drop in income and consumption. Figure 3(b) incorporates such a scenario without any prevention or coping action. This grim scenario would lead to a huge increase in poverty, malnutrition and even mass famines as well as serious disruption to development.

4. Case Studies

4.1. The Landslide of La Josefina in Ecuador

In 1993, a huge landslide occurred in La Josefina, located in the mountainous southern region of Ecuador near the city of Cuenca. The landslide covered the entire valley, and dammed the river, impounding it for 33 days, during which 1,000 ha were flooded. In all, about 200 persons were killed by the flood and 14,000 persons displaced, with damage to land and buildings. The costs in terms of agricultural lands, factories and residential infrastructure reached several million dollars.

This case is a good example of a natural disaster caused by a combination of human and natural factors. The area was exposed to a permanent danger of landslide; below the landslide site, there are about 35 scars of slides from the past. But this should not mask the human responsibility. The area has a dense rural population and after the land reforms, lands were divided into excessively small plots, worked by farmers with little experience using overly intensive agriculture. Mono cultivation of maize in rows following the slope was a frequent practice, though this leads to heavy erosion.

After the disaster, during the 33 days of flood, 47 NGOs were criticised for their lack of effective assistance and the provincial government for its passivity. Codevilla (1993) argued that there was

an excess of 'asistencialismo' from the locals, simply waiting to be helped. No structure in place was able to handle the disaster.

A solution recommended by Morris (Pelling, 2003) would be to promote a soft engineering (making low-energy adaptations) rather than a hard engineering approach (trying to match the power of nature). These suggestions spring from Abramovitz's recommendations (2001) advocating a greater control over land use, limitation of intensive farming, and the development of forestry in critical zones. This implies recognition of the significant risks linked to natural hazard, which cannot be totally controlled, and the acceptance of a tradeoff between higher short-term productivity due to intensive farming and the long-term benefits resulting from the maintenance of a more resilient ecosystem.

4.2. *A Successful Disaster Recovery in Mozambique*

In a vulnerable country, one disaster can set back hard-won development efforts. Mozambique is one of the poorest countries in the world, with 69% of the population below the poverty line. The peace agreement of 1992 put an end to 17 years of civil war. From 1992 the growth rate of GDP per capita averaged 6% until the flood of 2000. The flood killed 700 people, 650,000 were displaced, and 4.5 million (a quarter of the population) were affected. It devastated 140,000 ha of crops and their irrigation systems, 350,000 livestock were lost or seriously injured, 6,000 fishermen lost at least 50% of their boats and gear, and about 500 primary schools and 7 secondary schools were destroyed.

However, the long-term economic consequences of the disaster largely depend on the capacity of the country to handle the recovery programme. Mozambique's recovery seems to have been generally effective. Recovery programmes have provided an opportunity for investments in upgraded services and infrastructure (Cosgrave *et al.*, 2001), many affected people have been assisted, and the rehabilitation and rebuilding of schools and health facilities have encouraged the development of new social structures such as associations and community committees.

This success can be explained by different factors, among them the creation of the National Disaster Management Institute in 1999, developing a culture of prevention, immediate and massive flows of aid and, above all, the government's determination to

establish a recovery programme aimed at strengthening national reconstruction and development policies. The objective was not simply to restore the previous level of development, but to generate the social and economic improvements that would increase the resilience to future disasters. A clear sign of progress is that the UNICEF (2002) has noted significant improvements in responses to the flood in 2001. Preparedness measures had been taken, including the pre-placement of food, boats and other relief materials. Neighbouring countries have been contacted to coordinate the displacement of affected populations.

One of the key elements of the success of the reconstruction was the extraordinarily high level of donor response of around \$450 million in May 2000 and a commitment from the government to maintain macroeconomic stability. These aid flows dampened the negative impacts of the disasters, allowing a rapid return to high levels of growth. Therefore, the 2000 and 2001 floods were not considered to have had a lasting negative economic impact. A recent World Bank report on the case of Mozambique (World Bank, 2005) has drawn the following reasons for the successful recovery:

- Intensive labour-based infrastructure works for disaster mitigation.
- Where possible, the use of local rather than international contractors.
- Increased levels of accountability and transparency through the use of independent reviews and evaluations of recovery works.
- Good practice guidelines to ensure gender issues were addressed, and adequate attention to recovery of complex livelihoods, land tenure issues and standards for housing.
- Emphasis on building capacity for disaster management at the district level, and sharing information on budget and planning for disasters.

4.3. Combining Vulnerability and Poverty Reduction

Instead of thinking of disaster response and development as two separate activities, can we think of programmes and projects that inherently combine them? An example of a successful project combining vulnerability and poverty reduction comes from Niger, one of the

poorest countries in the world. The project was implemented by the Small Rural Operation in Niger. It took 11 years (from 1988 to 1998) and targeted an area with a chronic food deficit for the population. The aim was to reduce drought vulnerability by intensifying off-season crop production through widespread use of existing, simple, low-cost technologies. Around 35,000 farmers benefited from the significant increase in production resulting from higher cropping intensities, cultivation of higher-value crops, and diversification towards non-crop activities. In this case the two objectives of poverty reduction and food security could not have been achieved separately because they are highly linked to the livelihood of the rural population. More such combined approaches are needed for the vicious cycle of disasters and low-level development to be broken.

5. Climate Change, Disasters, and Development

5.1. Climate Change: A Growing Risk to Sub-Saharan Africa

The IPCC has provided some of the most reliable reports on the observation of actual changes, and the forecast of future changes and their consequences. These predictions are unavoidably marked by uncertainty, but there are apprehensions that Sub-Saharan Africa and South Asia will be worst affected. Of course we must keep in mind that because Africa is a very diverse continent, any statement on the impact of climate change can hardly be applicable to the entire continent. Unless specified, information provided in this section is extracted from IPCC reports (1995, 2001).

Despite its tiny contribution to climate change, Sub-Saharan Africa is one of the most affected regions in the world. Indeed, the continent is highly exposed to climate change and its structural weaknesses result in lower resilience. With 40% of the population living on arid, semi-arid or dry sub-humid areas (UNDP, 1997), Africa is one of the most exposed areas of the world to global warming. It has experienced a warming of approximately 0.7°C during the last century and the temperature is expected to increase by 0.2°C (low scenario) to 0.5°C (high scenario) per decade in the future. Moreover, Hulme and Kelly (1997) note that in the preceding 25 years, the decline in rainfall observed in the Sahel was the most substantial and sustained recorded anywhere in the world within the period of instrumental measurements.

A high proportion of Africans live in coastal areas: one-quarter of the population resides within 100 km of a sea coast (Singh *et al.*, 1999). Because of the combination of an increase in climate variability and in sea levels, this population will be increasingly exposed in the next decades. Nicholls *et al.* (1999) found that the sea level rise could expand the number of people in Africa affected by flooding from 1 million in 1990 to 70 million in 2080 (simulating a 38 cm global rise of sea level during this period).

5.2. Africa's Low Capacity to Cope with Climate Change

Not only is the continent a highly exposed area, but it also faces structural difficulties that aggravate the consequences and limit its capacity to manage effective solutions. First, more than half of the African population is rural, which implies high vulnerability to natural hazards and high dependence on per capita food production, which has been declining in Africa for the past two decades, contrary to the global trend. Population growth, by putting more pressure on limited land available for cultivation or cattle farming, is also a main concern. African countries are highly vulnerable, not only to climate shocks, but also to economic shocks (such as terms of trade variability or aid volatility) and political shocks. The conjunction of different shocks has cumulative effects and undermines the countries' capacity to cope with crisis. To these weaknesses must be added the HIV/AIDS pandemic, which increases the burden on public resources and erodes human capital.

Nevertheless, the high vulnerability of Africa to the existing prevalence of disasters and to the possibility that their frequency may rise even further, must be addressed. This will require not only local initiative but also international help, as much of the continent will need to respond to effects induced by climate change, recognising that these effects were created by actions taken largely in the developed world. In other words Africa suffers from the development enjoyed elsewhere in the world, and is a consumer of the disastrous effects of climate change.

5.3. Main Concerns for the Future

Among the various problems that will be exacerbated by climate change, particular attention should be paid to the highly

interrelated issues of desertification, food security and water supply, which can have dramatic consequences on the poor.

5.3.1. Desertification

Desertification contributed to the death of 250,000 people in the Sahel drought of 1968–73 (UNCOD, 1977). By progressively reducing agricultural and livestock yields, the land capacity to support people is noticeably reduced while the population keeps increasing rapidly. The total population of Africa grew almost five times since 1950. In the meantime, desertification has reduced the productivity of one-quarter of the continent's land area by 25%, encouraging the exodus towards urban areas. Desertification also has feedback effects that can create vicious cycles through, for example, the release of CO₂, or higher susceptibility to wind erosion, which may reduce the water retention capacity of the soil. Besides, wind erosion (or loss of infiltration capacity due to vegetation loss or soil compaction) intensifies the effects of climate variability on crop failure. Accordingly, measures need to be undertaken to limit the extent of irreversible changes.

5.3.2. Food Security

There is a wide consensus that climate change will worsen food security in Africa through continuous shifts, as well as an increase in extreme events. Hunger is not a sporadic episode in Africa: nearly 200 million people in Africa are undernourished and 33% of African children are stunted, underweight or wasted (FAO, 1999). A combination of factors noted previously can explain the reduction and uncertainty on crop, livestock and fishery yields. These figures undeniably hide sizeable disparities. While recurrent conflicts have shrunk food availability in Burundi, considerable progress in Ghana was triggered by higher agricultural productivity.

5.3.3. Water Supply

Except in the equatorial region and coastal areas of eastern and southern Africa, other areas of the continent are dry sub-humid to arid. Global warming should result in a reduction in soil moisture in sub-humid regions, and a reduction in runoff because high

temperatures enhance evaporation of water. Africa has the lowest conversion factor of precipitation to runoff (15%) and the situation is worsening rapidly with a reduction in runoff of 17% in the past decade. Indeed, Arnell (1999) finds that southern Africa is the region that will experience the greatest reduction in runoff by the year 2050, increasing the number of countries included in the water stress category (using a per capita water-scarcity limit of 1,000 m³ per year). Likewise, Sharma *et al.* (1996) estimated that between 2000 and 2025, the number of African countries enduring water stress will rise from 8 to 18 and the population affected will double, reaching 600 million people. This relative scarcity of water is also the consequence of rapid population growth. Poor people will be the most affected because they have the most limited access to water resources; but it should have consequences on the whole economy—even industrial activity is threatened by the scarcity of water. In Ghana, the unprecedented drought of 1982–3 compelled electricity rationing until 1986, stressing the need for alternative sources of energy.

5.3.4. Water-related Conflicts

As an additional threat to African development, access to water is likely to be the source of an increasing number of conflicts in the future (Stern, 2007). National as well as cross-border conflicts motivated by water access have been observed already. In Mali the 1970s and 1980s droughts forced many semi-nomadic Tuareg to migrate; their troublesome return to their native lands was the basis for the ‘Second Tuareg Rebellion’ in 1990. The use of dams along the Senegal River provoked clashes between Senegalese and Mauritanian populations during the late 1980s and early 1990s (Niasse, 2005). The West African region has already experienced a decline in its rainfall of 10% to 30% during the past three decades. This raises a lot of concerns for the forthcoming decades: cooperative mechanisms will be required to prevent the commencement of additional water-related contentions.

5.4. Adaptation to Climate Change

Issues raised in this section often progressively augment the vulnerability of a country, which is often revealed only when an extreme

event occurs. Increasing the resilience to natural hazard implies a permanent effort to tackle the diverse consequences of global warming. Desertification, food security, water supply and other climate-related issues are strongly integrated and efforts to provide solutions should be combined.

A first essential step is improved resource management. There is much room for improvement in this field. Low-cost technologies for wind erosion control exist. Access to credit could stimulate the use of windbreaks, mulching, ridging and rock bunds (Baidu-Forson and Napier, 1998). Agricultural production can be enhanced by appropriate management of rainwater, like in Morocco, where scarce rains are used very efficiently for farming. As another example, South Africa has started to develop strategies to optimise the use of water through water prices and demand management tools.

Given that access to water is an increasing stake and most of the major rivers of Africa include several countries, international river basin management protocols are now fundamental to avoiding water-related conflicts. They have been fairly developed during the past decade and need to be encouraged through a strengthening of their financial and human resources, and a legal framework that would ensure equity and efficiency in the management of water supply.

In the medium-term, the development of forecasting offers many possibilities for improvement in the adaptation to climate change and the preparedness for extreme hydrological events. For example, crop models can be used to make adjustments in management by providing information concerning the probability of success of resource diversification or intensification. The development of data and local skills is a necessary step to enhance research and offer more practical solutions.

Finally, strong synergies can be identified between the reduction of vulnerability and global warming. Maintenance of forests would mitigate both flooding and climate change. There are new opportunities emerging from carbon trading that Africa could exploit.⁴ For example, in the EU market, firms are willing to pay as much as \$20 per ton for sequestration. On the assumption that a hectare of dense tropical forest will emit some 500 tons of CO₂ when it burns or rots, its international market value is as high as \$10,000. While conversion of tropical forest to farming gives high returns to the

⁴ This section draws from Chomitz *et al.* (2007).

farmers, these are often small compared with the international carbon trading options that are becoming available. For example, Tomich *et al.* (2005) have shown that the net present value (using a discount rate of 10%) for one hectare cleared in Cameroon gives a return of about \$283–623 for food crops, \$424–1,409 for cocoa and \$722–1458 for palm oil. Even if the carbon sequestration price were as low as \$3 per ton it would give better returns to Cameroon compared with the farming options. This does not include the other benefits of preserving tropical forests such as biodiversity. Yohe *et al.* (2004) have argued that an international agreement on carbon sequestration would be viable even at \$2.70 per ton.

6. Coping with and Preventing Natural Disasters

6.1. Financial Mechanisms

When governments do not resort to higher fiscal deficit to fund relief and reconstruction costs, they generally turn to international aid or reallocation of expenditure. However, other solutions are available for spreading risks. This section discusses the strengths and weaknesses of each solution.

6.1.1. Current Approach

Fiscal Deficits. When a government is submerged by a sudden overflow of emergency needs, higher expenditures leading to bigger fiscal deficits are easy answers. Nonetheless, the long-term costs of indebtedness are well known, making this choice the last resort for the government. Benson and Clay (1998, 2004) found no impact of natural disasters on the overall budget deficit except in drought affected Sub-Saharan economies, where five of the six case studies showed a noticeable increase in government borrowing succeeding the drought.

Reallocation of Expenditure. One of the most common ways to cope with the urgent needs of a post-disaster situation is to reallocate budgetary resources. This solution provides a rapid source of funding while keeping domestic credit and money supply under control. Still, it diverts funds from planned investments and thus hampers the development process. A main concern is that

reallocation of funds after a disaster should follow a formal process rather than emergency decisions, so that funds would not be diverted from projects essential to the long-term development of the country. This is often not the case and vital long-term development is affected.

International Aid. International agencies play a major role in helping countries that have limited resources to cope with the disaster. However, Benson and Clay (2004) suggest that post-disaster aid flows are not additional. In their three case studies (Dominica, Bangladesh and Malawi) they observed that disasters had little impact on the overall level of aid. Donors bring forward commitments and thus reduce the availability of aid during the subsequent years. The World Bank IEG report (2006a) confirms that despite the existence of an Emergency Recovery Loan, loan reallocations are the most frequent type of responses to disasters in highly vulnerable countries and that such reallocations often do not lead to good outcomes.

Another important issue in aid-based relief and reconstruction is that considerable flows of aid from different donors raise management difficulties for the receiving country. They have to submit to different conditions from the donors, which can take time and limit their sovereignty. It diminishes the government's ability to determine the allocation of reconstruction funds, and to set its own priorities.

Increasingly, countries are taking greater control over donor coordination during the relief and recovery period. But where institutional capacities are limited, coordination can also be provided by one of the donors. After the drought in Sudan in 1989, the World Bank worked with the other donors to organise the relief and avoid unnecessary overlaps in coverage. Special attention is required from the international community when a natural disaster occurs in a politically unstable country or in one with weak institutions.

Benson and Clay denounce an excessive reliance on international aid in the case of disasters. Natural disasters often substantially increase the gap between commitments and actual aid disbursements. In a situation of emergency, small delays may result in severe social and economic consequences. Moreover, as we look

into the future, aid flows might not be able to cope with the rapid increase in the annual cost of disasters; there is a need to begin to look at alternative options. And if natural disaster management must be seen as part and parcel of economic development, then special funding mechanisms for disasters may actually lead to avoidance of the more fundamental choices countries must make to build disaster management into their development strategy.

6.1.2. Financial Risk Mechanisms

Insurance. As noted by Freeman *et al.* (2002), currently less than 1% of the losses from natural disasters are formally insured in the world's poorest countries. This financial risk mitigation mechanism could certainly be developed further to reduce aid dependency for managing disasters. The expansion of insurance has been limited by its high cost: Catastrophe insurance premiums can be several times higher than the actuarially determined expected losses (Froot, 1999). Furthermore, to manage insurance schemes, strong institutions are required: regulation must insure that insurance companies are sufficiently cautious and big enough to diversify the risk or be reinsured. Moreover, clear and agreed triggers are needed for insurance pay-outs, on which it is often difficult to agree.

Because the risk is highly covariant and difficult to estimate, insurance industries always face considerable difficulties in providing insurance against natural hazards. When the risk is too low, agents have very few incentives to pay the insurance premiums. Conversely, in the most exposed regions, the soaring risk discourages insurance companies. A closer look at the developed countries points out that, in most cases, the insurance market is not fully private and the government plays a major role, generally by providing catastrophe reinsurance to the companies. As a consequence, the agents are encouraged to adopt a risky behaviour, knowing that they would not bear the full costs in case of a disaster. To limit the moral hazard, insurance can be provided conditionally on the implementation of loss reduction measures and the respect of building and land use zoning codes. In that way, the insurance companies can contribute to the national effort for preparedness and mitigation by creating the appropriate incentives.

A second limit to the suggestion of a government's backstop facility is that it does not eliminate the risk, but transfers it from

the local to the national level. If a rich country's government generally has the ability to absorb the costs, a poor country would not have the same capacity. In order to handle the additional pressure on its budget the government itself would need to resort to other sources of funding such as international aid.

Determination of Parametric Insurance Trigger. A possible solution would be to establish an insurance system in which payouts would be triggered by parametric observations such as extreme rainfall. Disbursing without damage assessment procedures can accelerate transfers and reduce transaction costs, but it is currently difficult to find simple instruments strongly related to economic costs. Further agro-meteorological research and good historical data are necessary for insurance companies to be able to calculate accurate rates of premium. It also requires good institutions; for example, many difficulties related to landholding titles would surge if these are not well defined.

Because of the difficulties of implementation, few examples of insurance with a parametric trigger currently exist. The Windward Islands Crop Insurance that covers the export of bananas in Dominica, Grenada, St Lucia, and St Vincent and the Grenadines, has a verification system close to the parametric trigger (Benson and Clay, 2004). Evaluation of losses is easy because the insurance covers one crop against one hazard. When a disaster occurs, a 5% physical survey of affected growers gives the proportion of damaged plants, avoiding lengthy damage assessment procedures. The benefit is calculated on the basis of the average deliveries during the preceding 3 years. The payment of premium is assured since it is directly deducted from export revenues. However, the scheme faces some difficulties, such as the high covariance risk, the fact that premiums are too low but cannot be raised because of political reasons and the long-term decline in banana prices. So far, WINCROP has been unable to extend the insurance scheme to other crops because of legislative restrictions and extremely high reinsurance rates.

In January 2006 the World Bank initiated the preparatory studies for the establishment of the Caribbean Catastrophe Risk Insurance Facility (CCRIF). The Facility will allow governments of the Caribbean Community and Common Market (CARICOM) to

have access to insurance coverage at a lower rate than each state could have obtained on its own for three main reasons: (i) participating governments will pool, and thus diversify, their risk (ii) donor partners will contribute to a reserve fund in order to reduce the need of international reinsurance and (iii) the use of a pre-determined parametric trigger will reduce transaction costs and moral hazard. Parametric triggers will allow immediate cash payment after the occurrence of a major earthquake or hurricane, helping governments fund immediate post-disaster recovery while mobilising additional resources (World Bank, 2006b). A high exposure to natural hazard has encouraged Caribbean country governments to look for creative solutions. African countries need to pay particular attention to such initiatives and conceive their own solutions.

Instruments for Spreading Risks Directly to the Capital Market. Instruments such as 'catastrophe bonds' could reduce post-disaster pressure on fiscal and external balances. The principle is very simple: the owner of the bond would receive regular payments. However, if the catastrophe occurs, an amount is taken from the principal or interest of the bond. It can provide an immediate and timely availability of funds, but because of the high transaction costs this solution is twice as expensive as insurance (Swiss Reinsurance Company, 1999). When compared with post-disaster assistance, which is generally highly concessional, it is not surprising that the demand for risk transfer mechanisms in the private market is very low in developing countries. But in countries with repeated disasters one could consider using part of the aid flows to invest in market-based risk spreading options like insurance, with part of the aid being used as a backstop facility. Turkey has developed such a scheme for earthquake insurance.

Micro-credit Institutions. Micro-credit institutions can help cushion the impact of the disaster for a part of the population that is highly vulnerable and not often reached by other institutions. Natural disasters have profound impact on households, including human losses, and also loss of housing, livestock, food stores and productive assets such as agricultural implements. The disaster-affected population has to replace homes and assets and

meet basic needs until they are able to recommence income-generating activities. In the absence of micro-credit institutions, poor households are forced to rely on moneylenders who charge considerably higher rates of interest.

However, special attention needs to be paid to micro-credit institutions, which are highly exposed. In Bangladesh, after the 1998 floods, considerable refinancing from the Bangladesh Bank prevented many micro-credit institutions from falling into bankruptcy. The government backstop is essential because, once again, the high covariance risk would result in the micro-credit agencies facing problems during a disaster. In order to avoid repercussions on the users of micro-credit, a contingent liability from the governments or donors will constantly be required. A risk-pooling arrangement with micro-credit institutions from different parts of the world could be another prospect to diversify the risk.

Increasing the Flexibility of Aid Disbursements. The term ‘moral hazard’ has often been used when accusing poor countries’ governments of not doing enough for disaster mitigation as part of their development strategy because of the expectation that they would rely on post-disaster external assistance. However, the cost of insurance can be so high that it could have long-run economic effects through diversion of capital from investment or any other spending, with a high opportunity cost. In this case it is not only rational to rely on international aid at a national level, but it is also rational at a collective level because international assistance would be the solution that minimises the long-run negative economic impact of natural disasters. It is likely that the capacity of a country to handle the risks linked to natural hazard without international assistance will depend heavily on its stage of development. For this reason, insurance and instruments for spreading risk linked directly to the capital market—such as catastrophe bonds—might be accessible mainly to middle-income countries. However, in the least developed countries, where the insurance industry is reticent because of risk aversion, the only solution might be an appropriate intervention: aid flows must be adapted to the urgent and massive needs subsequent to a disaster.

The limits of aid mentioned previously (such as the delays or the lack of coordination) are essentially due to the fact that

the donor community tends to be reactive rather than anticipative of disasters. Guillaumont (2006) suggests that aid could provide a guarantee to countries who accept to follow some predefined rules of shock management. This shift from ex-post conditionality to ex-ante conditionality could considerably reduce both delays and moral hazard. Disasters occur every year in the world and the trend is upward. We know disasters will occur, we just do not know exactly when and where. In this case one option would be to think of a regional or a global disaster facility. Based on recent recommendations from an evaluation, the World Bank has taken the lead to help establish a pilot Global Disaster Facility with a fund of \$5 million to encourage mitigation activities. If the procedures for the use of the facility are agreed up front then such a facility (once scaled up) would also reduce problems of donor coordination often seen in post-disaster reconstruction programmes.

Another solution that deserves more attention, although it has already been implemented, is the use of debt relief as a way to reduce rapidly the financial pressure on the country where the disaster occurred. It is a way to circumvent regular delays related to fund release from the donors. This solution is particularly adapted to Highly Indebted Poor Countries where the debt service can represent a serious burden, crowding out other important uses of scarce resources. For example, following the flood of 2000, the World Bank approved accelerated debt relief worth \$10 million to the Mozambican government to cover 100% of IDA debt interest over the next 12 months.

6.2. Can Disaster Preparedness Be Improved?

6.2.1. The Predictability of Natural Hazards

Most of the natural hazard risks are foreseeable in the sense that it is possible to predict where events are more likely to occur in the near future; and yet it is very infrequent that they are included in country development strategies, even in highly vulnerable countries (IEG report).

Accurate prediction of exactly where and when a natural hazard might strike is difficult—but past data can reveal the countries that are more vulnerable to disasters. Some of the most advanced

countries in Africa such as South Africa spend about \$5 million per year as against the economic cost of natural hazard that are estimated at \$1 billion per year. If forecasting research can make even a small contribution to better public decisions in mitigation, preparedness and crisis management, it would justify sustaining the effort in research on climatic forecast. Investments in early warning systems for flooding, tsunamis and hurricanes can also help save thousands of lives and even reduce the financial costs of disasters. There is a lot of room for improvement on climate forecasting in Africa: the density of weather watch stations is eight times lower than the minimum level recommended by the World Meteorological Organization, and reporting rates are the lowest in the world (Washington *et al.* 2004).

6.2.2. Planning the Relief and Reconstruction

As mentioned in the previous section, it is possible to identify a number of countries that are highly exposed to natural hazards. For example, in the following chart (Figure 4) are represented the countries of Sub-Saharan Africa where at least 10 disasters occurred between 1996 and 2005.

The number of disasters and number of people affected are represented per type of disaster for each country. One can see that floods and droughts are the most frequent types of disasters in Sub-Saharan Africa, followed by wind storms. However, droughts tend to affect a much higher number of people. In a country with such a history, the probability of another disaster occurring during the next decade is very high. Given the huge impact of disasters on poverty and economic outcomes, it would be expected that special attention would be paid to natural hazards in these countries' development strategies. However, among all the countries represented in the preceding chart, only two have incorporated aspects of hazard risk management in their Poverty Reduction Strategy Papers (PRSPs).

A more ambitious agenda would involve prevention or reduction in the frequency of natural disasters by designing development approaches and strategies that reduce people's vulnerability. Of course development itself, by reducing exposure of the population to agro-climatic conditions, reduces vulnerability; but more specific actions can be used as well, among them better

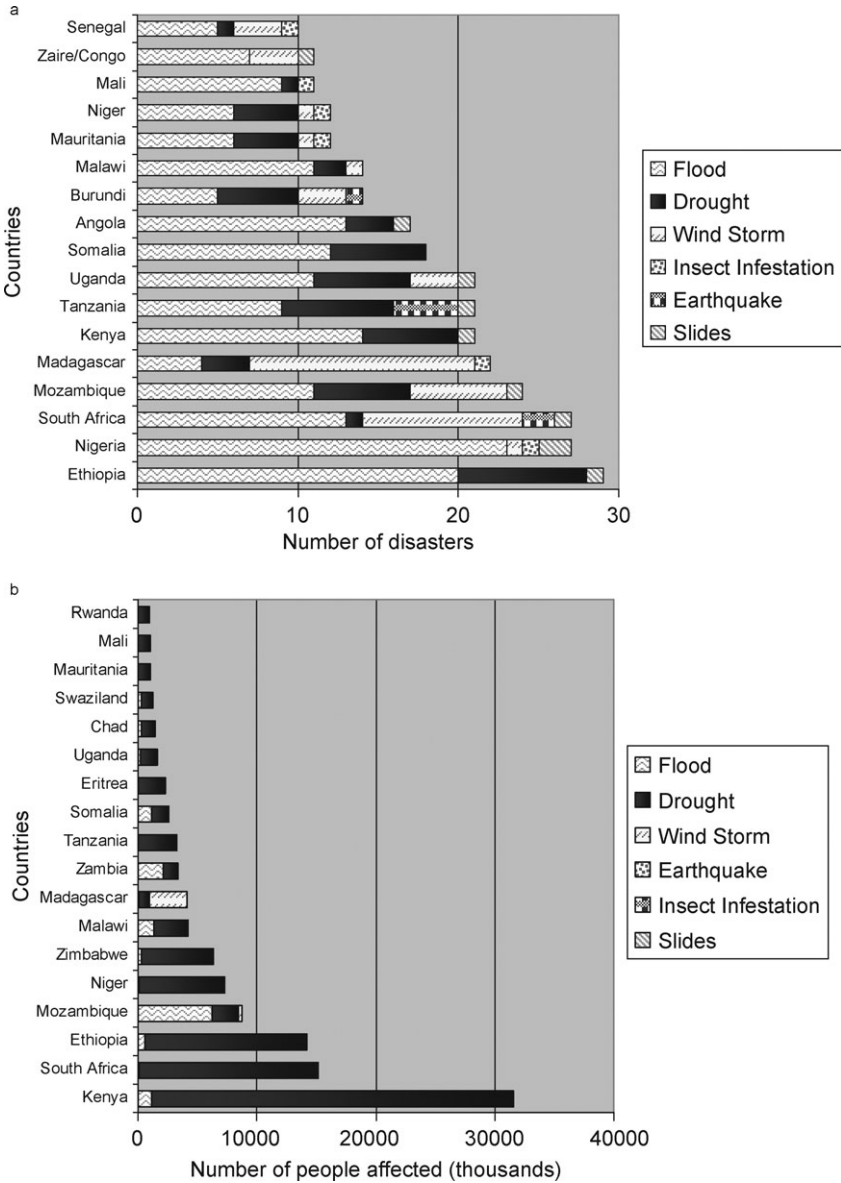


Figure 4: Most Exposed Countries in Africa: (a) Number and Types of Disasters (1996–2005); (b) Number of People Affected (1996–2005).

Table 1: *The Negligence of Natural Disasters in Development Strategies*^a

Number of disasters (1966–2005)	Number of countries	Number of countries including a discussion of disasters in the PRSP
21–29 disasters	7	1 (Mozambique)
11–19 disasters	6	1 (Malawi)
1–9 disasters	18	1 (Ghana)
Total	31	3 (10%)

^aOnly Sub-Saharan countries that have a PRSP are included.

water and land management, better infrastructure and housing and more careful attention to actions that increase people's vulnerability to natural hazards.

Disasters must be anticipated in order to make rational choices, even in emergency situations. In highly exposed countries, the government should prepare a clearly defined policy framework aiming at meeting urgent needs as well as minimising the long-term negative consequences of disasters. It should include a system of prioritisation of individual development projects and programmes to ensure that any budget reallocation would not harm those with the highest development impact for the country.

The Stern report (2007) also recognises development as a key to long-term adaptation to climate change; moreover it points out some particular areas of development that are essential to foster a country's adaptation to climate change:

- income and food security;
- education and health systems;
- urban planning and provision of public services and infrastructure;
- gender equality.

The cost of adaptation to climate change in the developing world is hard to estimate, but it would be up to tens of billions of dollars, which, however, is far less costly than the consequences of inaction. Firm measures to strengthen adaptation include the integration of

climate change impact in all national, sub-national and sectoral planning processes and macro-economic projections. The implication of a core ministry, such as finance, economics or planning, which would be accountable for mainstreaming adaptation, would be an undeniable sign of government commitment (Sperling, 2003).

7. Conclusions and Directions for Future Research

The objective of this paper is to draw attention to the growing impact of natural hazards on long-term development as well as the reciprocal effect of development on vulnerability. After a review of the existing literature, many areas of research have emerged that will need further investigation.

First, there is currently no consensus about the long-term economic impact of natural disasters. Some authors argue that while a consequent negative impact is observed during the year of the shock, it is generally followed by an expansion, allowing a rapid return to the long-term equilibrium. Others object that the reduction of human and physical capital can hinder the long-term development of the country, especially when the disasters are frequent. Because of technical difficulties, few previous studies have provided compelling empirical evidence confirming any of the two perspectives. Both theoretical and better empirical work is needed.

Second, further theoretical as well as empirical studies of the long-term impact of natural disasters will have to go into further detail in analysing the disaster. It is very likely that the impact will differ according to the type of disaster, its frequency, the contribution of international aid and the socio-economic conditions of the country. Pooling all natural disasters together would fail to consider the vast range of possible effects, and could be misleading.

Third, the link between conflict and natural disasters and vulnerability needs more attention, especially in parts of Sub-Saharan Africa where population pressure is being exacerbated, and land degradation and desertification are increasing rapidly.

Fourth, management of Africa's forest resources and the potential to use carbon trading mechanisms to pay for the preservation of forest resources as opposed to slash and burn farming open new areas for further research.

Fifth, the role of alternative funding mechanisms, be they market-based facilities like insurance and bonds, local funding such as micro-credit schemes to reduce vulnerability, or prearranged global or regional funding mechanisms also need more research, including on how they could be expanded and how the inherent moral hazard and covariance could be reduced.

Sixth, more work is also needed on adaptation to climate change where the focus has been largely on technical issues but much less attention has gone to the economic costs and benefits of different adaptation mechanisms.

Seventh, why do current development plans appear to ignore disaster risks? Is there a lack of incentives due to limited public awareness? Much more attention is needed on how disaster risk mitigation must be built more visibly and centrally into economic development plans and strategy through the PRSPs and national plans.

This paper has shown the importance of natural disasters to African development and the links between disaster management and economic development. The high costs of disasters, sometimes larger than aid inflows, the evidence that the intensity of disasters is determined by the choices countries make on economic development, and the need to stop considering natural disasters as one-off events are highlighted in this paper. We find that despite the frequency of disasters in many African countries they are discussed only in the PRSPs of three of them. Finally, after showing that while Africa is a very small contributor to factors causing global warming and climate change, it is likely to become the continent most affected by climate change, and the paper offers some options available for adaptation. We hope the paper will stimulate more discussion, research and better solutions to this issue.

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