

Why Resilience Matters

The Poverty Impacts of Disasters

Jun E. Rentschler

The World Bank
Global Facility for Disaster Reduction and Recovery
and Office of the Chief Economist
Sustainable Development Network
November 2013



Abstract

This paper presents empirical evidence of the profound and long-term damages from adverse natural events on poverty. It analyzes 30 years of macro-level damage data from disasters (including earthquakes, floods, and storms), according to income groups, and shows that low-income countries incur disproportionately large damages relative to their assets. Furthermore, the paper reviews the micro-level evidence of disaster impacts on the livelihoods of the poorest households. The evidence suggests that the poor are significantly more vulnerable and exposed to the economic and human capital losses caused by disasters. It discusses detrimental long-term

consequences for the income and welfare of the poor and the presence of poverty traps that result from damages to productive assets, health, and education. The roles of migration and ex-ante behavior are also discussed. In the context of climate change, the paper underscores the importance of considering the detrimental impacts of smaller but repeated crises, for instance caused by changes in local precipitation patterns. Lastly, the paper offers a brief discussion of policy options for strengthening resilience and highlights the need for further research for understanding the complex direct and indirect effects of disasters on the poor.

This paper is a product of the Global Facility for Disaster Reduction and Recovery, and Office of the Chief Economist, Sustainable Development Network. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The author may be contacted at jrentschler@worldbank.org, or contact@junrentschler.com.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Why Resilience Matters – The Poverty Impacts of Disasters

Jun E. Rentschler^{1,2}

Keywords: *Poverty, Disasters, Resilience, Human Capital*

JEL Classification: *I30, Q01, F63*

Sector Boards: *POV, SOCPT*

¹ The World Bank, Sustainable Development Network, Office of the Chief Economist; and Global Facility for Disaster Reduction and Recovery (GFDRR), Washington D.C., USA

² University College London, Department of Economics; UCL Institute for Sustainable Resources, London, UK
The author would like to thank Bianca Adam, Marianne Fay, Francis Ghesquiere, Stéphane Hallegatte, Niels Holm-Nielson, Prashant, and Emmanuel Skoufias for useful discussions and/or comments on an earlier version of this paper. Remaining errors are the author's.

1. Introduction

In recent years, adverse natural events have been increasing both in frequency and the magnitude of economic losses they cause – by now this statistical trend is frequently cited, yet insufficiently challenged for what it reflects and what it does not. Primarily, the drivers behind this trend can be thought to reflect increasing natural hazards at the country level (for instance due to climate change), increasing exposure and vulnerability to hazards, but also more accurate and complete monitoring and documentation systems. However, what is not reflected in this statistical trend is the impact of disasters on the poorest, and their long-term impacts on human and economic development. Oftentimes, the absolute economic losses of poor households are small relative to those of the wealthy, and thus the consequences on the poorest communities are marginalized in the analysis.

This paper summarizes the empirical evidence for the disproportionately large impact of disasters on the poor. It explains some of the main mechanisms, which make the poor particularly exposed and vulnerable to disaster losses (such as the lack of risk management systems). In particular, the longer-term and indirect consequences of disasters are discussed, both in terms of economic losses and human capital losses (such as malnutrition and education). In addition to the loss of life and physical destruction, disasters have various direct impacts on households. The economic and human capital losses can significantly lower the welfare and income levels of poor households. Since direct economic losses are associated with further indirect human capital losses, and vice versa, disasters may even result in poverty traps for the poorest households and impair their development prospects in the very long term (see Diagram 1.). Overall, this implies that direct disaster losses at the household level can have further serious consequences for social stability, migration, macro-economic outcomes, poverty and development. In order to prevent or mitigate such consequences, it is critical to strengthen the resilience of poor households.

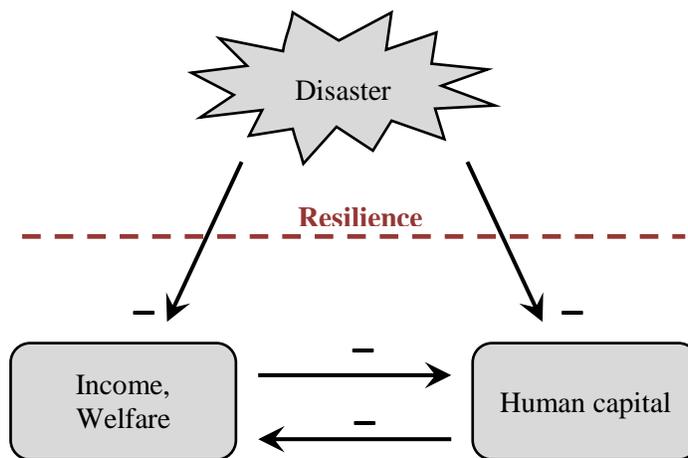


Diagram 1. Disasters (for instance caused by earthquakes, storms, or floods) have a detrimental impact on the income and human capital levels of poor households – and a decrease in either of them can result in a reduction of the other, thus creating a poverty trap. Building resilience is critical for reducing disaster impacts and limiting damages to the short-term.

The rest of the paper is structured as follows: Section 2 reviews the macro-level evidence of adverse natural events, suggesting that low-income countries suffer disproportionately high damages from disasters. Section 3 investigates evidence at the household level, with a particular focus on the implications for welfare and human capital of poor households, and discusses the role of ex-ante behavior. Section 4 discusses how disaster damages can translate into long-term and indirect impacts on income and welfare and create poverty traps. Section 5 highlights the importance of not overlooking the detrimental impact from small but repeated disasters – particularly in the context of a changing climate. Section 6 briefly discusses policy options for building resilience, underscores the need for further research to fully understand the link between disasters and poverty, and concludes.

2. Macro impacts of disasters – The poor are hit the hardest

2.1. Evidence at the country level

Taking a closer look at the loss data of natural catastrophes of the past 30 years, it becomes apparent that low-income countries suffer disproportionately high damages from disasters, even though the incurred economic losses may appear small in absolute terms. On the contrary, high-income countries have incurred very high economic damages (in absolute terms) as a result of disasters. However, these costs are borne at the margin – i.e., high-income countries have the resources and capacity to recover from these events without significant long-term consequences (at least at the national level).

Evidently, natural catastrophes affect countries around the world, regardless of their level of economic development. Depending on geographical circumstances, developing and developed countries alike can be prone to experience frequent natural “loss events” – for instance, Bangladesh (floods), the USA (hurricanes), or Japan (earthquakes). However, the nature of experienced damages and losses varies significantly across countries. Generally, such variation can be attributed to differences in terms of hazard probability (i.e. the frequency of hazards varies across countries), exposure (for instance, some countries having larger population shares in at-risk areas than others), vulnerability (for instance, countries with poorly enforced building codes being likely to incur more casualties in an earthquake), and resilience (for example, some countries being able to reconstruct more quickly than others). Of these factors, exposure, vulnerability and resilience all depend strongly on a country’s level of income.

Based on the analysis by Wirtz (2013), the following breakdown of the structure of disaster related losses illustrates three key facts: (i) the vast majority of human fatalities are experienced by low-income countries; (ii) absolute economic losses are the highest in high-income countries; and (iii) economic losses relative to GDP are the highest in low-income countries – which has further implications, e.g., for the speed of recovery and reconstruction.

In order to distinguish between different income levels, it is useful to apply the World Bank country classifications according to income groups³:

HIC: High-income countries (Per capita income US\$ > 12,275);

UMIC: Upper-middle-income countries (Per capita income US\$ 3,976 – 12,275);

LMIC: Lower-middle-income countries (Per capita income US\$ 1,006 – 3,976);

LIC: Low-income countries (Per capita income US\$ < 1,006).

³ For coherence with the subsequently presented data, we use the World Bank’s 2011 country classification.

Year	Event	Location	Fatalities	Income Group
2010	Earthquake	Haiti	222,570	LIC
2004	Earthquake, tsunami	Sri Lanka, Indonesia, Thailand, India, Bangladesh, Myanmar, Maldives, Malaysia	220,000	LIC, LMIC, UMIC
2008	Cyclone Nargis, storm surge	Myanmar	140,000	LIC
1991	Tropical cyclone, storm surge	Bangladesh	139,000	LIC
2005	Earthquake	Pakistan, India, Afghanistan	88,000	LIC, LMIC
2008	Earthquake	China	84,000	UMIC
2003	Heat wave, drought	France, Germany, Italy, Portugal, Romania, Spain, United Kingdom	70,000	UMIC, HIC
2010	Heat wave	Russia	56,000	HIC
1990	Earthquake	Iran	40,000	UMIC
2003	Earthquake	Iran	26,200	UMIC

Table 1. Disasters in terms of fatalities (1980-2012). Only very few of the deadliest disasters have occurred in high-income countries. Low-income countries (LIC) have experienced the highest human losses. *Source: MunichRE, NatCatSERVICE, Wirtz (2013)*

Year	Event	Location	Losses (US\$ m)	Income Group
2011	Earthquake, tsunami	Japan	210,000	HIC
2005	Hurricane Katrina, storm surge	USA	125,000	HIC
1995	Earthquake	Japan	100,000	HIC
2008	Earthquake	China	85,000	UMIC
2012	Hurricane Sandy, storm surge	USA, Canada, Bahamas, Cuba, Dominican Rep., Haiti, Jamaica, Puerto Rico	65,000	HIC*
1994	Earthquake	USA	44,000	HIC
2011	Floods	Thailand	43,000	UMIC
2008	Hurricane Ike	USA, Cuba, Haiti, Dominican Rep., Turks and Caicos Islands, Bahamas	38,000	HIC*
1998	Floods	China	30,700	UMIC
2010	Earthquake, tsunami	Chile	30,000	HIC

*The vast majority of economic losses were incurred in the USA, i.e. HIC

Table 2. Disasters in terms of absolute economic losses (in US\$ m, original values, 1980-2012). The costliest disasters have almost exclusively occurred in high-income countries (HIC). *Source: MunichRE, NatCatSERVICE, Wirtz (2013)*

Tables 1 and 2 present the most harmful natural catastrophes in terms of fatalities, as well as absolute economic losses between 1980 and 2012. Two features are particularly striking: The vast majority of human fatalities as a result of natural catastrophes are incurred in low-income or lower-middle-income countries (Table 1). On the contrary, the highest absolute economic losses from natural catastrophes are incurred in high-income economies (Table 2).

Considering all of the recorded natural catastrophes with human or economic losses between 1980 and 2011 offers a better understanding of how the harmful consequences are distributed across income groups. In this time period, a total of 22,200 events were recorded, of which nearly half were experienced in high-income countries (c.f. Figure 1)⁴ At 9% low-income countries experienced a relatively small number of natural catastrophes in this time period. It remains an open question to which extent this actually reflects better monitoring systems in high-income countries. Nevertheless, the distribution of fatalities offers a completely reversed image: nearly half of the 2,275,000 fatalities caused by natural catastrophes in the same time period were incurred by countries in the lowest income group, while high-income countries incurred far fewer fatalities (5%).

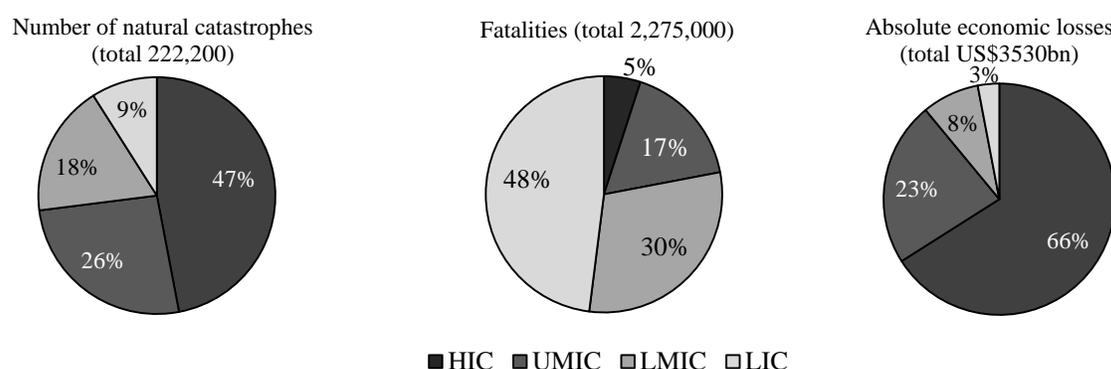


Figure 1. Distribution by income group (1980-2011); *Left:* Total number of loss events; *Middle:* Fatalities due to natural catastrophes; *Right:* Absolute economic losses in 2011 values; *Source:* MunichRE, NatCatSERVICE, Wirtz (2013)

In terms of economic losses due to natural catastrophes, the picture also relies strongly on the applied measure and the considered income group: For the period from 1980 to 2011, absolute economic losses of US\$3,530 billion were incurred globally due to disasters (mainly due to earthquakes, floods, and storms), of which two-thirds were incurred by high-income countries (c.f. Figure 1 right). Low-income and lower-middle-income countries combined incurred just over 10% of the total absolute losses (while incurring more than 75% of total fatalities).

Relative to GDP however, low-income countries incurred on average the highest economic losses as a consequence of natural catastrophes (c.f. Figure 2). Overall economic losses averaged close to one-quarter of GDP in the lowest-income group, while ranging between 5% and 8% in the other income groups. This demonstrates that even though absolute economic losses were low in low-income countries, the economic burden of natural catastrophes is disproportionately high in these countries, with further implications, e.g., for the speed of economic recovery and means for reconstruction. This is confirmed empirically by Skidmore and Toya (2007), who use a cross-section analysis of disaster loss data from 151 countries over the 1960-2003 period and find that the ratio of economic losses to GDP is decreasing with GDP per capita. Bakkensen (2013) finds similar results, even accounting for country fixed-effects. This result confirms that rich countries suffer from most of the losses while poorer countries have higher losses when compared with their resources.

⁴ Events are recorded at country level, i.e. 2012 Hurricane Sandy is recorded as a separate event for each affected country

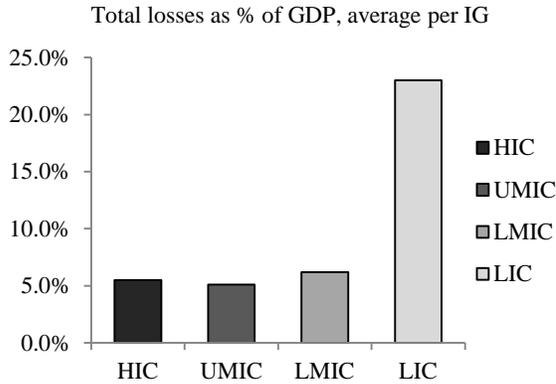


Figure 2. Economic losses as percentage of GDP, 1980-2011; *Source: MunichRE, NatCatSERVICE, Wirtz (2013)*

In addition to these indicators, there exists evidence that in low-income countries various other macro-indicators are particularly negatively affected by disasters. Cochrane (1994), for instance, provides evidence that, especially in countries where recovery and reconstruction costs have to be financed through external borrowing (i.e. typically low-income countries), disasters lead to increased stocks of external debt, and reduce longer-term growth prospects.

2.2. Evidence at the subnational level

Evidently, the country-level macro data presented in the previous section fails to reflect conditions at the subnational level: Certain cities or regions within a country may be particularly exposed or vulnerable to disasters. When tracking the recovery of a disaster-affected economy, the slow recovery of an affected region may be disguised behind strong development in non-affected regions.

Regions. In fact, only on rare occasions is an entire country affected by a single adverse natural event. Far more frequent are regional disasters, which leave the rest of the country unaffected or at least less affected. There is evidence that even in highly industrialized economies with large reconstruction and recovery budgets, the occurrence of a disaster can lead to significantly reduced per capita income in the long term. For instance, duPont and Noy (2012) find that the 1995 earthquake in the Hanshin area (Kansai region, Japan) caused a persistent, long-term decline in the regional GDP per capita. They estimate that without the earthquake, income per capita in the region would have been 13% higher 15 years later.

Cities. A study by Hallegatte et al. (2013) provides comprehensive evidence for the exposure and vulnerability of the world's 136 largest coastal cities in low-income countries. The authors develop different scenarios, based on varying assumptions about future adaptation measures and sea level rise, and assess the economic costs of future urban flood losses. In line with the evidence at the country level, the authors find that the relative economic losses (i.e. expected average annual flood losses, relative to the city's GDP) are particularly large in coastal cities of low income and lower-middle-income countries. A ranking of the 20 cities with the largest *relative* annual losses includes only four cities from high-income countries. In this context, the authors highlight the importance of adaptation: without significant investments in flood defenses, cities will incur enormous costs from flooding – with cities in low-income countries incurring the largest (relative) losses.

Overall, these figures provide a crude idea at the macro level of how similar natural events have different consequences in different countries. This underscores that the conditions which turn a natural hazard into a disaster are created by socio-economic circumstances. The extent to which these circumstances are resilient to natural hazards is at least partially determined by a country's level of income. This also hints at another fact not reflected in the above macro figures: many disasters in high-income countries do not happen in the first place, thanks to high institutional capacity, systems for prevention, and resources available for managing natural hazards and thus averting disasters. Furthermore, as discussed in the next section, particularly in the poorest countries, the true damages from disasters can extend into the very long term and have a significant negative impact on economic and human development. Thus, in the context of poverty alleviation, it is crucial to account for such indirect and long-term impacts in order to fully understand the true benefits from preventing disasters and building resilience.

3. Poverty and disasters – Impacts at the micro level

While the above discussion demonstrates at the macro level that the poorest countries are hit the hardest by natural events, it yields little insight regarding impacts at the micro level. The aggregation of disaster losses at the macro level merely accounts for the direct economic costs, but fails to consider indirect and long-term impacts on economic and human development. Particularly the poorest households suffer severely from disasters, but carry little economic weight and are thus often marginalized in the analysis. In addition to economic losses, the poor are also more vulnerable to incurring losses, which are difficult to fully capture by standard quantitative analysis (for instance, post-disaster traumas or depression; Baez, de la Fuente, & Santos, (2010)). Hallegatte, Henriet, and Corfee-Morlot (2008) thus argue for a multi-dimension measurement of disaster consequences, which complements standard quantitative with qualitative assessments. In this way it is possible to investigate the consequences, e.g., for income distribution, poverty levels and employment in informal sectors, which may be of significant size in poor communities.

In line with this argument, Hallegatte et al. (2010) offer a household level analysis of the consequences of the 2005 Mumbai flood on the poorest population and the informal economy. Their findings are representative of the typical poverty implications of disasters in most developing countries: the poorest households were found to be the most vulnerable, as they lacked the resources for coping with the requirements during and after the flooding. While the losses in absolute terms might not appear large, they found that the average flood losses incurred by households corresponded to the average size of savings. Having their entire saving wiped out obstructed the ability of households to recover and reconstruct in the aftermath – not least because the loss of assets entailed further consequences for poor households' creditworthiness, as a majority of sample households found themselves unable to borrow or repay previous loans.

3.1. Disaster impacts on household welfare and consumption

The inequality in the level of vulnerability across income groups is reflected in the level of post-disaster consumption – a common proxy for household welfare. Numerous studies show that consumption patterns of poor households are significantly influenced by natural risks. Baez and Mason (2008) for instance present evidence for El Salvador, where earthquakes in 2001 reduced income per capita (and thus

consumption) of the most affected households by one-third. Various studies have investigated the 1984/1985 drought in Burkina Faso and find consumption levels reduced by up to 19% in certain regions (Kazianga & Udry, 2006; Fafchamps, Udry, & Czukas, 1998). Islam (2013) presents evidence from various flooding events in Bangladesh, and illustrates the welfare implications for poor households: in certain years with major flooding events (such as 1974, 1988, 2004) up to 7.5 mil ha of crops, and more than 4 million houses were damaged or destroyed. This highlights that damages not only affect households directly, but can be transmitted through indirect channels: Damages incurred by the agricultural sector or industrial production (such as destroyed fields, or machinery, etc.) result in reduced employment opportunities, and can constrain the supply of food and other goods, thus driving up prices. Microenterprises that rely heavily on an expensive piece of machinery (the price of the machinery constitutes a significant part or even exceeds annual income) may be deprived of their only source of income, if this piece of equipment is destroyed. This illustrates that poor households will not only suffer from the damages incurred directly to their own assets and livelihoods, but they will also be heavily affected by the disaster impacts on their wider socioeconomic environment. Overall, similar to the macro-level data, the evidence suggests that in comparison to wealthier households the negative impact on income and consumption levels of the poorest households is disproportionately strong.

An important reason for the strong consumption variability across income levels is the lack of effective systems for risk management and coping available to the poor. It has been widely documented that particularly in poor communities households have limited options to insure themselves against the risk of a disaster, while the existing insurance practices are oftentimes inadequate (Dercon S. , 2002; Fafchamps, Udry, & Czukas, 1998; Skoufias & Quisumbing, 2003). Dercon (2002) reviews the literature on risk management and coping strategies of poor households, and concludes that such mechanisms are typically unable to prevent poor households from being particularly vulnerable to risk-related poverty. To cite an example, a common practice in poor communities is to save in-kind, for instance by advancing the construction of a house whenever resources become available. Such physical in-kind savings are typically subject to the direct risk of destruction in the event of a disaster, and thus cannot be sold when the proceeds would be needed for coping expenses. Further studies show that households attempting to sell off assets (such as livestock) in the aftermath of a disaster often fail to raise funds in this way due to a collapse in local demand and thus of prices (Dercon S. , 2007; Fafchamps, Udry, & Czukas, 1998; Kazianga & Udry, 2006). For the same reason, community-based risk-sharing mechanisms often fail in the context of natural events: for instance, a local insurance provider is likely to be unable to provide full insurance coverage if all its members and clients are simultaneously affected by a catastrophic disaster (Skoufias & Quisumbing, 2003).

This lack of adequate insurance and coping mechanisms, but also of adequate public services and infrastructure more generally, can often be attributed to the lacking institutional capacity common to poor communities and countries. In fact, corrupt and inefficient authorities have a direct impact, particularly on the poorest, and their ability to cope with a disaster and recover from it successfully in its aftermath. Ambraseys and Bilham (2011) for instance present empirical evidence that since 1980, 83% of all fatalities from earthquake-related building collapses occurred in countries with highly corrupt authorities – for instance due to poorly enforced building codes.

3.2. Effects on human capital: Education, nutrition, health

The impacts of adverse natural events on income and consumption can have severe direct and indirect consequences on human development indicators of poor households. By analyzing the impacts on human capital, the literature provides a starting point for a more comprehensive understanding of disaster impacts on the poorest individuals. Baez, de la Fuente, & Santos (2010) offer a comprehensive review and assessment of a wide range of studies, which investigate the consequences of disasters of various types and sizes around the world. They confirm that disasters typically entail substantial damages in the short term (such as fatalities and destruction). More interestingly, they find that due to severe impacts on human capital (in particular, nutrition, education, and health), the income generating capacity of households is significantly impaired. In addition, the review by Baez, de la Fuente, & Santos (2010) shows that most socio-economic groups within an affected population suffer negative consequences from disasters – however, the magnitude of such negative consequences varies significantly across different income groups in the reviewed studies. A finding common to all studies is that the poorest population groups are consistently found to incur the most detrimental damages in terms of various human capital determinants. Within the poorest population groups, women and children are found to be most vulnerable to incurring large human capital losses (Baez, de la Fuente, & Santos, 2010).

Malnutrition. One of the common human capital losses from adverse natural events is hunger and malnutrition. Evidence suggest that children from poor households are particularly vulnerable to malnutrition during and after disasters, which in turn can have long-term irreversible consequences for health and productivity. Alderman et al. (2006) show that early childhood malnutrition can have impacts potentially lasting a lifetime: evidence from Zimbabwe shows that the 1982/84 drought led to increased probabilities of child stunting, which delayed the school enrollment of these children by on average 3.7 months, and led to worsened performance at school (0.4 grades lower) measurable up to 16 years after the disaster (Alderman, Hoddinott, & Kinsey, 2006). These impacts can be expected to have further consequences on future productivity and income.

For Sub-Saharan Africa, for instance, studies suggest that children are particularly vulnerable to experiencing malnutrition or famines as a consequence of droughts: evidence of child stunting and undernourishment have been presented for Tanzania, Ethiopia, Zimbabwe, Côte d'Ivoire, and Kenya, among others (Alderman, Hoogeveen, & Rossi, 2009; Yamano, Alderman, & Christiaensen, 2005; Cord, Hull, Hennem, & van der Vink, 2008; Jensen, 2000). However, besides droughts, it has been shown that excessive rainfall shocks, or strong rainfall variation can also affect nutritional outcomes. Evidence from Bangladesh (1988) and Nicaragua (Hurricane Mitch in 1998) shows that the incidence of infant and child malnutrition increased up to three times as a consequence of such events (Foster, 1995).

Different to other types of losses, child stunting is irreversible after a certain age. Nevertheless, there is evidence that children from wealthier households who experienced a period of malnourishment can “catch up” with their lost growth and make a physical recovery. However, the chances of such a recovery are limited to a few years, and are clearly conditional on income levels and access to credit: Children from poor households have far lower chances of “catching up” (Foster, 1995; Hoddinott & Kinsey, 2001).

Of course, the negative impact of malnutrition due to disasters is not limited to children. The physiological condition of adults, and of women in particular (measured in terms of the body mass index) have been found to be negatively affected following droughts, for instance in Zimbabwe and Ethiopia (Hoddinott &

Kinsey, 2001; Dercon & Krishnan, 2000). Nevertheless, the impacts of malnutrition on poor children in their early development are more profound and in most cases irreversible.

Education. As outlined by Baez et al. (2010), the impacts of disasters on educational outcomes can be transmitted in various ways, and isolating these effects and determining their direction of causality can be difficult. Generally speaking, disasters can result in direct physical damages to education infrastructure (such as buildings), and related services and resources (such as loss of electricity, etc.). In a broader sense, such resources also include teachers, who are just as affected by natural events and are often unable to seamlessly proceed with teaching, as they try to cope in the aftermath. The resulting absence of a small number of teachers can effectively disrupt the education of a large number of children. Potential income losses may furthermore result in reduced school attendance (e.g., due to unaffordable tuition fees), or increased child labor. While the exact role of each of these channels varies from case to case (and remains to be fully understood), overall evidence of the negative schooling effects due to disasters has been documented for various cases.

In principle, income volatility can be expected to result in deteriorating educational outcomes of poor children, as poor households without access to savings or loans are typically forced to divert investments away from non-essential expenses. Jensen (2000) provides evidence that in those regions in Côte d'Ivoire, which experienced income shocks due to significant agricultural shocks between 1986 and 1987, school enrollment rates declined by 20% in comparison to non-affected regions. Krutikova (2010) offers evidence from Tanzania, showing that income shocks (which may include anything from natural events to theft, or fires) have a significant impact on the school attendance and performance of children from poor households. The author shows that older girls (age 12-15) and younger boys (age 7-11) are most negatively affected, and that these consequences are highly persistent (measurable at least 10-13 years after the shock). This is in line with evidence by Jacoby and Skoufias (1997), who suggest that a 10% decline in agricultural income due to reduced rainfall would result in an average fall in school attendance by five days in the respective season.

In the context of education, it is crucial to note that adverse natural events have been shown to also increase the incidence of child labor – usually at the expense of schooling. This evidence is part of a broader literature on increased child labor as a consequence of various idiosyncratic shocks, such as economic downturns. Santos (2007) shows that following an earthquake in El Salvador in 2001, not only did school attendance fall by 7% for children from heavily affected households – children from these households were also three times more likely to work. Baez and Santos (2007) offer further evidence for the impact of Hurricane Mitch in Nicaragua in 1998: The authors find that in those areas heavily affected by the hurricane, children's labor force participation increased by 58%. De Janvry et al. (2006) present further evidence suggesting that poor households use child labor as a mechanism to cope with (temporary) income shocks: survey data from low-income households in rural Mexico shows that more than 25% of teenagers aged 13-16 (younger children to a lesser extent) work intermittently, i.e. transition in and out of the labor force repeatedly whenever needed.

It is important to note that negative impacts on human capital outcomes can be either a direct or an indirect consequence of disasters. Impacts are direct if, for instance, an earthquake destroys schooling facilities and thus directly reduces school attendance of children. However, if a flood destroys a household's savings, an indirect consequence of this may be to take children out of education in order to

be able to afford essential consumption needs (such as food). Similarly, in the context of nutritional outcomes, a disaster may decrease the general availability of food (direct), or it may weaken a household's financial situation such that it can no longer afford a balanced diet (indirect) – and these effects may further result in malnourishment, thus reduced cognitive abilities and educational outcomes.

The distinction between these direct and indirect channels becomes important when designing policies for building resilience: In the above schooling example, direct impacts would need to be addressed by making school infrastructure more resilient – this could mean to make school buildings earthquake-proof, or having contingency plans in place which allow the restart of teaching in provisional facilities soon after a disaster. If a post-disaster decline in school attendance is due to the affected household experiencing an income shock, building resilience may mean to establish an effective system of social protection nets, or (conditional) cash transfers. This could prevent households from sending children to work rather than school. However, in order to make such policy choices, the nature of the link between disasters and human development outcomes needs to be understood more thoroughly.

3.3. Migration

A further common consequence in the aftermath of disasters is regional or even transnational migration. Such post-disaster migration is typically based on both 'push-factors' and 'pull-factors': Deteriorating socioeconomic conditions in the affected region, for instance lacking employment opportunities, may cause households to relocate. Similarly, the prospects of better employment opportunities, or safer living conditions, may attract households to non-affected regions. Such conditions are often overlooked in macro-data analyses: Even once the macroeconomic indicators of a country have recovered to pre-disaster levels at the national level, the conditions in affected regions may still be far from having fully recovered. This economic slowdown reduces labor demand in these regions, while labor demand in non-affected regions remains comparably high. This labor market imbalance is likely to cause migration as an economic adaptation behavior.

Dillon et al. (2011) have documented such ex-post migration by poor households after weather related events in northern Nigeria. They highlight that weather related events mainly affect agricultural productivity and thus lead rural households to migrate to urban areas. The authors conclude that urban migration is likely to further strain limited resources in cities, for instance in terms of residential space, or labor market outcomes. In fact, Strobl & Valfort (2013) offer evidence from Uganda that an increase in weather related migration rates decreases labor market prospects for both incoming migrants and present residents.

These results hint at further consequences from disaster-related migration: In low-income countries, when households from the poorest and most vulnerable income groups migrate, their situation may not necessarily improve. The lack of productive assets, ill-suited skill sets and unfamiliarity with the new environment can have significant impacts on urban development and poverty conditions. Furthermore, rapid urbanization combined with poorly enforced building codes and land rights may result in increasingly risky settlements within cities. Hallegatte et al. (2010) observe for instance that in the case of Mumbai, many of the river banks are inhabited by poor slum dwellers who once migrated to the city and occupied cheap land, which is subject to significant risk of regular flooding. The lack of economic

opportunity and poverty resulting from migration is also considered to be a driver of social tensions, and in some cases violent conflict (Reuveny, 2007).

In order to reduce their exposure to risks, households may choose to migrate to areas with less frequent or smaller natural hazards (Dillon, Mueller, & Salau, 2011). So far, there is little empirical insight to the social and economic obstacles to individual migration as an adaptation strategy after a disaster. Particularly for the poorest and most vulnerable households the costs of migration, as well as the challenges of adapting to the new environment, and job search with limited skill sets could create critical obstacles. A recent study by Bryan et al. (2012) provides evidence from a randomized control trial in Bangladesh, which provided poor households with a \$8.50 incentive to migrate during pre-harvest lean seasons, which are particularly prone to food shortages and famines. Remarkably, they find that this incentive induces the seasonal migration of a family member in 22% of all households, and that the household's food consumption increases by 30% as a consequence. Even once the incentive is removed, these households are found to repeat the seasonal migration practice in subsequent years. These findings by Bryan et al. (2012) suggest the cost of migration can indeed be a considerable obstacle to households close to the subsistence level. This implies that the risk of failure from a migration strategy (e.g. failure to find a job at the destination) leads to risk aversion, which may prevent households to experiment with migration, even if a disaster occurs regularly and can be anticipated.

Overall, when considering the true costs of disasters, migration and its indirect consequences need to be accounted for. These complex socio-economic interlinkages and drivers are analytically difficult to isolate from other shocks, but can critically influence the welfare level of the poor after a disaster.

3.4. The impact today of a disaster tomorrow

The presence of natural hazards, and a lack of resilience to them, can influence household behavior significantly. Particularly for the poor the absence of effective risk management mechanisms and social safety nets can constrain their economic and human development. One reason for this is the lack of formal insurance, lending, or social security institutions, which causes households to make predominantly low-risk and low-return investments (Zimmermann & Carter, 2003). For instance, in anticipation of future disasters a household may decide against investments in productive machinery, which could otherwise constitute an important source of household income. While this behavior allows households to mitigate the risk from natural hazards over time, it can also significantly reduce their lifetime earnings and reduce investments in human capital accordingly.

The anticipation of future external shocks can prevent occupational specialization, and thus lead to sub-optimal labor market outcomes. Bandyopadhyay and Skoufias (2013) analyze the link between rainfall variability and occupational choice in rural Bangladesh. They find that diversification of occupations within a household is used as an ex-ante risk management strategy in the face of local rainfall variability risks (droughts and floods). However, the authors provide empirical evidence that occupational diversification within households has negative effects on long-term welfare and consumption. They suggest that in order to mitigate risk, household members choose occupations which do not necessarily match their skills sets, and thus are not as productive as they would be if they specialized.

For similar reasons, poor households which anticipate the occurrence of disasters may decide to minimize savings (such as in-kind savings in the form of physical assets), as such savings would be at the risk of destruction in the case of a disaster. Such savings decisions result in lacking financial buffers (i.e. financial resilience) which would allow households to smoothen consumption in the event of transitory shocks such as droughts or floods – and may thus have further poverty implications.

The lack of clear and effectively enforced land rights has also been found to have similar effects on poor households: Facing the permanent risk of eviction from their homes, poor households are unlikely to invest in the physical resilience of their homes (such as retrofitting to strengthen homes against earthquakes). Such decisions to not invest can severely increase the vulnerability and worsen consequences in the event of a disaster (for instance fatalities due to collapsing building structures). As in other examples, the strengthening of institutional capacity and reliable protection of rights would help to create an environment conducive to resilience enhancing investments.

In line with this argument, Dillon et al. (2011) present evidence from Nigeria that disaster related migration by poor households is not only a reaction to a disaster (such as a drought), but can also happen ex-ante. In fact, Dillon et al. (2011) highlight that poor households can actively use such preemptive migration as a risk mitigation strategy – for instance by having members of the household migrate to a destination, where risks are least correlated with risks at home, and thus spatially diversifying income sources. If a household perceives the hazard and their vulnerability to be too high, it may decide to migrate as a whole – with the various potentially negative consequences outlined in the previous section. However, previously presented evidence from Bangladesh by Bryan et al. (2012) suggests that very poor households may be deterred from using this strategy due to the up-front costs of migration. This is possibly the case when future damages are anticipated to be manageable.

4. Poverty traps and long-term impacts

While the economic and human capital losses presented in the previous section are severe in their own right, it is critical to understand how these can obstruct long-term development, and create poverty traps. Various studies document how the post-disaster welfare level, approximated by consumption levels, is often significantly and persistently lower than the pre-disaster level, especially in the case of the poorest households. The reason for this is that those who are already surviving on income and asset levels close to or below the poverty line, will typically be forced to sell off productive assets (such as livestock or land), in order to afford the basic minimum of essential consumption (such as food and shelter). However, by depleting productive assets in order to subsist during transitory shocks, poor or near-poor households compromise their ability to sustain their pre-disaster income levels, and thus potentially lock themselves into poverty in the long-term. This effect is reinforced, as households are often not only forced to dispose of productive physical assets, but also reduce other vital expenditures, such as investments in their human capital. Deteriorating health and low education are then even more likely to perpetuate poverty as a long-term impact of a disaster. Such poverty traps can in fact be passed on to subsequent generations: Children are often particularly vulnerable, as lacking investment in their health and education reduces economic opportunities for them and their future households (Ferreira & Schady, 2008).

Maccini and Yang (2009) analyze the role of early-life rainfall on the long term socioeconomic outcomes of Indonesian adults. They find that women who experienced 20% higher rainfall during their birth year

have on average undergone 0.15 more years of schooling and have 5.2% higher household incomes – even 26 to 47 years after birth. This suggests that early-life rainfall has a significant positive impact on the long-term welfare outcomes of women, while no similar correlation is found for men – possibly due to preferential treatment when resources are scarce. Maccini and Yang (2009) suggest that higher rainfall is associated with higher agricultural production, thus improving household income, nutrition and health. These are beneficial for girls' human development, eventually leading to a higher socioeconomic standing even in the very long term.

Indeed, various studies confirm the existence of poverty traps as a result of disasters. Similarly, Carter et al. (2006) analyze data for the 1998/2000 drought in Ethiopia and the 1998 Hurricane Mitch in Honduras to investigate the role of households' income levels in the recovery process. They document differences in the speed of recovery across income groups, while the poorest households in both countries were particularly likely to experience poverty traps: Above a certain threshold level of income (e.g., in Honduras estimated at roughly \$250 per person per year), households managed to recover their pre-disaster level of assets. Households with annual incomes below this threshold were unable to fully recover their pre-disaster asset levels even in the long term.

Along the same lines, Dercon (2004) presents evidence from the 1984-1985 famine in Ethiopia, as a consequence of which poor households did not manage to recover to pre-disaster consumption levels for on average ten years. Similar evidence exists for the droughts in 1999 in Ethiopia (Carter, Little, Mogues, & Negatu, 2006), as well between 1991 and 1995 in Tanzania, where more than ten years after the disaster the poorest households faced consumption levels between 17% and 40% lower than pre-disaster (Beegle, Dehejia, & Gatti, 2006). Further evidence for long-term negative impacts on welfare indicators of households, such as consumption, earnings and labour market outcomes, has been presented for Brazil, Honduras, and El Salvador (Mueller & Osgood, 2007; Rodríguez-Meza & González-Vega, 2004; Baez & Mason, 2008; Carter, Little, Mogues, & Negatu, 2006).

These findings on malnutrition as a consequence of disasters have various implications for the link between disasters and poverty outcomes. A weak physical constitution due to early childhood undernourishment, is argued to result in poorer cognitive skills, reduced life expectancy, and chronic diseases, which in return can all be expected to reduce labor market productivity and lifetime earnings. Hoddinott et al. (2008) manage to capture and quantify this long-term effect on earnings by using data from a nutrition supplementation project in rural Guatemala (1969-1977): they find that those who received nutrition supplements during age one to three, had 46% higher average wages than stunted children. This suggests that if disaster-induced malnutrition affects a child in its critical early-childhood years, it can have a substantial effect on future earnings and productivity – thus, protecting the post-disaster nutrition status of children in low-income households could be an important and cost-effective long-term economic investment. Baez, de la Fuente, and Santos (2010) offer a further comprehensive review of the literature on the long-term effects of disaster related malnutrition.

Similar evidence has been found for the long-term effects of educational outcomes. De Janvry et al. (2006), for instance, present evidence from Mexico for state dependence: Once children have been taken out of school, even if it is only due to a temporary shock, they are 30% less likely to proceed with their education than children who remain at school. This suggests that temporary spending adjustments by poor

households often result in permanent shifts – at the expense of the child’s human capital and future productivity.

As a critical consequence of such poverty traps, affected households become significantly more vulnerable to future disasters and are susceptible to incurring increasingly severe consequences on their livelihoods. For instance, the lack of in kind savings, lack of collateral for obtaining credit, or weaker health conditions, deprive households of the basic coping capacity, which they may have had at their disposal in the first instance.

These poverty traps at the micro level can in fact threaten socioeconomic prospects at the macro level, and annihilate previous gains and future prospects of economic development and poverty reduction. Roy and Kreimer (1999), and Benson and Clay (2004) have stressed that low-income countries with limited reconstruction capacities are more likely than high-income countries to suffer from strong long-term impacts to economic development. Hallegatte et al. (2007) extend this argument and show that regular disasters can lead to macro-economic poverty traps in low-income countries, which lack the capacity to rebuild destroyed infrastructure at a sufficient pace after each event in order to accumulate productive capital. Loayza et al. (2012) provide further empirical evidence that low-income countries are particularly sensitive to natural events, with damages persisting in the long-term. In addition, Miguel, Satyanath, & Sergenti (2004) find that economic and social consequences of a disaster can highly increase the risk of conflict.

5. The detrimental power of small repeated crises

The observation that the first occurrence of a disaster pushes poor (or near poor) households into poverty traps and reduces their ability to cope with further disasters necessarily raises the question about the impact of *repeated* crises. Evidently, the long term welfare levels attainable by poor households will not only be affected by the severity, but also the frequency of disasters. If households cannot recover their pre-disaster level of consumption before the next disaster occurs, households find themselves in the vicious cycle of a poverty trap: lacking coping capacity, more severe consequences, longer recovery periods, and persistently reduced income reinforce a downward spiral perpetuating poverty.

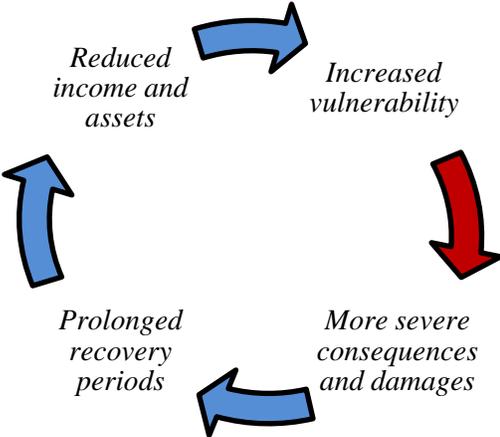


Diagram 2. Poverty traps: The vicious cycle of perpetuated poverty and vulnerability

The role of more frequent, even though possibly smaller natural crises becomes particularly relevant considering the anticipated impacts of climate change. In addition to large natural catastrophes, which typically affect entire regions (such as earthquakes or hurricanes), climate change can be expected to lead to increasingly frequent natural hazards for those located in at risk areas. For instance, changes in local precipitation patterns are likely to result in local natural hazards, which have the potential to materialize frequently – for instance, landslides, and crops affected due to soil erosion or droughts. Especially in poor rural communities, which rely heavily on agricultural productivity, frequently occurring natural crises can have a detrimental effect and create poverty traps through the mechanisms discussed in the previous sections and Diagram 2. In addition, people historically not affected by natural hazards and thus with low resilience levels may also be increasingly at risk as a consequence of climate change.

Lavell (1999) is one of the few emphasizing the importance for policy makers to take into account small, but frequent disasters. He argues that the cumulative impact of such events could in fact be just as severe as those from major disasters. In practice however, large scale disasters attract the most attention from policy makers. Similarly, most of the existing literature focusses on the impacts of major natural catastrophes, whereas empirical evidence is scarce about the magnitude and time scale of losses due to smaller repeated natural crises.

The lack of attention by policy makers can also be attributed to the political economy of managing risk: The benefit of mitigating the risks from small repeating crises is likely to only materialize in the long-term, i.e. much longer than political mandates. Furthermore, such benefits tend to be difficult to observe and measure. Effectively this implies that addressing smaller disasters yields lesser political reward, which results in a bias towards less effective ex-post action, rather than prevention and building resilience. Linked to this is the fact that public attention tends to be easily captured by major disasters with high damages and fatality figures, but far less so when disasters are small. This bias is also both a consequence and reason for biased media coverage, which largely overlooks small repeated crises.

Results by Hallegatte et al. (2007) suggest that also at the macro-level, the frequency of disasters can play a critical role: If financial capacity is insufficient to rebuild destroyed infrastructure quickly enough after a disaster, a country will be unable to build a sufficient stock of productive capital. This implies that countries such as Guatemala which experience frequent extreme weather events are at an increased risk of poverty traps.

6. Toward resilience - Discussion and conclusion

Building the evidence base. The existing literature provides clear evidence that poor people are in general the ones suffering the most adverse and long-lasting damages from disasters. However, understanding and experience is still limited as to which concrete measures can effectively build resilience and prevent poverty traps. As the nature and importance of different transmission channels of disaster impacts vary significantly according to country specific circumstances, research needs to determine how to tailor effective yet flexible policy measures in the interest of the most vulnerable. Research on conditional and unconditional cash transfers could be one promising part of what needs to be a comprehensive evidence base for comprehensive policies for resilience building.

Furthermore, the understanding of the impact of repeated natural crises is still limited. This partly reflects a fundamental data problem, as smaller repeated disasters and weather events are poorly monitored. While large disasters are documented increasingly well, the impact of small disasters is particularly difficult to isolate from other effects, which influence outcomes in household welfare. Thus, further research is required to quantify the negative impacts of small repeated crises and the mechanisms behind them – only then can informed and effective policy measures be taken. The understanding of such smaller repeated crises is also of increasing relevance considering the impact of climate change on local precipitation patterns.

The stark asymmetry which currently characterizes disaster risk policies means that the focus is on ineffective *ex post* relief measures, rather than building resilience. Quantified and widely accepted understanding of disaster losses and the associated mechanisms, repercussions and side-effects on human capital and poverty traps will confront policy makers with a stronger case for building resilience among vulnerable population groups *ex ante*.

Making informed policy choices. The concrete measures needed in order to protect vulnerable groups from the adverse impacts of disasters will essentially depend on the mechanisms and circumstances specific to the country (or even region, community, and household) – such as institutional capacity, existing risk management systems (incl. physical and financial), labor market structures, etc. Depending on the channels through which disaster losses are transmitted and reinforced, policy makers are required to provide different types of support. This includes the implementation of *ex-ante*, i.e. prevention, measures (such as protection and early warning systems, and other risk management tools), as well as of *ex-post*, i.e. coping, mechanisms (such as insurance systems, cash transfers or the provision of flexible social safety nets) – and these measures may need to be implemented (and coordinated) across the household, regional and national levels. Baez, de la Fuente, and Santos (2010) particularly underscore the importance of effective social assistance programs, such as social safety nets and cash transfer programs for affected population groups. Such programs can help in preventing low-income households from selling off productive assets, or from diverting money away from human capital investments in order to ensure a minimum consumption level; thus such policies can be essential in preventing poverty traps and adverse effects on welfare and human capital.

In general however, strengthening disaster resilience of the poor requires the provision of flexible systems of risk management, which can build resilience to the various impact channels of disasters. From the process of knowledge generation and dissemination, to the implementation of prevention and coping measures, risk management needs to account for more than the financial dimension and must aim to protect human capital and livelihoods, particularly of the most vulnerable. In this process it is essential to also account for the indirect and long-term losses caused by disasters. In practice this will require policy makers to act in forward looking, well-coordinated and integrated manners – which can be particularly challenging in low-income countries.

The role of authorities. While the adequate choice of concrete policy measures depends on the circumstances in each case, the role of authorities is of major importance in any case. From the national to the local level, governments play a crucial role in protecting the welfare of the poorest in the aftermath of a disaster. The provision of effective, flexible, scalable, and well-targeted assistance requires institutional capacity, which is typically inadequate in low-income developing countries. While higher-income

households may have the means and capacity (at least to a certain extent) to manage their risks and cope with the consequences of a contingency, the poorest households are particularly dependent on government support. In the long run, this means that in an effort to reduce the losses experienced by the poor, it is crucial to strengthen institutional capacity and improve the integration and coordination of risk management across different government bodies and levels. In practice this could require the establishment of a dedicated disaster risk management body, which coordinates action across ministries and government levels. Only in a strong institutional environment will the vulnerable be able to strengthen their resilience and reduce the risk of poverty traps and long-term damages.

Trade-offs – choosing policy measures with the highest impact. It is important to recognize that simply implementing risk management measures targeted at the poorest and most vulnerable is not necessarily the most effective way of building their resilience. This implies that policy makers need to evaluate trade-offs and co-benefits, in order to determine in which way limited resources can have the highest impact. This may confront policy makers with politically difficult choices: When aiming to strengthen resilience, should policy measures target the most vulnerable directly, or is it more effective to target a broader population set? The latter approach may yield critical co-benefits to the poor and reduce their vulnerability. Generally, evaluating such trade-offs requires a thorough understanding of the mechanisms at work: if lacking resilience is due to structural issues in the broader socioeconomic environment of the poor and vulnerable, a broader approach may be more effective (e.g. policies for nationwide economic growth may also improve the financial resilience of the poor). Similarly, if lacking resilience is due to a specific external obstacle, policy action might need to target this rather than the vulnerable directly (e.g. reforming general land rights may significantly increase the resilience of slum dwellers). An approach directly targeting the poor may be more effective, if vulnerability is due to for instance a specific missing service directly affecting the risk management capability of the poor (such as insurance).

Other trade-offs may relate to choosing the location of policy measures. In certain cases the risks faced by the population are extremely high. The cost of protecting and insuring against extreme hazards can be unacceptable relative to the available resources, and drain resources from other purposes. For instance when a certain population group is located in an extremely risky area, targeted measures to reduce their risk to an acceptable level may be prohibitively expensive. Rather than investing in costly protection at this risky location (e.g. by building a dike) and thereby only helping a small group, policy makers may need to consider providing assistance and incentives for this population group to move to less hazardous areas, and making investments in resilience and risk management with benefits extending to a larger population.

Overall, the evidence presented in this paper calls for strong action towards building disaster resilience. Poor people are typically the most vulnerable population group, as they suffer disproportionately large disaster losses, which often reduce their living standards in the very long term. This can lead to perpetuated poverty traps and reduce development prospects of entire countries. For policy makers to make adequate decisions, the understanding of the mechanisms and repercussions of direct and indirect disaster losses needs to be improved and documented. Based on such evidence, policy makers need to identify the most appropriate measures for increasing resilience of the most vulnerable – this includes the evaluation of trade-offs and identification of the highest impact measures for building resilience. Once adequate measures are identified, they need to be implemented in a coherent and integrated framework, by coordinated and capable and politically independent authorities (if at all possible). The implementation

of all of these suggestions will in practice be impaired by a variety of obstacles, for instance due to the political economy of risk management. However, even if the implementation falls short of perfection, it is evident that as much progress as possible must be made in order to protect the livelihoods of the most vulnerable and poorest by building resilience.

Bibliography

- Alderman, H., Hoddinott, J., & Kinsey, B. (2006). Long-term consequences of early childhood malnutrition. *Oxford Economic Papers*, Vol.58 (3), pp. 450-474 .
- Alderman, H., Hoogeveen, H., & Rossi, M. (2009). Preschool Nutrition and Subsequent Schooling Attainment: Longitudinal Evidence from Tanzania. *Economic Development and Cultural Change*, Vol. 57 (2), pp. 239-260 .
- Ambraseys, N., & Bilham, R. (2011). Corruption kills. *Nature* , Vol. 469, pp. 153–155.
- Baez, J. E., de la Fuente, A., & Santos, I. (2010). Do Natural Disasters Affect Human Capital? An Assessment Based on Existing Empirical Evidence. *IZA Discussion Paper Series 5164*, Institute for the Study of Labour (IZA).
- Baez, J., & Mason, A. (2008). Dealing with Climate Change: Household Risk Management and Adaptation in Latin America. *Background paper for the 2008 Flagship Report on Climate Change in Latin America and the Caribbean*, World Bank, Washington DC.
- Baez, J., & Santos, I. (2007). Children's vulnerability to weather shocks: a natural disaster as a natural experiment. *Working paper*, Pennsylvania State University.
- Baez, J., Santos, & I. (2007). Children's vulnerability to weather shocks: a natural disaster as a natural experiment. *Working paper*, Pennsylvania State University.
- Bakkensen, L. (2013). Adaptation and Natural Disasters: Evidence from Global Tropical Cyclone Damages and Fatalities. Working Paper.
- Bandyopadhyay, S., & Skoufias, E. (2013). Rainfall variability, occupational choice, and welfare in rural Bangladesh. *Review of Economics of the Household* .
- Beegle, K., Dehejia, R. H., & Gatti, R. (2006). Child labor and agricultural shocks. *Journal of Development Economics*, Vol.81 (1), pp. 80–96.
- Benson, C., & Clay, E. J. (2004). Understanding the economic and financial impacts of natural disasters. *Disaster Management Series No.4*, Washington DC: World Bank.
- Bryan, G., Chowdhury, S., & Mobarak, A. M. (2012). Seasonal Migration and Risk Aversion. *CEPR Discussion Paper* , No. DP8739 .
- Carter, M., Little, P., Mogues, T., & Negat, W. (2004). Shocks, Sensitivity and Resilience: Tracking the Economic Impacts of Environmental Disaster on Assets in Ethiopia and Honduras. *Staff Paper No. 489*, Department of Agricultural & Applied Economics, University of Wisconsin.
- Carter, M., Little, P., Mogues, T., & Negatu, W. (2006). Poverty Traps and Natural Disasters in Ethiopia and Honduras. *World Development*, 35(5): 835-856.

- Chhibber, A., & Laajaj, R. (2013). The Interlinkages between Natural Disasters and Economic Development. In A. Borde, D. Guha-Sapir, & I. Santos, *The economic impacts of natural disasters* (pp. 28-56). New York: Oxford University Press.
- Cochrane, H. (1994). Disasters, Indebtedness and Faltering Economic Growth. *Prepared for the 9th International Seminar on Earthquake Prognostics, September 9-23, San Jose, Costa Rica.*
- Cord, L., Hull, C., Hennem, C., & van der Vink, G. (2008). Climate change and poverty: an integrated approach for poverty. *PREM Notes*, Washington DC: World Bank.
- de Janvry, A., Finan, F., Sadoulet, E., & Vakis, R. (2006). Can conditional cash transfer programs serve as safety nets in keeping children at school and from working when exposed to shocks? *Journal of Development Economics*, Vol. 79(2), pp.349–373.
- de Janvry, A., Finan, F., Sadoulet, E., & Vakis, R. (2006). Can conditional cash transfer programs serve as safety nets in keeping children at school and from working when exposed to shocks? *Journal of Development Economics*, Vol. 79(2), pp.349–373.
- Dercon, S. (2002). Income Risk, Coping Strategies, and Safety Nets. *World Bank Research Observer*, Vol.17 (2), pp. 141-166. .
- Dercon, S. (2004). Growth and shocks: evidence from rural Ethiopia. *Journal of Development Economics*, Vol. 74 (2), pp. 309–329.
- Dercon, S. (2007). Fate and fear: risk and its consequences in Africa. Paper prepared for the African Economic Research Consortium, Oxford University, Oxford.
- Dercon, S., & Krishnan, P. (2000). Vulnerability, seasonality and poverty in Ethiopia. *The Journal of Development Studies* , Vol.36 (6), pp.25-53.
- Dillon, A., Mueller, V., & Salau, S. (2011). Migratory Responses to Agricultural Risk in Northern Nigeria. *American Journal of Agricultural Economics*, Volo.93 (4), pp.1048-1061. .
- duPont, W., & Noy, I. (2012). What happened to Kobe? A reassessment of the impact of the 1995 earthquake in Japan. *University of Hawai`i at Mānoa, Department of Economics Working Paper Series*, No. 12-4.
- Fafchamps, M., Udry, C., & Czukas, K. (1998). Drought and saving in West Africa: are livestock a buffer stock? *Journal of Development Economics*, Vol. 55(2), pp. 273–305.
- Ferreira, F., & Schady, N. (2008). Aggregate economic shocks, child schooling and child health. Policy Research Working Paper Series 4701, The World Bank.
- Foster, A. (1995). Prices, credit markets and child growth in low-income rural areas. *The Economic Journal*, Vol.105, pp. 551-570.
- Hallegatte, S., Green, C., Nicholls, R., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change*, DOI: 10.1038/NCLIMATE1979.

- Hallegatte, S., Henriot, F., & Corfee-Morlot, J. (2008). The Economics of Climate Change Impacts and Policy Benefits at City Scale: A Conceptual Framework. *OECD Environment Working Paper 4, ENV/WKP(2008)3*.
- Hallegatte, S., Henriot, F., Patwardhan, A., Narayanan, K., Ghosh, S., Karmakar, S., et al. (2010). Flood Risks, Climate Change, Impacts and Adaptation Benefits in Mumbai. *OECD Environment Working Papers No. 27*.
- Hallegatte, S., Hourcade, J.-C., & Dumas, P. (2007). Why economic dynamics matter in assessing climate change damages: Illustration on extreme events. *Ecological Economics*, Vol.62 (2), pp. 330–340.
- Hoddinott, J., & Kinsey, B. (2001). Child growth in the time of drought. *Oxford Bulletin of Economics and Statistics*, Vol.63 (4), pp. 409-436.
- Hoddinott, J., Maluccio, J., Behrman, J., Flores, R., & Martorell, R. (2008). Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet*, Vol.371, pp. 411-416.
- Islam, N. (2013). Urban and nonagricultural impacts of flooding and their assessments - The case of Bangladesh. In A. Borde, D. Guha-Sapir, & I. Santos, *The economic impacts of natural disasters* (pp. pp. 269-295). New York: Oxford University Press.
- Jacoby, H., & Skoufias, E. (1997). Risk, financial markets, and human capital in a developing country. *Review of Economic Studies*, Vol. 64(3), pp.311-335.
- Jensen, R. (2000). Agricultural Volatility and Investments in Children. *American Economic Review*, Vol. 90(2), 399-404.
- Jensen, R. (2000). Agricultural Volatility and Investments in Children. *American Economic Review, Papers and Proceedings*, Vol. 90(2), pp.399-404.
- Kazianga, H., & Udry, C. (2006). Consumption smoothing? Livestock, insurance, and drought in rural Burkina Faso. *Journal of Development Economics*, Vol. 79(2), pp. 413-446.
- Krutikova, S. (2010). Who gets to stay in school? Long-run impact of income shocks on schooling in rural Tanzania. *CSAE Working paper Series 2010-36*, Center for the Study of African Economies.
- Lavell, A. (1999). The impact of disasters on development gains: clarity or controversy. *Latin American Social Science Faculty (FLASCO) and The Network for the Social Study of Disaster Prevention in Latin America-LA RED*, Paper presented at the IDNDR Programme Forum, Geneva, July5-9, 1999.
- Loayza, N., Olaberria, E., Rigolini, J., & Christiaensen, L. (2012). Natural Disasters and Growth: Going Beyond the Averages. *World Development*, Vol.40 (7), pp. 1317–1336.
- Maccini, S., & Yang, D. (2009). Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall. *American Economic Review*, Vol.99 (3), pp. 1006–1026.

- Miguel, E., Satyanath, S., & Sergenti, E. (2004). Economic shocks and civil conflict: An instrumental variables approach. *Journal of Political Economy* , 112(4): 725-753.
- Mueller, V., & Osgood, D. (2007). Long-term impacts of droughts on labor markets in developing countries: Evidence from Brazil. *The Journal of Development Studies* , Vol. 45 (10).
- Reuveny, R. (2007). Climate change-induced migration and violent conflict. *Political Geography*, Vol. 26 (6), 656-673.
- Rodríguez-Meza, J., & González-Vega, C. (2004). Household Income Dynamics and Poverty Traps in El Salvador. *Manuscript*, 2004 AAEA Annual Meeting.
- Roy, G., & Kreimer, A. (1999). Learning from the World Bank's Experience of Natural Disaster Related Assistance. World Bank, Urban Development Division, Washington, D.C.
- Santos, I. (2006). Risk-Sharing and the Role of Inter-Household Transfers after a Natural Disaster. Evidence from Hurricane Mitch in Nicaragua. Kennedy School of Government, Harvard University.
- Santos, I. (2007). Disentangling the effects of natural disasters on children: 2001 earthquakes in El Salvador. Kennedy School of Government, Harvard University.
- Skidmore, M., & Toya, H. (2007). Economic development and the impacts of natural disasters. *Economic Letters* , Vol.94, pp.20-25 .
- Skoufias, E., & Quisumbing, A. (2003). Consumption Insurance and vulnerability to poverty: A synthesis of the evidence from Bangladesh, Ethiopia, Mali, Mexico and Russia. *Manuscript*, IADB and IFPRI.
- Strobl, E., & Valfort, M.-A. (2013). The effect of weather-induced internal migration on local labor markets : evidence from Uganda. *World Bank Policy Research Working Paper 6600*, Washington DC: World Bank.
- Wirtz, A. (2013). Natural disasters and the insurance industry. In A. Borde, D. Guha-Sapir, & I. Santos, *The economic impacts of natural disasters* (pp. 128-153). New York: Oxford University Press.
- Yamano, T., Alderman, H., & Christiaensen, L. (2005). Child growth, shocks, and food aid in Ethiopia. *American Journal of Agricultural Economics*, Vol.82 (2), pp.273-288.
- Zimmermann, F., & Carter, M. (2003). Asset smoothing, consumption smoothing, and the reproduction of inequality under risk and subsistence constraints. *Journal of Development Economics*, Vol.71, pp. 233-260.