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Climate Shocks and their Impact on Assets

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Key concepts

Risk refers to possibly occurring events that can damage wellbeing (Dercon 2001). Others prefer the talk about damaging fluctuations that are not perfectly predictable (Sinha and Lipton 1999). Both definitions allow to point out that households can have a priori some sense of the likelihood of events occurring (i.e., can attach a probability distribution to risk events), without really having any direct control over them (i.e., they are not perfectly certain that will occur in any given future).[1] Some authors find useful to make a distinction between risk and shocks as well implying that shocks go one step further in the definition of risks. They are defined as realizations of highly unexpected events that cause welfare losses. In other words, risks are prospects of a shock or, alternatively, shocks can be thought as the realization of risks (Fafchamps 2004; Sinha and Lipton 1999). According to Sinha and Lipton (1999) the term 'shocks' has already a very specific connotation that encompasses: i) unexpectedness (i.e. the risky damaging fluctuation already happened, though it had low ex-ante probability); ii) size, iii) high damage due to concentration on persons with high vulnerability and low resilience; iv) exogenousness in the source*;* and v) physical or psychological strain to one or more individuals due to that stress. Thus, the term climate shock would already cover what the disaster literature considers to be a natural disaster: those events that outstrip the capacity of a society to cope with it (Anderson, 2000). This note mostly refers to natural disasters as climate shocks.

Household assets are the stock of wealth used to generate wellbeing (Siegel and Alwang 1999). They are usually divided into tangible and intangible. In the first case, they design things such as natural, human, physical and financial capitals. More specifically, human capital alludes to the household member's education and their health status. Physical capital is associated with productive assets such as land, tools, equipment and work animals, and with household assets such as housing and household services, or stocks such as livestock, food and jewelry. Finally, financial capital will refer to cash, savings, and access to credit. Intangible assets result from the interaction of members within households as well as from households with each other inside the community and beyond. These include gender relations, social ties and networks, including participation in associations and organizations, and intra-household relations. Households and communities can strengthen linkages with other communities participating in regional politics, marriage and migration, but also being part of inclusive political systems and markets (Siegel and Alwang 1999). And finally, at the community and extra-community level physical, environmental and social infrastructure remains fundamental, such as the existence of schools and clinics, forests and rivers and communication infrastructure.

To assess the impact of climate shocks on household assets one can rely on the concepts of *sensitivity* and *resilience*. The former refers to the magnitude of a system's response to an external event or, in other words, the extent to which a household's asset base is likely to resist or not (following responses to) a shock given the intensity with which it was experienced. The later refers to the ease and rapidity of a system's recovery from stress or, in other words, the household's ability to resist negative shocks and to recover from them (Bayliss-Smith 1991; Davies 1996). More than identifying both dimensions in particular shocks, the HDR team is interested in the implications they could have for the analysis of climate shocks on assets. The extent to which a household is *sensitive* to a climate shock is obviously determined by its characteristics of the shock itself -most notably its covariate nature and the length, frequency and severity with which hits- and by the assets it has at hand to cushion the impact of the shock. The *resilience* of a household has a straight connection with the strategies employed by households to manage risks. This means that not only the type of natural disaster that people face, but also how they call on their assets in times of stress can have important implications for their future livelihoods. In other words, the methods of using assets to relieve the pressures of a shock after it occurs (i.e., the coping

strategies) will have important implications for their ability to 'bounce back' to their pre-shock asset levels.

Channels of impact

The physical contact of climate shocks with humans and/or with property can bring death, injury, disruption of socio-economic activities and damage or destruction to property and natural resources and other physical assets. Since some of these assets can be transformed into income-enhancing productive activities to entitle households to goods and services that provide access to different dimensions of wellbeing, including consumption, nutrition, and health, their depletion can lead into short-term welfare fluctuations and push people into sudden poverty.

More importantly, the capacity of households to lift- stay out of poverty could be further compromised by climate shocks in the long-range. This could happen in two broad ways. In the short-run environmental factors such as flooding, storms or drought may cause the physical extinction of some assets, but access to public or private sources of recovery would prevent any worsening of this impact. If households have restricted means to protect the most vulnerable members inside them, such as the children under 3, shocks can have long-lasting effects on them through nutrition shortfalls that in turn could affect their human development later in life. In addition, if households have few means to react to natural disasters they can end up adopting strategies with high costs in the future, such as dropping children from school or depleting their few available productive assets. Furthermore, even when adequate mechanisms to mitigate and cope with shocks are in place their application can further compromise food security, human development, and growth prospects if the climate shocks persist over several years in a row or the covariate nature of the problem is not well understood: the value of assets could drop if all affected household try to sell them at once. Finally, the inability of households to hold to their meagre asset bases in the presence of climate shocks will most likely end up affecting their asset recovery efforts too as they exit the shocks with few assets left. Therefore, special attention should be devoted to poor populations across developed and developing countries whose assets are scarce and whose access to credit and insurance markets is restricted.

This connects with the second and often much less explored channel through which climate shocks can affect assets. This happens before the shock actually takes place and is explained through the existence of risk aversion motivations combined with a limited number of assets - including liquidity constraints and restricted access to insurance markets – that cast a shadow over the household perspectives for dealing with the consequences of a climate shock. This scenario would be conducive to the adoption of suboptimal asset portfolios for organizing a livelihood where the value and productivity of assets declines.

In short, climate shocks can affect assets in many ways. First, through the impact on their amount, value and productivity. This could be the direct result from the shock or a ramification of its impact through the absence or inadequate application of coping mechanisms. Poor households tend to pay a higher cost for mitigating and coping with risk due to their reduced asset base. This is reflected in the human capital of its members, particularly the children, and the forced disposal of physical assets; in addition, any asset recovery efforts are more difficult to achieve. The same attributes of value and productivity are likely to be affected before climate shocks occur as households reallocate assets in response to risk exposure (asset portfolio influences a household's risk attitudes). For instance, households with higher physical and human capital endowments, tend to be less risk averse, more efficient in resource allocation, and better situated to handle risk-related losses. In contrast, poorer households tend to adopt risk management strategies that concentrate in lower risk and lower return assets, which can lead to poverty traps.

Most disasters occur in poor countries and the people who bear the brunt of them are usually those who are poor (World Bank 2000). This is true in at least two senses: first, natural disasters are more frequent in developing countries, and second, the poor are more likely to suffer damages from natural hazards as usually they can only afford to live in marginal areas and have a limited ability to manage these risks.[2] For instance, people in low-

income countries are four times as likely as people in high-income countries to die in a natural disaster (World Bank 2000). Hence, this review is mostly concerned with the empirical evidence across poor populations in the developing world.

SENSITIVITY

Climate shocks have immediate effects on assets

Wealth can be substantially damaged by the occurrence of extreme climate events, such as floods, droughts, hurricanes and other weather-related shocks. Most obviously, there are 'direct' impacts caused by physical contact of these hazardous events with humans and/or with property that result in death, injury, disruption of socio-economic activities and damage or destruction to property and natural resources and other physical assets.

The injuries, disabilities and loss of life occasioned by natural disasters is by far the most notable impact on any livelihood and its assets, particularly if this involves the breadwinner or any other working-age members. This is so because the poor tend to lack material assets, and thus labour in all its forms, including formal wage employment, informal work for cash, unpaid labour and subsistence production, remains the most important resource that they have to face vulnerability. In that sense, the devastating impacts of Hurricane Mitch raging over Central America in 1998 and the tsunami disaster in the Indian Ocean in December 2004 are well captured by their respective death tolls: 10,000 people killed and three million homeless, mostly from flood-related disasters in Honduras and Nicaragua, and over 200,000 lives and more than 1.5 million people homeless in the tsunami affected countries (World Bank 2005).

If assets are considered intrinsically valuable, then when climate shocks hit human capital that may also push people into current poverty. Here human capital assets, in particular health, become an extra category to the multidimensionality of poverty just as it happens with low levels of consumption or income. For instance, substantial increases in illness followed the 1998 floods in Bangladesh even after the floodwaters had receded partially or totally: in a sample of 757 households obtained from a multi-round survey in seven flood-affected areas 9.6 percent of individuals suffered from diarrhoea, and 4.7 percent were affected by respiratory illness in the immediate post-shock period (Del Ninno et al. 2001).

Finally, the reduction or extinction of physical assets due to climate shocks is a third impact that becomes immediately visible, both at the household and communal level. Take as an example the floods in Bangladesh in 1998, which inundated two-thirds of the country for an unprecedented 11 weeks starting in July damaging an estimated 15,000 kilometres of roads, 14,000 schools, and thousands of bridges and culverts affecting their externalities and public good attributes. Besides public infrastructure, the floods damaged over 500,000 homes, production, and productive inputs, and significantly altered agricultural patterns and lowered farming yields (Narayan et al. 2000). All this can lead to short-term fluctuations in well-being as physical assets are usually combined with other forms of capital and transformed into income-generating activities or activities that entitle households to goods and services that provide access to different dimensions of wellbeing, including as consumption, nutrition, and health.

Because most assets are stocks –as opposed to income and consumption flows- and the poor usually report more difficulties to recover from disruptions as explained below, the rest of this note concentrates on the extent to which the loss of wealth for deprived sectors of the population could compromise their health and socio-economic development in the medium to long-run.

But can also have long-lasting effects…

As noted initially, assets are stocks that can be combined and transformed to generate income and satisfy consumption and other essential needs and so if they become affected by climate shocks that could generate short term welfare fluctuations. More importantly if households have few assets to protect vulnerable groups inside them during hardships this can transform into more permanent disadvantages (i.e., restrict access to profitable opportunities in the

future).[3] The most common example found in the literature relates to rainfall shocks causally related to human capital formation: temporary poor health and child malnutrition that results from a drought could turn into stunting (height-for-age levels below some level observed in healthy populations), lower school achievement, and attainment, as well as lower health and lower wages and productivity as an adult.

On health and education

The nutrition and food security literature have widely documented the effect that short-term blows to nutrition could have on health conditions through stunting, especially on the children. Tracing the impact of the 1982-84 droughts in Zimbabwe it was found that the temporary hunger followed by stunting of those children aged between 12 and 24 months at the time of the drought –recognised as the most critical time for child growth- led to lower height (2.3 centimetres) in late adolescence as well as delays in school enrolment (3.7 months) and reduction in grade completion (0.4 grades) 13 to 16 years after the droughts (Alderman, Hoddinott and Kinsey 2006). The educational setbacks are probably mediated by the slow height growth in children (Glewwe, Jacoby and King 2000). Similarly, the 1994/95 drought in that country lowered annual growth rates of children in the same age group by somewhere between 1.5 and 2 cm., and four years after the failure of the rains in 1994/95, these children remained shorter than identically aged children who had not experienced this drought (Hoddinott and Kinley 2001).

Consistent with the findings in Zimbabwe, drought shocks (expressed through crop damage) in Ethiopia over the period 1995/96 had a large detrimental effect on child health. Children aged six to twenty four months experienced about a 0.9 cm growth loss in height over a six-month period when half of their crop was damaged compared to communities whose percentage of damaged crop area was 50% points lower. Put in a different way, a 10 percent point increase in the proportion of damaged plot areas corresponded to a reduction in child growth by 0.12 cm over a six month period (Yamano et al. 2005). Similarly, Hurricane Mitch in Nicaragua made the children in affected areas 30% less likely to be taken for medical consultation conditional on being sick, even though there was no significant difference on the prevalence of illness between affected and non-affected children. Furthermore, the probability of being undernourished among children in regions hit by Mitch almost quadrupled (8.7 percentage points increase) and the overall distribution of their nutritional status –especially of those in the tail– worsened significantly as a result of the storm (Baez and Santos, 2007).

The damage to physical infrastructure and child labour are additional channels through which climate shocks can have an effect on children's educational attainment in the long-run. An examination into the determinants of completed grades of schooling amongst adults born in four villages in eastern Guatemala found that the 1976 earthquake in that country had a statistically significant impact on the number of grades attained. By constructing three measures of school quality (whether all six grades of primary schooling were offered; the ratio of teachers to grades taught and the ability of a preschool) and comparing them with whether schools closed after the 1976 earthquake and controlling for individual's sex, cohort effects and locality fixed effects, two measures of school quality were found to be affected by the covariate shock (Stein et al. 2003). The quality of school attainment could also be compromised by child labour. Three years after Hurricane Mitch hit Nicaragua in 1998 no significant effect was found on school enrolment, however, labour force participation increased by 58% among children in areas affected by the hurricane. Similarly, the proportion of children simultaneously enrolled in school and working more than doubled, going from 7.5% to 15.6% (Baez and Santos 2007).

Children are not the only group highly exposed to natural disasters. Studies of the 1994–95 drought in Zimbabwe showed that women along with young children were the most affected while no impact on men's health was found. For women, though, the drought's effect on health was temporary. With good rains the following year, they regained much of the lost body mass. But sometimes the differentiated impact can be life-threatening. In a group of 4,118 households in 16 states in India surveyed from 1969 to 1971 child mortality rates

increased during periods of very low rainfall and were significantly higher for girls than for boys (Rose 1999). In recent times, during the 2004 tsunami more women than men died. This was highlighted early on when Oxfam announced that, in the villages it had surveyed, there were three times as many adult male survivors as female ones, with some districts reaching female death percent rates of 77 and 80 (Oxfam 2005). Evidence that women's deaths outnumber men's also can be found after the 1991 Bangladesh cyclone, as well as the 1993 Maharashtra earthquake.

Women and men have different vulnerabilities, and they cope with disasters differently. However, on balance, female-headed households fare worse than male-headed households following a natural disaster, in part because of their smaller average resource base and customary or formal laws that prevent their access to household possessions.

Vulnerable Groups during the Indian Ocean tsunami

On December 2004, a massive earthquake struck off the west coast of Northern Sumatra. This led to the most destructive series of tsunamis in recorded history, affecting up to 14 countries around the Indian Ocean. Indonesia, Sri Lanka, the Maldives, India and Thailand were the hardest hit with entire coastal zones being destroyed, and the tsunamis causing damage up to 3km inland in some cases.

The magnitude of the tsunami disaster is dramatically captured by the death tolls: over 227,000 people lost their lives and some 1.7 million were displaced. This raw death toll, however, masks the disproportionate effect which the tsunamis had over some of the most vulnerable groups. In the Maldives those aged 65 or over, though comprising only 3.1 per cent of the population, accounted for 17.3 per cent of the deaths. Elsewhere the tsunami typically claimed more people under-15s and over-50s, with countries varying as to which of these two groups had the highest mortality rates.

Substantial gender imbalances in terms of fatalities were also present. Several studies across Indonesia, Sri Lanka and India looking at the mortality risk for females compared to males found consistently higher ratios for females varying from 1.2 (1.2 times as many women died) to 2.1, with wide variations for individual villages. Overall, the tsunami killed 40,000 to 45,000 more women than men.

Some of the reasons given for the gender and age differences in survival rates in these disasters are usually related to strength and stamina, and the ability to swim or climb trees. For instance, one study in Tamil Nadu found that women who were able to swim were more than twice as likely to survive. However, it is clear that pre-existing vulnerabilities, whether socioeconomic, environmental, political, psychological, age- or gender-based, also contributed to the multiple differentiated impacts cited. In women, for instance, a number of factors contributed to their particular vulnerability before, during, and after the tsunamis: a lack of information about evacuation warnings and shelter options, culturally restricted mobility, and responsibilities within the family that make women stay behind to care for the young and the elderly. Moreover, governments not always recognised or advanced their property rights during the post-tsunami implementation of housing, relocation and livelihood strategies. During the response phase, female-dominated businesses, such as small-scale cottage industries and fish processing, were not always as visible as businesses run by men, and were less likely to be supported with livelihood recovery grants. There were also concerns about women being excluded from cash grant projects. In Sri Lanka, Oxfam found that women experienced difficulties in accessing benefits, especially cash payments and rations, because families are usually registered for government and insurance purposes under the man's name'. Similarly, in the Maldives, women with small businesses often had no official registration and because they could not prove that they had lost their livelihoods, they did not qualify for assistance.

Policy interventions should be tailored to the special needs of all these vulnerable groups to climate shocks —women, children, and the elderly—; and particularly sensitive to possible forms of discrimination against them during recovery. Involving women in the management of shelters, targeting female-headed households for support to lighten their workload, ensuring equity of treatment on employment as well as gender neutrality in housing acquisition and access to land ownership, and establishing workfare programs adapted to their needs, can all improve the recovery for women and households headed by women. Expanding early childhood development programs for newborn infants is also very important so as rebuilding schools —to avoid loss of human capital for those already in school-age and providing shelter for displaced people, including the elder.

A notable response along these lines during the tsunami came through the involvement of women groups in cash for work projects and helping them understand their right to equal pay for equal work as unskilled labour performed by women usually earns less than for men. This was the focus of the Indian NGO NESA's cash for work (CFW) program in India, which included seeding of plantations, pond and canal renovations, among other projects. While many men objected to this, the NGO insisted on it –as indeed it would have contravened labour laws if the wages had been different- and women were able to participate and have a say on how cash was spent. NESA's CFW project also strove to change attitudes and behaviour towards dalit households – at the bottom of the Hindu caste hierarchy- by involving them in the cash economy through CFW projects developing community assets which they had hitherto been excluded from. Participation in the CFW project in these areas in effect renegotiated access by these groups to these resources, including women within them.

Sources: Adams and Nagarajan, 2006; World Bank, 2006; Telford et al., 2006; Oxfam, 2005; World Bank, 2000.

The shocks' persistence on the health, nutritional and educational status of children could have further repercussions on their earning potential during adulthood. Looking at the 1982/83/84 drought in Zimbabwe and using the values for the returns to education and age/job experience in the Zimbabwean manufacturing sector, it was found that 16 years later those children affected by the drought had 7 percent loss of lifetime earnings (Alderman, Hoddinott and Kinsey 2006). The mechanisms through which reduced height of a child could lead to lower productivity and lifetime earnings as an adult are the following: i) lower adult height associated with reduced earnings as an adult (Thomas and Strauss, 1997); ii) poorer cognitive function as a child associated with poorer cognitive achievement as an adult which could lead to lower adult earnings; iii) shorter stature as a child is associated with slower progress through schooling which bring delays for enjoying its benefits once finished or simply not finishing produces less grades completed and thus an impact on wages; and iv) stature by age three is strongly correlated with attained body size at adulthood which in case of deficit could lead to the early onset of chronic diseases and premature mortality among male due to increased risk of cardiovascular and obstructive lung disease (Fogel, 1994), though no evidence for developing countries exists on this yet. The early onset of chronic diseases could turn into reduced life expectancy leading to shorter productivity or lifetime earnings (Alderman, Hoddinott and Kinsey 2006).

Rainfall shocks can also result in lower adult agricultural productivity and wages through their impact on adult's Body Mass Index (weight in kilograms divided by squared height in meters) rather than children's height and intellectual development (Dercon and Krishnan, 2000). An investigation into the ability of household to smooth consumption in Ethiopia show that rainfall shocks during 1994/95 significantly affected adult Body Mass Index. Even though rainfall was relatively favourable in this period, relatively poor rainfall in some communities lowered BMI by about 0.9 percent for households with low landholdings, suggesting that the absence of effective risk management strategies was costly in terms of adult health.[4] Moreover, the observed scale of adult malnutrition had functional consequences and affected labour productivity. In particular, clear correlations were found between malnutrition and the ability to perform standard tasks, such as hoeing a field or carrying water (Dercon and Krishnan 2000).[5]

Rainfall shocks could affect socioeconomic status at adulthood besides earnings and productivity through a series of pathways that start at child health and end up in the choice of a more educated partner. On examining the effect in 2000 of weather conditions around the time of birth on the health, education, and socioeconomic outcomes of Indonesian adults born between 1953 and 1974,[6] it was found that women with 20% higher rainfall in their year and location of birth attained 0.14 cm greater height, finished 0.15 more years of schooling, lived in households with 5.2% higher expenditures per capita, and have spouses with 5.1% higher earnings. The proposed causality to reach this outcomes was as follows: The positive impact of rainfall on agricultural output at the time of birth lead to higher household incomes and better health for infant girls. More importantly, suggestive evidence was presented that eventual benefits for adult women's socioeconomic status are mediated by improved schooling attainment, which leads to higher spousal quality, which in turn improves socioeconomic status (Maccini and Yang, 2006).

The relevance of shocks to child growth beyond their immediate health or nutritional effect or the long-term productivity effect could alert of a possible intergenerational transmission of poorer health status resulting from a drought shock. A human development trap could be backed by some epidemiological evidence that taller adult women experience fewer complications during child birth, have children with higher birth weights and experience lower risks of child and maternal mortality (World Bank 1993).

The policy implications are obvious: earlier interventions that shield children from potential damages of natural disasters on their human capital can reduce the likelihood of negative repercussions in their productive life during adulthood as well as on the health of their offsprings.

Droughts in Zimbabwe: repercussions and interventions to handle them

In rural Zimbabwe most households are regularly exposed to food shortage risk as a result of drought, but at the same time Zimbabwe is one of the more developed countries in sub-Saharan Africa, with markets more likely to function relatively well, making efficient responses to the risk of drought possible. It has been possible to test this and other hypotheses in a group of some 400 rural households for over a decade (1983-96) in which the country has experienced four major droughts (1982-84, 1986-87, 1991-92 and 1994-95), including the most serious drought in the living memory of the country (1991-92).

In each drought private and public measures have been taken to thwart any possible negative effects. For instance, in the 1992 drought a series of government initiatives, including free food distributions for the elderly and the disabled and food-for-work programs for destitute families with able-bodied members were put in place. Assistance with school and examination fees was provided as well as child feeding supplementary programs. Households also implemented their own mechanisms to cope with food shortage, the most important of which had been cattle sales.

Yet, there was little evidence that children from poor or nutritionally vulnerable households got preferential access to the public feeding schemes. Moreover, the extent of action by the Zimbabwean government had been impeded by the regularity of the previous successive droughts which brought about continuous risk-mitigation program demands. The core budget for the Department of Social Welfare, for example, declined in real terms by some 50% from the 1991-92 droughts to the next one in 1994-95.

Overall back in 1992 food consumption fell in spite of the variety of smoothing mechanisms employed by households and government. Households cut sharply the quantity served at meals. At the peak of the drought almost a third of the panel households took only one meal per day and another 50% only two meals. In addition, nearly 70% of households reduced the quantity served at meals, and about a third of households consumed "wild foods", such as edible plants, fruits and seeds, as well as animals and insects.

Such inability to smooth consumption is even more serious as the short-term blows to nutrition could translate into stunting, especially on the children. For instance, tracing the impact of the 1982-84 droughts it was found that the temporary hunger followed by stunting of those children aged between 12 and 24 months at the time of the drought –recognised as the most critical time for child growth- led to lower height (2.3 centimetres) in late adolescence as well as delays in school enrolment (3.7 months) and reduction in grade completion (0.4 grades) 13 to 16 years after the droughts. Similarly, the 1994/95 drought lowered annual growth rates of children in the same age group by somewhere between 1.5 and 2 cm., and four years after the failure of the rains in 1994/95, these children remained shorter than identically aged children who had not experienced the drought.

Furthermore, the shocks' persistence on the health, nutritional and educational status of children had further repercussions on their earning potential during adulthood. Looking back at the 1982-84 droughts and using the values for the returns to education and age/job experience in the Zimbabwean manufacturing sector, it was found that 16 years later those children affected by the drought had 7 percent loss of lifetime earnings.

All this damage which compromised the human development of children and jeopardized long-run potential gains achieved through their human capital underscores the relevance of adopting effective measures against recurrent droughts. In particular, a gradual shift from the emergency relief measures described, including cyclical public safety net responses, towards ex ante actions that could enhance wellbeing and reduce poverty making households more resilient to hardships seems desirable.

An empirical study tracking the same group of rural Zimbabwean households this time over five years (1992-1996) with the 1994-5 drought episode in the midst compared the income effect of the observed ex post public responses to drought (grain loans) against the effect of a counterfactual ex ante intervention two years prior to the shock (provision of capital and extension services). After developing an empirical model in which capital and extension services increase net crop incomes that in turn increase holdings of agricultural tools and livestock without crowding out private transfers, the value of the assistance transferred to households in the form of grain loans was reallocated into households in the form of capital and extension services to run a series of counterfactuals. Doing so reduced poverty in non-drought years and at the same time allowed households to build up enough buffer stock to protect against the potential droughts. Incidentally, additional livestock only reduced marginally the impact of the drought in income terms, but it might have assisted positively children anthropometric measures as another study looking at children aged 12-24 months residing in households below and above the median value of pre-drought livestock holdings during the 1994/95 drought found that the shock only affected the growth height of children residing in households with little livestock.

Sources: Alderman et al. 2006; Owens et al. 2003; Munro 2002; Hoddinott and Kinsey 2001; Kinsey et al. 1998.

On livestock

In accordance with the theory of optimal savings, more liquid assets and savings in the form of livestock or other non-fungible items might imply less vulnerability for those households which face substantial climate risks but cannot smooth consumption through insurance or credit (Fafchamps et al. 1998). In many rural areas, including sub-Saharan Africa, livestock herds are the main way to compensate the failure of access to credit and insurance markets. However, during droughts many factors affect the capacity of the household to turn this productive asset into a better command over food – the trades of terms with other goods of consumption deteriorate, high covariance with other sources of income and death susceptibility. In the Ethiopian drought of the late nineties, livestock herds began to decline as early as late 1997 due to death, but a larger number were also sold at 'throwaway' prices of 30 per cent or less of normal rates. Group interviews at the time (1999) showed that livestock sales were the main drought coping mechanism for 90 per cent of male and 71 per cent of female herd owners. Sales and physical extinction brought aggregate declines in oxen and total herds of almost 40 per cent from 1998 to mid-2000.

Moreover, when households start with very low levels of livestock the effects of drought on livestock can go beyond the inability to meet short-term needs. In the same study of Ethiopia, those families with few livestock had limited breeding in their herds. In contrast to better off households who usually manage to get back to their asset lots, they were forced to borrow or purchase animals during the post-drought period when livestock prices were especially high, and were also constrained in pursuing cultivation just as conditions were improving. This difficulty for re-stocking herds contributed to the fact that 95 per cent of those households with one or fewer TLU remained poor or vulnerable after six years in the study (Little, et al., 2006). Another study of famine effects in the Horn of Africa during the mid 1980s confirmed the harshness for households to improve or recover their status: 10 years after the famine, cattle holdings in Ethiopian households were still only two-thirds what they were just before the famine (Dercon 2002).

Sometimes households intentionally destabilize consumption to conserve livestock during a drought (Udry 2006). The deliberate postponement of short-term consumption to preserve the future sustainability of the livelihood by conserving productive asset is not uncommon either, but the implications of going hungry are then unknown. Ideally, access to credit services in a post-disaster situation will enhance the coping capacity of the poor not only by helping them to smooth consumption, but also by preventing them from the need to make distress sales of assets such as land or livestock at bargain prices while allowing faster replacement of lost assets.

On land and housing

Although access to land and housing varies widely from one context to another and is often illegal and insecure, where available it represents more than shelter to ensure physical wellbeing. In the urban context, housing makes up for failures observed across formal labour markets. It can become an important productive asset to generate income through rental opportunities and the use of its space for home-based production activities as well as collateral to access credit and other formal risk management mechanisms to fulfil emergency loans for consumption purposes or shield other productive assets during shocks.

However, a set of elements usually conspire against housing and land rendering them highly ineffective to smooth any impact. Land pressures force people to move into areas at risk of floods or landslides. This limited access to appropriate housing markets translate into lack of land rights, for example shantytowns, which means there is little incentive to make adaptations to dwellings so that they are more able to withstand damage. It also means that authorities can refuse services and infrastructure to illegal settlements. Hence, the resulting bad quality of housing, infrastructure and services exacerbates the degree of exposure against climate hazards.

If the usual replacements against credit market failures, such as land and livestock in rural areas and housing material and personal belongings in urban areas are affected by natural calamities the prospects of recovery become distant. In post-Mitch Honduras, when

household experienced housing loss, the recovery of productive assets was significantly slowed by approximately 10%. When people's homes were destroyed, they lose a valuable asset and even their means to make a living as they lose tools and materials.[7]

An in-depth qualitative study of poverty and vulnerability carried out in 10 Guatemalan villages in 2000 also revealed how natural disasters can have long-lasting negative effects on the welfare of families through the destruction of physical key assets. Some 25 years after the earthquake of 1976 in that country many respondents reported still living in homes that were badly damaged by it. Similarly, the experience of one ladino village located in the Nororiente Region of the country reflected how Hurricane Mitch completely wiped out the main productive base of some villages. Prior to the hurricane, the main source of income for the village was agriculture, with a diverse range of production: lemons, papaya, tobacco, melons, eggplant, palms for raw material from artisan work, corn for subsistence, and livestock. In the aftermath of Mitch, however, land was severely damaged, rendering it largely infertile because the flooding basically washed away the productive topsoil and dumped rocks all over the fields. Livestock animals and farm implements were also destroyed forcing most individuals to travel elsewhere to look for jobs, with some 400 (half of the village population) migrating to the capital or to the US and leaving their families behind (Tesliuc and Lindert 2002**)**.

In cases where housing and land are being permanently affected by climate hazards it becomes almost impossible for households to improve their lives and reduce their long-term vulnerability. In Bangladesh, the population living in the char lands[8] which form and re-form on an annual or longer basis with changes in courses along all of the major rivers due to floods becomes periodically landless and homeless. It is estimated that 4.3 million inhabitants of the char lands in the major river system comprise the most vulnerable group in this country. The recurrent destruction of agricultural land and village settlements limits their opportunities to relieve debt and attain savings. Moreover, displacees are not only removed from their socio-economic structures, but usually enter the urban workforce with marked disadvantages because of their lower levels of education and lack of marketable working skills (Hutton and Haque 2004).

…And very possibly in social capital

The lack of access to formal credit and insurance markets is also compensated informally through mutual support networks. However, it is increasingly acknowledged that family and community support mechanisms come under stress during natural disasters, including drought-induced famines (Rahmato 1988; de Waal 1989). In principle, the mobilization of support inside communities during common shocks should be harder because everyone is affected and thus risk cannot be shared (Skoufias 2003). Even more fundamentally, the persistence of poverty heightened by continuous climate shocks leaves little time for association and social action with others as the families have to use most of their time to ensure their basic needs. Women's community activities and links between nuclear and extended families may be reduced due to the need for women to leave their home and search extra work as well as children for participating in productive activities. All this could lead to weakened relationships with the extended family and ineffective reciprocal exchange with neighbours and even anger and resentment.

A study comprising 500 households living in prefabricated houses in three provinces of Turkey after the 1999 East Marmara earthquake found that this shock torn apart the fabric of society. The survivors lost their houses, shops and durable goods and their rent. They were forced to liquidate their savings and faced strong pressures of indebtedness. This reinforced the difficulties for dealing with the hardship even in the presence of social networks because households had in general less financial means and hence more constrained to give away. In consequence, a second factor identified as social solidarity, which included items of solidarity among friends, neighbours, relatives, countrymen and within the family before and after the earthquake was also adversely affected. Inter familial ties and support relations with relatives, neighbours and fellow immigrants after the earthquake were strained and almost broken as people were hardly able to think and care about others (Kasapoglu and Ecevit 2003).

Another channel that needs to be explored is the impact of migrations and displacement provoked by climate shocks as possible sources of distress. The cohesion of households and communities certainly erodes when men and women are forced to migrate to find employment. Family members left behind for long stretches have less time and fewer resources to contribute to and sustain community relations. In addition, migration can reduce social cohesion in the host community.

There is no conclusive evidence in this respect. The existing literature seems to acknowledge that migration is one of the primary responses to a natural disaster. Yet, a couple of empirical studies reviewed go against the tide by showing either non-occurrence of out-migration in the aftermath of a tornado in Bangladesh in 2004 (Paul 2005) or at least the maintenance of rural reciprocity networks despite flood-induced migration (Hutton and Haque 2004).

Short and long-term impacts on assets are borne disproportionately by the poor

Short and long-term climate shock impacts are more likely to be observed across poor households as these can only afford to live in marginal areas and have a limited ability to manage risks due to their low asset holdings and manifest constraints to access credit and insurance markets. In rural areas, for instance, land pressures lead small farmers to retreat further into steep mountain regions. This could have fatal consequences. In the 1977 floods in Andhra Pradesh, India, the 23-27% death rate for small farmers and fisherman, contrasted with the 3% death rate for large farmers and local level officials. The later non-poor group was less vulnerable to the cyclone because of their ability to speedily evacuate by road, the type and strength of their houses, and the small variations in topography in their residential locations (Winchester 1986).

Physical asset recovery from natural disasters can also be wealth-differentiated affecting those with less means. Looking at the effects of Mitch on productive assets in Honduras, across all pre-Mitch wealth quartiles households without asset losses showed substantially higher growth than those that suffered losses 30 months later. However, as of 2001, the gap was 13.8% for the lowest quartile where poor households had showed -5% net growth (loss) over the post-Mitch period, while poor households without losses had 8.8% growth, whereas the gap was a smaller 5.1% for the wealthiest quartile (-2.1% versus 3% post-Mitch growth) (Carter et al. 2006).

More generally, a study on poverty and vulnerability in Guatemala in 2000 showed how the probability of experiencing a material loss following bad harvests and droughts, drops significantly as household wealth rises, after controlling for other potential determinants (Tesliuc and Lindert 2002). This regularity seems to endure for other regional contexts as well. Richest households in both Burkina Faso and Ethiopia had much higher crop yields than the poorest during the severe drought years of 1984/5. For instance, cow milk yields in Ethiopia for the richest group were unchanged by the drought at five litres per day through the use of purchased feed, but for the poor group, milk yields fell from five to one litres per day. In the same group of studies, the richest in Sahelian Burkina Faso and Upland Ethiopia appeared better protected from crop price variations than the poorest (Webb and Reardon 1992).

The material incapacity of poor households to protect from natural disasters can end in the forced extinction of their few remaining assets or the adoption of strategies which could bring about a serious backlash in human development deepening their poverty or even worst prolonging their poverty into future generations.

This could lead to the depletion of an already diminished asset base

Even if the odds for loosing assets are not tilted against the poorest households, any impact in their wealth is likely to have more resounding effects. A survey of rural poor households in Honduras shown that by 1999 Hurricane Mitch had destroyed household implements, tools, or animals of over one quarter in the highest quintile of wealth compared to just 10 percent of the poorest households. But because the poorest had so few assets to start with, the impact of the Hurricane losses was much more significant to them: affected households in the lowest

quintile of wealth lost nearly 18% of their pre-Mitch asset value and 40% of their total crop value, compared to just 3% and 25% respectively for the affected households in the highest quintile of pre-Mitch wealth and crop value (Morris et al., 2002). The same conclusion was reached by a different study on the impact of Mitch on rural Honduran households: despite the percentage of households suffering a loss of productive assets (primarily plantations and land) increased with household wealth rising from 22% to 68% from the first to the fourth wealth quartile, among those households suffering asset losses, poorer households lost a greater percentage of their productive wealth (31%) than did wealthier households (8%) (Carter et al, 2006).

…or to the adoption of strategies that can erode the asset base

While coping strategies might be useful in the short-term or indeed those who employ them face little option, they might hurt long-term development. Some people have proposed three stages of coping starting with the adoption of insurance and non-erosive mechanisms; then the disposal of productive assets or erosive coping; and ending in destitution or non-coping (De Waal 1989; Davies 1996). Migration is often placed in this last stage perceived as a failure to cope.

Withdrawing children from school to cope with shocks in the presence of credit and insurance market failures is also considered an erosive strategy as it is possible that lost schooling leads to lifelong losses in the earning ability of children. Poor rural farmers in the Semi-Arid Tropic (SAT) region of India rely on child labour, and thereby school attendance, as a central self-insurance strategy against income fluctuations arising from rainfall shocks. In particular, small farm households are inadequately insured ex ante and therefore have a greater probability of taking children out of school after unanticipated weather shocks (Jacoby and Skoufias 1995). A similar case of droughts affecting human capital accumulation in the presence of credit constraints was observed in the 1962-63 drought in Rajasthan. At that time, small farm households relied heavily on wages from public relief works to supplement or as sole income whereas large farmers sold their assets. The resulting situation was one of higher food prices, falling asset prices (except goats) and a deleterious impact on human capital formation as 42 children no longer attended school (Jodha 1975). More recently, evidence from poor rural households in Mexico observed over the period 1998-2000, shows an increase in child labour as a response to droughts and other climatic hazards in their communities, confirming that children are indeed used as risk-coping instruments to respond to natural disasters. This is particularly notorious for the 15–18 age group, which is highly vested in the labor market with a participation rate of 38.8% (de Janvry et al. 2006).

Comparable responses have been identified in rural areas of Africa. Exploiting inter-regional weather variation between 1985 and 1988 and cross-sectional data from Cote d'Ivoire it was found that enrolment rates declined by about 20 percentage points for boys and girls in shock regions -were rainfall data was more than one absolute standard deviation from the historical mean- relative to children in the non-shock regions (Jensen 2000).

The adoption of erosive coping responses that may destroy or reduce the asset stock of families in response to the absence of other key assets goes beyond education. It can also happen with physical, financial, or social capital leading to more permanent effects. In the SAT region of India it has been shown how the presence of low incomes combined with borrowing constraints and no weather-insurance has led to underinvestment in bullocks which are a central production factor for impoverished rural farmers. Bullocks are one of the favourite mechanisms used to cope with shocks in rural South India, but this comes at the expense of agricultural profitability by not permitting farmers to accumulate larger capital goods (Rosenzweig and Wolpin 1993).

Climate shocks covariance exacerbates the fragility of poor people's assets

According to the food security literature, the most heavily used mechanism to compensate for shortfalls in income is borrowing for consumption in the informal credit market. The practice of going into debt seems to be common among both the urban and rural poor who most probably turn to friends and relatives, and from moneylenders who probably charge high

interest rates, especially if we consider that access to formal credit markets is uncommon in rural areas. However, borrowing to maintain consumption is ineffective when the risk is covariate, as many people borrow at the same time pushing up interest rates and rationing credit. Even in the presence of informal group-based borrowing institutions interest rates are likely to go up as the village credit market is necessarily personal and spatially restricted so that severe droughts over consecutive years eventually lead to rising interest rates. Hence, borrowing money in the presence of a covariate and prolonged climate shock, especially droughts, is likely to send household into a cycle of spiralling debt transforming the resources into a financial liability as interest rates go up and the consumption needs remain present.

In the 1962-63 droughts in Rajasthan, India, borrowing from friends and neighbours was the major household coping strategy in the initial three months after the flood. But the reliance of poor and flood-exposed households on private sector borrowing had adverse implications for their food security and economic growth in the medium term. Fifteen months after the flood, 64.2% of flood-exposed households in the bottom 40% of the expenditure distribution who were in debt averaged 146% of one month's average consumption; and for the poorest 40% of households flood -and non-flood-exposed, total debts averaged 150% of monthly expenditures (Jodha 1975).

Likewise, the fairly localized but prolonged three-year drought in the mid-1980s in the Telangana region within India's Semi-Arid Tropics Region, where Mahbubnagar villages are located, precipitated a sharp rise in borrowing in the informal market in Dokur where the large village tank did not fill for rainy season paddy cultivation from 1985/86 to 1987/88. During the first drought year the village credit market was found relatively capable of financing a surprising amount of consumption credit without appreciable changes in interest, but appreciable changes in interest rates were recorded well into the second drought year (Bidinger et al. 1991).

In the 1998 floods in Bangladesh, more than 60% of poor, flood-exposed families in a sample of 750 households borrowed money in the months immediately following the flood, and of these more than half borrowed money for food. Household debts rose to an average of 1.5 months of typical consumption compared with only a small percentage of monthly consumption in January 1998, about eight months before the floods. The percentage of households with outstanding debt one year after the flood decreased progressively from November 1998, when it was at the highest with 66% of the households, to 54% in November, 1999. Nevertheless, the average amount owed still constituted a large share of the total expenditure leaving households vulnerable to another shock (del Ninno et al. 2001).

Another reason for asking for loans even if moneylenders charge exorbitant interest rates could be that poor people refuse to liquidate valuable assets (Fachamps et al. 1998). This last-resort action usually takes place to protect consumption. Unfortunately, the aggregate nature of climate shocks might condition the usefulness of assets as precautionary savings because the oversupply (sale) of assets during times of distress may depress their value as everyone tries to sell them at the same time. In addition, the ease with which they can be mobilized becomes really circumscribed in the presence of aggregate shocks affecting more their value.

Many regions have witnessed the process of collapse in asset prices when everyone tries to sell them at the same time leading to very low returns. The detailed study of the 1962/63 drought in several villages in Rajasthan India remains the classical example of farmers' response to (except for the prominence of livestock) and the consequences of severe drought in India's SemiArid Tropics (Jodha 1975). At that time, traditional risk management methods did little to protect crop and livestock income, which contributed negligibly to household sustenance income during the drought year. With scarcity the price of pearl millet, the staple food, increased by about 60 percent; and milk prices rose by 280 percent. Most households particularly small farm households, relied heavily on wages from public relief works while large farm households compensated for the shortfall in agricultural income by selling assets, which led to gyrating prices. The price of bullocks declined by 51 percent, dry cows by 80 percent, lactating cows by 48 percent, sheep by 60 percent, and bullock carts by 40 percent. The only exception was the price of goats, which are more divisible and better

acclimate to drought than most other domestic livestock species, that actually went up by about 24 percent (Jodha 1975). Ultimately, compared to the year before the drought, food grain consumption per day per adult fell by about 14 percent showing how droughts can affect health and nutritional outcomes.

Similarly, the 1999 drought in Ethiopia was also a year of heaviest livestock asset reductions, both due to animal deaths as well as sales. Based on interviews in the course of qualitative surveys in the study area, it was estimated that 25 percent of livestock reductions in 1999 were distress sales at which the seller received less than 50 percent of the normal price of the animal sold. Cattle prices, for example, dropped from an average of 625 birr in the pre-drought period to 291 birr. Price swings of this magnitude constituted a huge capital loss for those forced to sell livestock during this period (Carter et al., 2006).

The problem of covariation between local shocks and local asset prices has led some studies to conclude that livestock does not always serve empirically as a buffer to the extent suggested (Fafchamps et al. 1998). However, the interplay between shocks and responses such as drawing down assets is inconclusive. Other studies point out at small stock as an important mechanism that households can rely on when dealing with risk (Rosenzweig and Wolpin 1993) and thus avoid further impacts on human development. During the 1994/95 drought in Zimbabwe, livestock did appear to buffer the drought impact over children living in poor households: a regression of growth in the height of children 12-24 months for children residing in households below and above the median value of pre-drought livestock holdings found that drought only affected the growth of children residing in poorer households (Hoddinott and Kinsey 2001).

… And so does their frequency

The frequency and intensity of major disasters is also of great relevance to the recovery of poorer households. It has been suggested that in the presence of consecutive negative shocks the use of asset savings for consumption smoothing is not compatible with accumulation (Deaton, 1992; Dercon, 2002). If bad harvests resulting from climate shocks persist over several years in a row households would have to have large stores of assets to smooth consumption; otherwise this outcome would be unaccomplished and buffer stocks themselves could become depleted. A time series of 100-period horizon simulations over income, consumption and assets randomly generated shown that consumption is much smoother than income due to the existence of assets that buffer the effects of poor harvests.[9] However, if consumption gets protected by assets initially after a shock, in a second consecutive bad harvest with no time to build up assets, consumers are left exposed to a succession of poor harvest (Deaton, 1992). This makes drought and flood especially bad within the different types of natural disasters (Morduch 1999).

On a more practical basis, a study of drought impact on poverty dynamics in north-eastern Ethiopia from 1997-2003 with a major drought in-between (1999-2000) found that the ability of the poor and very poor in this area to move beyond a certain threshold of asset viability before the next drought strikes is limited, and this has been the case for many households since at least the 1984 famine in Ethiopia. According to this study, under a very optimistic post-drought annual growth rate of about 0.3 TLU per year, it would still take very poor households about eight to ten years to reach an asset threshold of around 1.0 TLU per capita (an average of 4.5 TLU per household or two oxen, one cow and 15 small stocks would be the equivalent of a non-poor household in the area). But because in the past 20 years there were major droughts in 1983–84, 1991–92, 1999–2000, and, again, in 2002, and minor ones in almost one out of three years, the poor face a situation where once they begin to re-build their assets, the next drought wipes out the gains and recovery ensues again. The main difference between the poor and non-poor is not that the former have higher post-drought recovery rates, but that they rarely reach a level where they can sustain themselves out of poverty before the next drought strikes (Little et al. 2006).

In a study of drought impact in Zimbabwe over 1983-96 in which the country experienced four major droughts (in 1982-84, 1986-87, 1991-92 and 1994-95) the problem of zero stocks as a result of a series of negative shocks was not relevant for the population as a

whole. In fact, wealth in the form of cattle had grown enormously in the panel of households studies, in spite of the repeated occurrence of drought. However, if the panel was disaggregated the reduction of herd size for particular groups of the population was quite dramatic. For instance, in the 1992-93 drought more than 20% of households experienced negative changes in herd size in relation to the opening stocks of cattle; Secondly, the extent of action by the Zimbabwean government was impeded by the adverse consequences of successive droughts. For instance, in the face of continuous risk-mitigation program demands, the core budget for the Department of Social Welfare declined in real terms by some 50% from one drought to another (1990-91/1994-95).

In a similar fashion, there is a general consensus that the 1998 Bangladesh floods had a lower impact on the affected population than the 1988 floods, even though the 1998 floods were of a considerably longer duration in most places. One of the reasons for this was that previous to 1988 there had been two major floods, in 1987 and 1984, which undoubtedly left many poorer households in a precarious situation and unable to recover their pre-disaster situation before the next disaster occurred (Beck 2005).

In sum, the impact of climate risks on assets goes beyond their physical extinction. If bad harvests resulting from climate shocks persist over several years in a row households could find relatively large stores of assets insufficient to smooth consumption. There are other asset attributes that could also be affected by the occurrence of climate risks due to their aggregate nature. For instance, the fact that assets can hold their value or, in other words, maintain a reasonable return and limited risk during times of stress is an important dimension that needs to be considered when assessing the specific impact of natural disasters on assets. In addition, shocks can affect the returns-generating potential (i.e., sustainability) of an asset via the nutrition-adult height-adult productivity conduit early illustrated.

RESILIENCE

Some recovery from natural disasters is still possible…

There is some evidence of catching-up from the effects of weather-induced shocks on nutrition, that is, over time children may recover lost nutrition and return to their personal growth curve. Full catching up from lost height growth was found in samples from rural India and Philippines after controlling for the endogeneity of past anthropometric levels (Behrman, Deolalikar and Lavy 1995). However, their results might not be completely valid as they conflate children above 3 with children below 3 for whom catch-up growth might not be expected (Hoddinott and Kinsey 2001).

Other studies focusing on weight, rather than height, have produced evidence of catching up controlling for all sorts of different effects. In a study of weight gain among children in Bangladesh over a three-month period following the 1988 floods, children of less weight in the immediate post-flood period tend to grow more over the subsequent period. However, there was faster growth among children in better-off households or those who had better access to credit markets whereas those children in the landless households were especially vulnerable to the conditions created by the flood due to credit constraints (Foster, 1995). Moreover, as opposed to the considerable evidence linking child height with subsequent adult health and other outcomes, there is very limited literature linking lower child weight to adult weight, productivity and lifetime earnings. Hence, ultimately, the economic importance of these findings remains unclear (Hoddinott and Kinsey 2001). This may be because weight fluctuates much more than height in the short-run, and because very short-run changes in weight are not necessarily manifest in long-term height growth. But even if some catching up results this would not avoid the substantial transitory costs to the child's health (Dercon 2005).

But this is largely driven by the existence of adequate coping mechanisms

The lack of adequate assets to deal with a shock could largely compromise the growth prospects of the household members. In the absence of buffer stocks the household might not be able to protect its most vulnerable members or might adopt costly coping strategies for both short -and long term well-being. For instance, the 1998 flood in Bangladesh caused

many preschool children to lose weight and/or to fail to grow at a critical period in their mental and physical development.[10] This situation was brought about by a combination of factors, including reduced access to food, the increased difficulties of providing proper care for children that came with disruptions in home life and the greater exposure of children to contaminants. However, 15 months after the flood, most children appeared to regain the same nutritional status they had a few months after the flood (in November 1998). Unfortunately, within the flood-exposed households, the percentage of stunted children for those in the bottom 40 percentile remained much higher than that of households in the top 20 percentile a year after the flood making more likely a long lasting impact on the nutritional status of these poor children (del Ninno and Lundberg 2005).

Coping mechanisms in turn seem to be strongly determined by wealth

Recovery is also possible on productive assets affected by natural disasters. However, as suggested by the cases of weight recovery and nutritional status of Bangladeshi children, this recovery might be wealth-differentiated militating against any tendency of the poor to catch up with wealthier households. Moreover, as noted earlier, those households with limited resources for dealing with hardships could end up adopting coping strategies which erode the subsistence base of the household thereby compromising its future recovery or the prospects of some of its members. For instance, rather than keeping livestock for productive purposes households could be forced to sell them out to meet short-term needs; or instead of keeping children in school to enhance their human capital parents pull them out to involve them in remunerative activities. A couple of studies on asset dynamics and recovery experiences in the wake of environmental shocks in Ethiopia (three-year drought during the late 1990s) and Honduras (Hurricane Mitch in 1998) reveal that the poorest households appear to be forced into long-term poverty traps as they have to dispose of valuable assets which are then needed for recovery and in consequence struggle several years after the shocks to recover their pre-shock asset levels if ever.

Looking at pre-drought and recovery livestock growth trajectories for a sample of rural Ethiopian households tracked over a seven-year period from 1996 to 2003 it was found that the better endowed decumulate assets faster in the course of experiencing a series of droughts, and also that this group was relatively better equipped to rebuild assets in the wake of these shocks. The growth rate of livestock was found to be increasing in herd size up to a level of 25 tropical livestock units (TLUs)[11] indicating that households that exited the drought with few livestock were strongly disadvantaged in their rate of recovery period growth. Moreover, community membership in social organizations (social capital) increased the rate of growth (or limited the rate of loss) of livestock over the six years, but again primarily for households in the higher wealth groups (Carter et al. 2006).

Likewise, a study over a sample of rural Honduran households on the impact of Hurricane Mitch in 1998 on the value of land, plantations, machinery and livestock right after the shock as well as their evolution up to 2001, two and half years after Mitch, also proved that post-shock resilience displays a strongly wealth-differentiated pattern, especially in the absence of labour and capital markets.[12] With absent good market access, a low wealth household that experienced an immediate 31% asset loss went through further declines and a net asset growth rate of -48% from its pre-Mitch position to the time of the study 30 months later. In contrast, a wealthier household that experienced an identical 31% loss recovered partially from the loss and exhibit a net growth rate of -14%. But given that wealthier households on average only lost 7.5% of their assets (not 31%), then the unequalising effect of the shock was further magnified. Interestingly, under labour and capital market access, lower wealth households would be able to offset much of the 31% asset loss (climbing back to a net asset change of -10%) while wealthier households would also benefit slightly from better market access, giving place to almost a complete elimination of the final recovery gap between poor and rich households (Carter et al. 2006).

Hurricane Mitch: wealth differentiated damage and recovery

Hurricane Mitch hit Honduras –as well as other areas of Central America- from 25 October to 1 November 1998. As it moved inland and remained static over the isthmus for days, it resulted in the largest natural disaster experienced in the recent memory of the country.

Honduras is well-known for its vulnerability to natural disasters, including seismic and volcanic activity, hurricanes and tropical storms. However, man-made factors compound this vulnerability. Environmental degradation, in particular the loss of hillside pine forests mainly due to extensive logging and slash and burn agricultural practices created the conditions for massive flooding and landslides during the Hurricane. In addition, massive disparities in the distribution of wealth had historically pushed wider segments of the population into marginal areas with a limited ability to manage this type of shocks due to low asset holdings and manifest constraints to access credit and insurance markets.

The disaster affected over 1.5 million people, the highest on record for any disaster in Honduras, including: 5,757 dead, 12,272 injured and 8,058 reported missing; 441,150 people displaced; and over 4.2 million people without access to running water or the equivalent to 70% of the entire population. Health problems skyrocketed including gastro-intestinal infections, acute respiratory infections, dehydration, and injuries caused by the floods. Even leptospirosis, which had been virtually non-existent in the previous year, reappeared.

Beyond the immediate death toll, Mitch severely damaged or destroyed key productive assets, seriously disrupting the livelihoods of many households permanently. Agricultural output dropped dramatically, as livestock animals were lost or drowned, and land became largely infertile or eroded, because the flooding basically washed away the productive topsoil and dumped rocks all over the fields or covered them in mud. Roads, hospitals, and even prisons, were damaged or destroyed on a massive scale as well. The loss to the economy has been estimated at some US$4 billion.

With over half of its total population living in poverty and about the same share of the total population (49%) living in rural areas, it was the rural poor who bear the brunt of the impact, even though many of them were not living in the northern coast and the southern watersheds -the most affected areas by the Hurricane. According to poverty estimates before and after Mitch the share of rural households living in poverty following Mitch increased about five percentage points, from 69.2 % to 74.6%.

And more precisely it was on the poorest of the rural poor where the Hurricane had the more resounding effects. A survey of rural poor households in Honduras shown that by 1999 Mitch had destroyed the household implements, farming tools, or animals of over one quarter in the highest quintile of wealth compared to just 10 percent of the poorest households. But because the poorest had so few assets to start with, the affected households in the lowest quintile of wealth lost nearly 18% of their pre-Mitch asset value and 40% of their total crop value, compared to just 3% and 25% respectively for the affected households in the highest quintile of pre-Mitch wealth and crop value.

Recovery on productive assets for the poorest households would have been easier in the presence of labour and capital markets, but in their absence this recovery became wealth-differentiated militating against any tendency of the poor to catch up with wealthier households. More importantly, a study on asset dynamics and recovery experiences in the wake of Mitch revealed that the poorest appear to be forced into long-term poverty traps as they have to dispose of valuable assets, which were then needed for recovery and in consequence struggle several years after the shocks to recover their pre-shock asset levels if ever.

Tracking the value of land, plantations, machinery and livestock of rural Honduran right after the shock as well as their evolution up to 2001, two and half years after Mitch, proved that with absent off-farm labour market earnings and access to credit, a low wealth household that experienced an immediate 31% asset loss went through further declines and a net asset growth rate of -48% from its pre-Mitch position to 30 months later. In contrast, a wealthier household that experienced an identical 31% loss recovered partially from the loss and exhibit a net growth rate of -14%. But given that wealthier households on average only lost 7.5% of their assets (not 31%), then the unequalising effect of the shock was further magnified. Under labour and capital market access, lower wealth households would have been able to offset much of the 31% asset loss (climbing back to a net asset change of -10%) while wealthier households would also benefit slightly from better market access, giving place to almost a complete elimination of the final recovery gap between poor and rich households.

Sources: Carter et al. 2006; Telford et al. 2004; Morris et al. 2001.

The organisation of livelihoods before shocks materialise can impact on asset returns

Household's assets can also be affected by uninsured climate risks before they actually take place through the adoption of asset and activity decisions. An ex-ante or behavioural impact on assets occurs when households faced with the prospects of droughts or other serious climate shock that would affect their welfare have no assets to rely on and thus are pushed into sub-optimal risk mitigation strategies such as the adoption of low risk activities and asset portfolios at the expense of lower mean returns and incomes.

Household behaviour in terms of investment and activity portfolios is also mediated by the stock of wealth available to cope with shocks. In rural Ethiopia the use of fertilisers usually result in higher yields and substantial returns on average. However, the application rates for their use between 1994 and 1999 were substantially lower due to the farmers' inability to cope with the consequences of droughts (i.e., when rains fail financial returns to fertiliser use are typically very low or negative given its sunk cost). Fertiliser application rates would be up 43 percent if downside consumption risk were to be reduced by one standard deviation (Dercon and Christiaensen 2005). In other words, fertiliser uptake in Ethiopia would be substantially higher if some insurance were to be offered against downside consumption risk thus avoiding lower short-term returns of crops in its absence.

Similarly, rural farmers in Tanzania grow sweet potatoes more than any other major crop (sorghum, maize and cotton) despite having returns per hectare at least 25% below them. Households grow this crop because of its high resistance to droughts becoming a low yield risk, and simultaneously because no alternative consumption security mechanisms or liquid assets are available to them. In contrast, a household with an average livestock holding would have a proportion of land allocated to sweet potatoes 20% smaller than that of a household with no liquid assets. As a consequence, the crop portfolio of the richest quintile yields 25 percent more per adult than that of the poorest quintile (Dercon 1996). A similar conclusion was reached by a study in rural South India were asset-poor households devote a larger share of land to rice and castor which are low-risk low value activities. If only the lowest wealth group were provided the same protection as the highest wealth group that would result in 25-50% higher returns per $ assets due to portfolio effects (Morduch 1990).

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Notes

[1] This distinction makes risk different from uncertainty in the sense that under uncertainty the probability distribution of events is unknown, there is no way to attach probabilities to events occurring (Dercon 2001). Some authors treat the terms risk and uncertainty interchangeably (Siegel and Alwang, 1999).

[2] The distribution of exposure to hazards over the planet's surface is non-uniform. Four-fifths of the planet's volcanic activity occurs in the so-called Circum-Pacific Volcanic Belt, within which are located many Asian and Latin American countries. The droughts that regularly follow the onset of El Niño years are concentrated in Southern Africa and South Asia. The El Niño-related "malarial fringe" is located along coastal regions of South America and South Asia. On the other hand, poor people live in housing of poorer quality, and often on marginal land; they face liquidity constraints that limit their access to saving or insurance in the face of risk; they cannot as readily escape disaster zones; their human capital is lower and more vulnerable to shocks, as when poor households decide to withdraw children from school so that they may earn labour income (Anderson, 2000).

[3] A strand of research called critical-period programming deals with the link between early life conditions and outcomes later in life. The idea is that the fetal stage and infancy are critical periods in physical development, and that early-life shocks can have long-lasting effects on health. When facing low nutrition or other adverse health conditions, the developing fetus or infant prioritizes the brain to receive limited resources, compromising the development of other organ systems. The damage is to some extent irreversible, and the individual is thus 'programmed' for worse health later in life.

[4] Results are based on a model regressing the change in BMI (natural logarithm of BMI) on the previous level of BMI, shocks and a number of time-varying control variables, as well as controlling for fixed effect in the change in BMI.

[5] A third of those measured as grade II or grade III malnourished have some difficulty hoeing a field, compared to less than 15 percent of normally nourished adults. Almost a quarter of the adults who are grade III malnourished cannot hoe a field. Other activities such as carrying water for a short distance displayed similar correlations.

[6] This was done linking historical rainfall for each individual's birth-year and birth-location with their current adult outcomes from the 2000 wave of the Indonesia Family Life Survey.

[7] Hurricane Mitch in Nicaragua affected around 19% of the population (870,000 people). Almost half (45.8%) of the households surveyed in the 1999 LSMS reported their dwellings being harmed during the hurricane and, in fact, 29.4% had to temporarily leave their home. Furthermore, 17.3% of the affected households moved permanently to another residence due to Mitch (Baez and Santos, 2007). In post-tsunami Indonesia, the sector that experienced most damage was housing and human settlements: 141,000 houses were destroyed, which accounts for 47.9 per cent of the total damage (Telford et al., 2006).

[8] Land located in an active river basin that is subject to erosion and accretion.

[9] This simulation was based on a model of self-insurance through savings under presence of imperfect credit markets where households maximize expected utility over time and have precautionary motives for saving (from which they receive a safe return). Also, they behave as if there was an infinite planning horizon building up assets in good years to draw them down when income is poor –and thus leading to a time when assets get exhausted.

[10] In this analysis, households were classified according to their level of direct exposure to the flood using a household's flood exposure index, which includes the depth of water in the homestead and in the house, and also the duration (number of days) of water in the house.'

[11] A tropical livestock unit (TLU) is a measure that weights together different kinds of animals into cattle equivalents.

[12] The labor market indicator is the average off-farm labor market earnings within its community, and the capital access measure was designed from a set of questions to probe if the household was price rationed in the credit market or not.