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Private and Public Responses to Climate Shocks

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This section assesses a range of interventions and responses that have been implemented in the face of natural disasters. This requires information on the characteristics of the shock itself; the strategies brought forward to deal with it; and the welfare outcomes derived from the interaction of these two.

Climate shocks are also known as covariant as they strike groups of households or entire communities at the same time. However, their scope could vary from a few households within a village to an entire country. In addition, the frequency, length and severity can vary widely across natural disasters having different implications for the implementation of responses. An earthquake despite being relatively short-spanned could have catastrophic consequences as opposed to a series of frequent, but less intense floods. The effectiveness of responses can also differ according to the length of the natural disaster; a one-off event (such as a hurricane) will have different implications than a more spread disaster as the case of droughts.

There are many ways in which climate shocks and their consequences try to be handled. It is common to group strategies by objectives and mechanisms.[1] By objectives, there are *risk prevention* mechanisms employed to avoid the materialization of the risk, for instance, resettlement in volcanic-prone areas or civil works projects, such as constructing levees to avoid flooding. If the risk cannot be prevented *risk mitigation* mechanisms are employed to lower exposure to it via diversification of income sources or access to credit and insurance, including self-insurance and mutual support networks. Finally, there are *risk coping* mechanisms used to cope with natural disasters after they have occurred. Some measures include the intensification or expansion of household labour by augmenting the number of hours of those already employed or bringing new members into work and withdrawing children from school, drawing down assets, reducing or minimizing household expenditures, and calling on support networks. Similarly, the government may provide ex post relief in the form of food-aid, emergency medical assistance and evacuation or construction of temporary shelters.

The above strategies can be further refined according to the nature of the arrangement that mediates their implementation. There are *informal* arrangements such as the private transfers that originate from social networks and group-based informal insurance mechanisms. Similarly, self-insurance strategies such as savings in the form of stored grain, small and large livestock, jewelry, durables for potential sales during hardships or borrowing from friends, relatives, moneylenders or the workplace are all considered informal. In contrast, *formal* arrangements involve market goods and services such as the acquisition of accident, disability or crop insurance and access to credit from financial institutions, as well as publicly-provided goods including infrastructure, public health and education facilities, and the provision of direct cash assistance and public work programs or enacting building codes for disaster prone areas as a preventive strategy. In turn, both types of arrangements can be placed along a continuum depending on the instance that carries them out (i.e., individual or household, community or government). Certainly, during climate shocks one observes a combination of more than one of the above.

An insufficient response to climate shocks creates a welfare-damaging gap that could be appreciated in a series of outcomes. In particular, impact evaluations of ongoing programs can be informative about the effectiveness of the program to breach this gap. This forms the basis of the analysis. At other times, however, the studies take a "black box" approach with regard to the risk mitigating mechanisms that might have contributed to the welfare outcomes observed (i.e., consumption). Finally, many other assessments reviewed here lack strong quantitative analysis and are based mostly in self-evaluations or qualitative interviews with the intended beneficiaries and providers. These findings are also informative, but their origin should be borne in mind.

The main findings of this review stand as follows: **(i)** the reliance on asset-based self-insurance and group risk-sharing mechanisms is insufficient to deal with natural disasters.

Consumption smoothing is often not achieved through these private means due to numerous constraints, including the riskiness of assets and the covariance of natural disasters. This calls for the involvement of a wider set of actors including NGOs, multilateral and bilateral development institutions, private sector, and governments and local institutions;

(ii) The existing complementarities across actors involved in the creation of a social protection system against climate shocks should not mask potential problems that might arise from these interactions as well. In particular, much evidence is still needed on the efficiency and equity of public systems relative to informal institutions, and the incidence and distribution of crowding-out; **(iii)** Governments in the past have responded to natural disasters mainly through in-kind disaster relief, but more recently there has been a tendency to emphasise cash transfers as well. Both components should be part of a broader counter-cyclical social policy that strengthens current disaster management programs and expands, when feasible, the role of social assistance. The type of climate shock (i.e., slow onset events: droughts *versus* rapid onset events: hurricanes or tsunamis), and various ex ante conditions, including institutional capacities at different government levels and the situation of markets will determine the appropriate mix of cash/food responses to the disasters caused by climate shocks; **(iv)** Even if both cash and in-kind measures are adopted as part of a broader risk management policy further effectiveness could be accomplished by adopting disaster reduction and mitigation mechanisms that address the structural factors which make households more vulnerable to natural disasters. Having mechanisms in place before the realization of a climate shock is fundamental. At the macro level, early warning systems and social funds that can involve community-based initiatives seem particularly relevant. At the micro-level, providing households with safer assets, especially savings, and avoiding physical asset-based risk management strategies by focusing on the provision of credit for productive purposes and insurance products are the best solutions devised; **(v)** There should be flexibility to adopt interventions (i.e., to bring in the most suitable interventions within a range of options and combine policies in the presence of synergies) as well as a solid basis to scale them up in a timely fashion. For instance, in a drought-induced food security crisis, if local food markets are functioning well cash transfers should be provided rather than food aid. But if children are among the most affected groups this measure might be accompanied by a child feeding program to address the loss of control over the money transfer once it reaches the family. Finally, there seem to be mounting pressures for scaling up cash schemes and weather-indexed insurance products, in some cases to the national level, especially in the context of longer-term social protection strategies. However, capacities on the ground should be carefully assessed and built before any attempt to implement any of these mechanisms at a larger scale.

Private Responses

When climate shocks hit households in contexts characterized by widespread poverty and precarious access to credit and insurance markets it is not surprising to find that most of the responses to them are based on self-help and informal mechanisms. Supplying more work is by far the most important strategy. This makes sense considering that labour is the most abundant resource that households have at disposal. Borrowing money most probably from friends, relatives or local moneylenders, rather than banks, comes afterwards. Another informal source follows the sequence: receiving help from relatives, friends or neighbours. Selling animals and assets is done less regularly probably because they are most valued or simply less available. Finally, government help is usually reported as the least likely device to which households turn in case of hardship (de la Fuente, 2006; World Bank, 2005; Tesliuc and Lindert, 2002).

Does assiduous reliance on informal mechanisms means they are more effective? The extensive literature on consumption smoothing reveals that most of these informal strategies are insufficient for managing and coping with climate shocks as consumption shortfalls remain high. Moreover, this literature alludes to the existence of inter-household transfers, loans and other means of dealing with shocks, but only takes into account their net contribution at once to determine whether they allow households to smooth consumption.

This is of little help as it is hard to disentangle the individual effects of all available mechanisms (Morduch 1999).

Self-insurance

Most self-insurance responses to climate shocks in developing countries are asset-based. Therefore, an alternative way to assess the effectiveness of traditional self-insurance is looking at the performance of different asset attributes in the presence of climate shocks. The characteristics that appear to be more important to manage natural disasters at least in rural areas are: divisibility; ease of sale or mortgage, and good price value during hardship (Dercon, 2005).

Divisibility means that physical assets should be easy to sale or mortgage to be reliable buffer stocks. For livestock, regarded as an important mechanism to insulate consumption from fluctuations in income in rural areas (Rosenzweig and Wolpin, 1993), divisibility is a serious problem: livestock usually requires a sizable outlay to acquire it and thus a strong capacity to save. This is often not possible in small-size household economies. There is evidence in this respect across rural areas in sub-Saharan Africa. In western Tanzania, for example, buying a cow costs about a fifth of mean annual crop income. As a result few households can afford to equip themselves with enough units of livestock and therefore are more exposed to serious threats. For instance, during the 1981-85 drought in Burkina Faso livestock sales compensated for only 15-30 percent of the shortfall in crop income (Czukas, et al., 1998).

Even if households are able to pile up enough livestock, their usefulness could be seriously hindered by climate disasters. If traditional buffer asset values hold a strong covariance with the household sources of income that could lead to low asset returns just when they are more needed. This is so because aggregate shocks, such as droughts or floods, typically affect income generating sources (i.e., crop yields) drying up cash flows into the household, but at the same time damage or extinguish those assets that could lessen the impact caused by income drops, most notably livestock (Dercon, 2005).

A related problem with buffer assets in the presence of a natural disaster is that the terms of trade between them and goods for consumption are altered by the aggregate effect of the shock. As noted in the previous section, during droughts many households might be tempted or forced to sell their livestock to ease liquidity constraints, but if everyone follows the same action the sale price goes down. At the same time, the price of food is usually pushed up by its scarcity and thus the purchasing power of livestock relative to food deteriorates. The expected gains in consumption from the distress sale of assets are so slim that households stop their sale at the expense of affecting other welfare outcomes. For instance, during the 1984-85 famine in Ethiopia asset terms of trade collapsed, and households cut their consumption drastically rather than selling assets (Dercon, 2005).

Moreover, if the climate shock is likely to persist over time informal asset-based strategies are likely to experience further limitations. It has been shown that if bad conditions persist over various years households would have to have large stores of assets otherwise consumption smoothing is unlikely to be accomplished (Deaton, 1992). This is what makes drought and flood especially bad within the different types of natural disasters (Morduch 1999).

The interplay between climate shocks and destocking assets is far from conclusive. It seems more an empirical matter that needs to be continuously tested. However, it appears that self-insurance mechanisms are especially weak in places and at times when are most needed precisely because many of the assets that households rely on are fairly circumscribed and markets for them are very restricted making them highly risky. Counter-cyclical safety nets that mitigate asset-price shocks might be promising developments in this respect. In recent times, the government of Kenya has put in practice a subsidy to livestock transport in pastoral regions aimed at reducing the trucking cost of animals in times of drought. This would increase the price that distressed herders are able to receive for their animals. Similarly, Botswana has responded to droughts by purchasing animals on government account in affected areas (Alderman and Haque, 2006).

Informal Risk Sharing Mechanisms

Besides self-insurance through asset savings, households engage in risk sharing arrangements to borrow money and goods in case of need during hardships. This borrowing most often comes from friends and neighbours in the form of group-based mutual support networks such as occupational associations and local borrowing schemes and from relatives as part of the extended family. However, it is increasingly acknowledged that informal risk-sharing institutions cannot handle natural disasters precisely because these affect many households simultaneously wiping out the entire network's resources and thus making it difficult to share risk (Morduch, 1999; Skoufias, 2003). In other words, given that credit markets are personal and spatially restricted, especially in rural areas; common climate shocks render them ineffective. In addition, it appears to be that these institutions are very slow to handle changes like large shocks. For instance, large shocks would change risk distributions requiring some restructuring of existing arrangements. This could possible exclude certain groups or undermine the social norms and sanctions sustaining these mechanisms (Dercon 2005).

There is plenty of evidence that informal risk sharing against income fluctuations derived from erratic rainfall takes place across regions as diverse as Ivory Coast, India, Thailand, Ethiopia and Uganda. As with self-insurance, this is far from perfect, but at least offers some protection in contexts where market-based insurance is not very accessible (Townsend 1994, 1995; Dercon and Krishnan 2000). More critically, once again the evidence available takes a 'black box' approach to the mechanisms by which consumption is smoothed: the results are consistent with both gift exchange within communities -but not with perfect risk sharing- and with self-insurance activities such as borrowing and saving -but not with the perfect ability to smooth consumption-.

Even market-based coping mechanisms such as borrowing from formal financial institutions can become ineffective during macro shocks. For instance, when a natural disaster affects a whole village, being a member of a rural financial institution where the majority of deposits are from community members engaged in agricultural activities may be of little help for lending purposes because most probably those deposits will be withdrawn to face any resulting flood or harvest failure (Skoufias, 2003).

The only exception to ineffective risk pooling between families during climate shocks is when family members or friends live outside the stricken community. Informal arrangements in the form of migration and remittances from other areas of the country and/or abroad can become a useful cross-country insurance mechanism because risks are not highly positively correlated (Townsend, 1994). But even in those instances, support is not always guaranteed or the reported transfers have minor impacts. For instance, in the smaller ICRISAT survey of poor villages in rural South India, it was found that transfers respond to risk but that they cover less than 10 percent of the typical shortfalls in income (Rosenzweig, 1988). In fact, borrowing and saving are typically far more important coping mechanisms in practice than the exchange of transfers (Morduch, 1999).

Public Interventions

The reliance on informal strategies undertaken at the household and community level, such as asset-based self-insurance and group risk-sharing mechanisms is insufficient to deal with natural disasters. Consumption smoothing is often not achieved through these private means due to numerous constraints, including the riskiness of assets and the covariance of natural disasters. In consequence, households end up resorting to non-optimal coping mechanisms, such as cutting back food consumption below adequate levels. Altogether this evidence calls for the involvement of government and other instances.

Governments tend to embark in multiple ex ante and ex post strategies to deal with natural disasters. In the past, they have traditionally responded through in-kind disaster relief, but more recently there has been a tendency to emphasise cash transfers as well. Even if both measures are adopted further effectiveness could be accomplished by adopting disaster reduction and mitigation mechanisms.

Cash Transfers

Transfers to individuals in the wake of natural disasters can either be provided in-kind, in the form of food aid, shelter materials, agricultural inputs or blankets, or in cash, enabling people to decide for themselves what they most need, and to buy it in local markets. According to a recent review on cash-based responses to emergency relief, efforts have traditionally focused on the former, but also the dominance of this approach is starting to erode while experiences with cash and voucher schemes is increasing (Harvey, 2005).[2]

A three-year research project looking into the role of cash transfers (cash grants, cash for work, conditional cash transfers and voucher programs) during emergencies, in settings as diverse as Ethiopia, the 2004 tsunami affected countries, Pakistan and Zambia and Malawi found that providing people with cash or money [during natural disasters] was successful in terms of their impact. Money was spent sensibly, cash projects did not result in sustained price rises and women –one of the most vulnerable groups to climate shocks- were able to participate and have a say on how cash was spent (Harvey, 2007; Adams, 2007).

Relative to food aid cash transfers can play a more useful role in the following ways: First, they can provide households with the highest flexibility on how to use them. Similarly, they can be most cost-effective and timely in the sense that once the infrastructure and distribution technologies are in place, the cost of operating cash transfer programs would often be much lower that the cost of providing in-kind assistance and even more safe. Third, it could have beneficial knock-on effects on local economic activity provided food and goods are available in local markets. And finally, if cash transfers are conditional they can deter the use of erosive coping strategies, including child labour (Harvey, 2007a; de Janvry et al., 2006).

Many NGOs, including Oxfam GB, Novib, the Red Cross and Save the Children, have used cash transfers in emergency contexts, including recent droughts in Ethiopia, Kenya and Somalia, floods in Bangladesh, Haiti and Mozambique, Hurricane Mitch in Guatemala and Nicaragua, and the Indian Ocean tsunami of 2004. In 2005/06, the World Food Programme successfully piloted a cash transfer scheme in Sri Lanka as a post-tsunami recovery measure (Devereux, 2006). This program gave place to the most thorough evaluation of a cash transfer pilot program designed explicitly to compare cash and food aid. In this it was found some significant changes in consumption patterns between cash- and food-receiving households. Consumption of staples (e.g. rice) increased for food households, and declined for cash households. In fact, cash households tended to consume less food in terms of quantity, but of higher quality (basically switching to meat, dairy products and packaged foods). The cash program also increased spending on clothing and footwear and almost half of the cash households reported using the cash to finance business and home improvements. However, there were also indications that cash created some disincentive to work relative to food and that on average half of the beneficiaries preferred cash and half food. As for the operational tradeoffs, almost 60% of food households incurred in additional costs in transporting ration to home and cash was quicker (2hours) to collect than food (3hours) and almost 5% cheaper to implement (Harvey, 2007; WFP, 2006).[3]

However, there are some valid concerns related to the implementation of public money transfers. They might be impractical because of the risks of corruption and insecurity incurred, as well as more difficult to target than commodities given that traditional mean-tested or geographical targeting methods would be inaccurate to capture the transient poor resulting from climate shocks. Even if these issues are sorted out, there are concerns about the proneness [of cash transfers] to strain the social fabric due to the traditional exclusion of women and the misuse of cash in local communities and once it enters the household. In fact, the design of emergency aid and safety nets towards the more vulnerable members of household during weather shocks must take into consideration the intermediary role of families. Once transfers go into the household due to reallocations of resources within it policy makers have no direct control. Some of these issues are likely to remain valid concerns whereas others have been more effectively addressed.

Cash for work (CFW)

Labor-based employment schemes, public works and employment-intensive infrastructure programs remain the most common type of cash-based emergency responses and have disproved some of the most common arguments contended against cash transfers. A recent Mercy Corps CFW program in Aceh, Indonesia in response to the 2004 tsunami reported as part of its main impacts that 91 percent of participants indicated that cash facilitated return to their communities and gave communities an opportunity to work together. Moreover, the program was implemented only two weeks after the tsunami in around 60 villages and at a peak had nearly 18, 000 participants. This proved that cash disbursements could be safely delivered on a widespread basis in emergencies and that when implemented on a short-term basis, can have positive impacts at the individual and community level (Doocy et al, 2006).

In a similar fashion, the Action Contre la Faim CFW program implemented against drought in the Wajid region of southern Somalia in 2004 proved an efficient way to deliver relief.[4] Concerns about security and exclusion of those requiring support proved ill-founded. With cash being highly portable and not as visible as large-scale commodity distributions the looting of trucks or vehicles, such as boats, that occurs relatively frequently in Somalia during commodity distributions was avoided. The other great success of the program was the targeting method which usually represents an important feature for cash-based schemes. For both security and targeting issues were managed to a large extent with the enhanced involvement of the communities and village leaders. A two-level targeting system (village targeting led by the aid agency, followed by community managed targeting at the household level) proved satisfactory. The public works component (i.e., water catchments) of the program facilitated even more the targeting because the traditional management system for water catchments customarily involved some of the most vulnerable families in villages in their operation and maintenance (Mattinen and Ogden, 2006).

Addressing the usual concerns about cash for work schemes does not mean their most attractive features should be left without scrutiny. There is ample evidence of public works creating poorly build infrastructure and assets. Having a work requirement and getting the right wage rates to attract the truly needy and thus avoiding the identification of beneficiaries could also be problematic. For instance, linking work on community projects to payment could make communities less willing to work on a voluntary basis in future years (Harvey, 2007a). Setting very low wages to encourage self-targeting may leave participants unable to meet their basic needs. In contrast, too high wages may saturate the capacity of the providing agency to sustain the program as well as disrupt local labour markets by absorbing workers from nearby villages and other job markets.[5] Finally, even if wage rates are correct, certain groups may not be reached by the scheme, for instance, women that have to look after their children may not find time to take part or in general people surviving during or recovering from emergencies are almost always more than fully occupied rebuilding their livelihoods, so careful thought is needed before imposing onerous work requirements that may undermine their own attempts to recovery (Dercon, 2006; Harvey 2007a).

More generally, transfer policy interventions cash and in-kind alike should be tailored to the special needs of the most vulnerable groups to climate shocks —women, children, and the elderly—. Involving women in the management of shelters, establishing workfare programs adapted to their needs, and ensuring gender neutrality in housing acquisition can improve the recovery for women and households headed by women. Expanding early childhood development programs for newborn infants, particularly mother and child feeding programs, is also very important. Rebuilding schools should be a top priority—to avoid loss of human capital and perhaps to provide shelter for displaced people (World Bank, 2002). Yet, some of the available evidence on social insurance schemes and policies ensuring food security to shield infants from the health consequences of temporary environmental shocks shows that this are not always successful (Munro, 2002).

The key issues for CFW programs successful implementation are the government budgets, where to set the wage, the eligibility criteria to determine whether projects can be self-targeted, and if not how to select participants, how to address the needs of those unable to

work, the quality of assets being built, what sort of work to get people to do and how to measure and monitor the work being done (Morduch, 1999; Harvey, 2007a).

Is it possible to design a transfer system that serves the dual role of alleviating poverty and insurance simultaneously?

To the extent that cash can be used for emergency situations ways should be investigated to link emergency response more closely with social protection systems and safety nets that increasingly have a cash-based component. This could happen in two different ways. In places where cash transfer mechanisms already exist as part of a wider social protection safety net, it might be possible to expand the welfare safety nets during periods of crisis, to help people to deal with shocks. For instance, based on the positive impact of the human capital conditional cash transfer program on poor families in Nicaragua since 2000, the Red de Protección Social (RPS), the Government of that country along with the World Bank has been designing a pilot that aims at targeting cash transfers to families that are vulnerable to exogenous aggregate shocks, such as droughts. Focusing on six municipalities in a region frequently affected by droughts, the program has two main objectives: (i) strengthen households' ex-ante risk management strategies that aim at improving human and physical capital accumulation, thus reducing short and long-run vulnerabilities to shocks (e.g. exposure to drought); and (ii) reduce the impact of aggregate shocks on human and physical capital investments by decreasing the need for ex-post, adverse coping mechanism through cash transfers.

It seems that attaching conditionality on cash transfers is vital to achieve any desired risk-mitigating effect. A recent analysis into rural households in Mexico shows that natural disasters have large effects in taking children out of school and also induces them to increase their work participation. Yet, Progresa transfers conditional on sending children to school largely or completely protected children from the effect of these shocks on school enrolment. The income effect of the transfers was still not sufficient to affect household behaviour with respect to the use of child work in response to shocks (de Janvry, et al., 2006).[6]

Another aspect to consider before linking any emergency responses to existing safety nets is that means testing and geographic targeting were conceived to identify the structurally poor and thus could fail to identify the temporary poor generated by a natural disaster (Skoufias, 2003). The question goes beyond pouring more cash into those households already in the program, but to decide if the program has the built-in flexibility to expand coverage to households falling below the poverty line during times of crises and if self-targeting mechanisms need to be employed additionally to provide both the transfer and insurance. In this sense, traditional safety nets should not be idealized as they can have a limited ability to cope with disasters when scaled up due to design issues (chronic *versus* transient poverty) and limited local level capacity for scaling up (World Bank, 2005).

There may also be opportunities to develop cash transfers that began as emergency interventions into longer-term social protection programmes as a way to break cyclical dependence on aid and, more importantly, address some aspects of chronic poverty. In contexts such as Ethiopia and northern Kenya, for instance, aid providers have discussed moving from food to cash-based safety nets as a way to strengthen the pastoralists' income-smoothing capacity and thus manage the drought cycle more appropriately. As opposed to the short-notice with which food relief is brought and the difficulties involved in setting the type and levels of help needed, a standard transfer for all conditions (though not ruling out extra assistance for a particularly severe drought) could improve herd management by allowing

pastoralists to increase their herds in good years, so that they can sell more animals in worse years (Harvey, 2007). Reducing the humanitarian caseload by addressing chronic poverty is another way of expressing the pre-eminence that ex ante responses should take.

Two last considerations should be made with regard to the policy implications of adopting cash-transfer mechanisms to cope with climate shocks as part of a broader social protection system. One is on the robustness of the evidence, according to a six-country review of cash-based experiences the studies do not seem to have reached that 'critical mass' necessary to draw reliable lessons (WFP, 2006). The number of cash transfer studies is still marginal compared to the magnitude of food aid operations and experience. Moreover, with the exception of cases as the WFP's Sri Lanka pilot cash transfers have been self-evaluated by the implementing NGOs and often lack strong quantitative analysis, including household baseline information, follow-up surveys and sound panel data for market analysis. The second warning is that a possible mismatch between evidence, policy and capacity could happen. There seem to be mounting pressures for scaling up cash schemes, in some cases to the national level, especially in the context of longer-term social protection strategies. However, as noted before, limited capacities on the ground are often severe constraints for rapid scaling up. Capacities should thus be carefully assessed and built before any attempt to implement large-scale cash transfers (WFP, 2006).

Food Aid

It cannot be assumed that longer-term cash-based safety nets will be a substitute for humanitarian relief always. Not all climate shocks will be suitable for cash injections or not at all times leaving a predominant role for food aid. For instance, efficient cash transfer implementation requires sound delivery mechanisms and administrative capacities that are to certain extent familiar with cash flows, but may not be present in the most remote areas. A long-term safety net may reduce people's vulnerability to food insecurity, but in the immediate aftermath of a drought or flood (first 1-3 months) cash may not be appropriate due to medium-short term contingencies in market dynamics (i.e., non-availability or restricted food markets) or surges in staple prices. Take for example the cash-for-work winter irrigation initiative among vulnerable households affected by the drought in Malawi in 2005. The program assessment revealed that beneficiaries unanimously agreed that they would have been better with food transfers than cash transfers especially during the period of implementation because maize prices were skyrocketing. Women beneficiaries of both cash and food interventions also observed that food transfers would be preferred because their husbands normally do not take the food away from them unlike cash (WFP, 2006). Similarly, an econometric analysis on the merits of a foodgrain program for Bangladesh in 1998/99 shortly after the massive floods that affected that country indicated that transfers-in-kind targeted to poor women and children lead to greater wheat consumption than would result from an equivalent increase in cash income. Even though other factors including the cost of delivery, efficiency of targeting and policy objective need to be factored in during a final assessment, the study concluded that the marginal propensity to consume wheat from wheat transfers is large enough to have significant implications for the wheat consumption and the design of the program (del Ninno and Dorosh, 2003).

In addition, beneficiaries may well prefer food over cash if they live in remote areas distant from main markets as opposed to those whose closeness to markets makes it easier to spend cash on the desired goods; in addition, food relief may be more desired during the lean season, or hungry 'period' whereas cash relief would be more appropriate right after the harvest, when food is likely to be available in markets; and finally, cultural habits on the management of cash resources within the households make women more likely to prefer food transfers, while men prefer cash (WFP, 2006).

Food aid is also likely to have its own difficulties. Some of the problems embedded in this mechanism are well-known: leakage to non-targeted individuals in the household or region combined with missing intended beneficiaries (bringing low humanitarian impact); highly pro-cyclical deliveries destabilizing food availability and great delivery lags; product price effects if local food markets are functioning well and labor supply disincentives (Barrett

and Maxwell, 2005). Most of these aspects came in during a series of impact evaluations of food aid programs implemented after three nationwide emergencies: the 1998 floods in Bangladesh, the 2002 drought in Ethiopia, and the 2001-02 failed maize harvest in Malawi. All three cases show limited long-term impact on asset holdings and future consumption in the aggregate from either food-for-work or free food distribution, although positive impacts were found for some groups of recipients in all three studies. The sparse average impacts appear to be related to quantity, timing, and targeting. Households received only small amounts of food aid, when compared with their total consumption. In addition, some of the transfers arrived months after the crisis began. In many instances, they were not regularly available or sustained for more than a season. And targeting was in many cases inconsistent or ambiguous as to whether to focus on the poorest or those most affected by crisis (IFPRI/WFP 2006; Quisumbing, 2005; Gilligan and Hoddinott, 2006; Sharma, 2005).

In fact, the nature of in-kind aid seems also limiting to assist those who suffered greater losses or who are poorer following a disaster given that in the aftermath of a disaster the need for food, clothing and medicines is similar across households. A couple of studies on the relief allocation following Hurricane Mitch in affected countries in Central America found that that targeting was primarily based on the size of asset losses experienced by households and much less on the level of pre-hurricane vulnerability of households (Wodon and Morris, 2003; Ambler 2005).

The modality of food aid is likely to have differentiated implications for reaching the desired group of population and for impacting the welfare indicator (usually nutritional status) that the intervention aims for. In particular, several studies have found that food-for-work seems to accomplish a better targeting towards asset-poor households as compared to community-based targeting or free distribution (Quisumbing, 2003; Barrett and Lentz, 2005).

Since food aid is almost always post hoc with few rules and difficult knowledge about how much will come and who will get the aid, the key issues for food aid management programs would be: good targeting methods; appropriate timing for food aid flows making them countercyclical, launched as early as possible and budgeted on a physical not monetary basis; aligned with positive incentives such as other factor prices (seed, fertilizer, assets) and labour supply; appropriate assessment of the best procurement modalities, such that if there is sufficient food available nearby to fill the gaps the provision of food should base on local purchases and triangular transactions or otherwise carry intercontinental shipments to bring food aid; known and consistent schedule of assistance to help recipients to plan consumption and investment; and finally find an adequate balance of food aid with cash: the use of food aid should only come if a problem of food availability and market failures underpin the lack of access to food. On the contrary, if local markets are functioning well then cash transfers or jobs to targeted recipients should be provided (Barrett and Maxwell, 2005; IFPRI/WFP, 2005).

Cash or Food?

In practice, very often cash and in-kind transfers should be combined to suit the different circumstances that arise as a result of the program objectives, market assessments[7], timing of distribution (i.e., seasonality in rural areas), institutional capacity requirements and beneficiary preferences. For instance, participants in a real-time self-evaluation of the drought-relief programme implemented in southern Zambia in 2005/06 appreciated the fact that both cash transfers, food, and inputs were delivered to the most vulnerable people affected by crop failure and in different contexts: cash transfers going into areas with functioning markets where the traders could respond to an increase in effective demand and food-based transfers going into areas with low stocks and weak market performance (WFP, 2006).

Similar conclusions came from a couple of market assessments and trader surveys following the 2005 earthquake in Pakistan: A Save the Children study in urban conglomerates found that business in food shops went down by 70-80% on pre-earthquake levels due to the loss of income of buyers and the lack of demand for food due to provision of in-kind relief. On the other hand, food prices increased around 15-20% in villages, with the most remote

being worst affected. The solution devised was to reactivate markets as quickly as possible with support for reconstruction and credit to shopkeepers going hand-in-hand with a phased increase in the provision of cash transfers rather than in-kind aid (Save the Children, 2006). This conclusion was echoed by a WFP study in the most food-insecure areas of Pakistan which concluded that food assistance in urban areas would be likely to hinder market recovery, and thus food aid distributions were retargeted to rural areas (Hoskins, 2006; Donovan et al, 2005).

In short, it is the combination of the type of climate shock (i.e., slow onset events: droughts *versus* rapid onset events: earthquake, hurricane or tsunami), its impact, and various ex ante conditions, including institutional capacities at different government levels and the situation of markets which should determine the appropriate mix of cash/food responses to emergency disasters caused by climate shocks.

And yet, an effective food and cash transfer programme would be the last layer of response to a humanitarian emergency. Public interventions at an earlier point could be sufficient to prevent the initial shock, say a drought or flood, escalating towards a famine. A 'first best' solution could be to prevent subsistence crises from occurring at all by investing in agricultural technology, building transport infrastructure to integrate markets, and building asset buffers at the household level to reduce their vulnerability. A 'second best' solution would be to strengthen insurance mechanisms against the impacts of weather shocks, including employment guarantee schemes as a form of insurance or weather-based insurance as will be explained later. The point being that if formal transfers mobilised in the aftermath of a climate shock including food aid and cash transfers are being promoted as a panacea, to the neglect of policies that strengthen production, build markets and infrastructure, or provide effective insurance against livelihood shocks the underlying conditions of precariousness could remain (Devereux, 2006).

Should governments focus on ex ante strategies?

A gradual shift from the traditional emergency relief towards ex ante actions to reduce and mitigate climate risks in the developing world should be encouraged. First and most obviously natural disasters are the antithesis of development. They bring irreversible damages, including death and destruction, sometimes of long-run gains, and seriously jeopardize asset recovery of human and physical assets.

A second aspect to consider is that adopting ex ante strategies could de facto enhance wellbeing and reduce poverty making households more resilient to hardships. Dealing with risk and insecurity is central to the way poor develop their livelihood strategies. A case could be made both in terms of efficiency and equity grounds. On equity terms the poor should be supported against the need to deplete their hard-earned assets. In terms of efficiency, insurance could also allow the poor to engage in more risky activities and bring higher returns (Dercon, et al. 2006). Safety nets might achieve equity, but not necessarily efficiency.

An empirical study of rural Zimbabwean households tracked over seven years (1992-1997) with a drought episode in the midst (1994/5) compares 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 is reallocated into households in the form of capital and extension services to run a series of counterfactuals. Doing so reduces poverty in non-drought years and at the same time allows households to build up buffer stock to protect against the potential drought or other impacts (Owens, et al., 2003). Incidentally, additional livestock only reduced marginally the impact of the drought in income terms, but it might have assisted positively children anthropometric measures as related studies on this same group of households have shown (Hoddinott and Kinsley, 2001).

It could be argued that despite the attractiveness of anticipating to climate shocks there are limited resources and capacities as well as other development short-term priorities.

However, even under pure economic considerations, the rising economic cost of disasters, for instance El Nino and global warming, and the acknowledgment that aid will never cover more than a small fraction of the cost of disasters should spur the adoption of ex ante measures. For instance, from a number of studies that have assessed the relative costs and benefits of individual disaster risk reduction initiatives it has been found that for every dollar invested in pre-disaster risk management activities between two and four dollars are returned in terms of avoided or reduced disaster impacts (DFID, 2006).[8]

Ex ante actions can take place at different levels: disaster preparedness through solid analytical frameworks and information systems can be implemented nationwide. At the community level disaster management initiatives, including training programs and social funds, should be strengthened. Both sets of actions should complement the provision of incentives to individual and household units to adopt risk-prone activities that can bring higher returns and a more diversified asset base.

Disaster Preparedness

Preparedness can play a huge role in the effectiveness of natural disasters management strategies. This is usually conceived as the set of activities and measures taken before hazard events occur to forecast and warn against them, evacuate people and property when they threaten and ensure effective response (e.g., stockpiling food supplies). It consists of planning and institutional development.

On the planning side efforts concentrate on good analytical frameworks[9] and information systems to understand what disasters entail for those who experience them and stimulate a critical reflection on the best initiatives to deal with them. For example, early warning systems can help to monitor natural hazards, plan response activities, identify affected populations and their needs, assess the flexibility of existing instruments or the functioning of markets or facilitate targeting of beneficiaries. For example, prior to Hurricane Mitch the communities along the Coyolate River in Guatemala had undertaken a joint flood map, established a high-rainfall alarm system and had constructed evacuation shelters. The result was that the impact of the Hurricane was substantially reduced upon the inhabitants and there was no loss of life (DFID, 2006). Risk mapping activities can be greatly enhanced by recent developments on the collection of natural disasters data via new risk modules that have been developed and are widely integrated in household surveys as well as recent advances in poverty mapping techniques that have improved the identification of vulnerable populations (Vakis, 2006). A major advantage derived from this exercises would be acting upon relocating those inhabiting very high-risk locations. When resettlement is not feasible or desirable (i.e., the incentives for the poor to abandon risk-prone areas are not in place), governments can help them to upgrade and invest in dwelling and community infrastructure. This might involve a number of community-based disaster management approaches, such as undertaking socio-economic projects, including drainage works in urban areas to reduce people's vulnerability.

Investing in institutional preparedness has proven to be the other priority in disaster preparedness, especially at the local level where destruction of road networks and lack of transport could leave communities in isolation for several days. Training activities for preparing communities for disasters include paralegal training, specialised topics on community organising, evacuation management, emergency response, health and sanitation, environmental education and simulation exercises. For example, there were no deaths in La Masica on the coast of Honduras, where external agencies, including UNDP, had supported a local capacity-building programme for risk reduction featuring a community-based flood early warning system linked to preparedness training (1996-98).

A key feature for successful investing in local capacity is to work with pre-existing forms of organization within communities. In Nicaragua, a hazard-prone country, NGOs working in disaster preparedness have concentrated most of their efforts on community organisation and have achieved their greatest successes in this area.[10] Several organisations that have been working in disaster-affected areas for many years have created and trained their own networks of promoters to help them channel aid more quickly and effectively, often

relying on pre-existing structures in the communities. That is the case with the rural community committees that assume the title of emergency committees when they act to manage natural disasters. Similarly, in certain zones, particularly those most affected by the armed conflict of the 1980s there is already an installed and consolidated organizational capacity that enables the local population to tackle different climate shocks successfully. The extent of these capacities was demonstrated during Hurricane Mitch in 1998 in the conflict-affected municipalities of Wiwilí and Jalapa, for example, were evacuation was done rapidly and the mobilisation of provisions and organisation of emergency shelters was very effective. Training for institutional development related to disaster preparedness was managed by both community development experts and from other coming from a relief or civil defence background. The methodology employed was often a combination of participatory methods together with hierarchal civil defence-style approaches. This blend of local ownership and awareness combined with relief skills and predetermined chains of command turned out quite effective in practice (Christoplos, 2001).

Social Funds

Social funds are a suitable place for the emergence of community-based disaster management strategies. They allow poor people to become actively involved in the development of their communities by supporting small projects ranging from infrastructure and social services to training and micro-enterprise development identified by the communities. They are typically managed by a wide range of actors, including local governments, NGOs, line ministries, community groups and local project committees (Vakis, 2006).

Social funds have demonstrated to be amongst the most flexible and innovative instruments to deal with natural disasters (Independent Evaluation Unit, 2006). A number of factors explain this situation. First, they are apt to respond rapidly in the aftermath of natural disaster due to simplified administrative procedures, good management and operational autonomy. Additionally, public responses are likely to be more effective if they are based on programs and mechanisms that are in place before the shock occurs. The preparation of contingency manuals ahead of time as has been done in the hurricane prone country Saint Lucia is a case in point. During shocks the constraints to act increase due to scarcity of fiscal resources, the lack or weakness of institutional capacity to respond quickly, and the lack of instruments and information problems. Social fund are usually beforehand in areas affected by climate shocks facilitating immediate action in concert with municipal governments and other agencies to prioritize and implement projects where most needed. If there are pre-established links with communities and local leaders as noted earlier, that could guarantee community participation at all stages of the project cycle and facilitate effective targeting. Finally, social funds can also be used as a channelling devise to direct relief from donors. This can be especially crucial during the crucial first hours or days of a natural disaster.

The usefulness of social funds can go beyond the satisfaction of short-term needs. They can also facilitate the recovery and rehabilitation process of affected communities through the reconstruction of basic infrastructure such as sanitation, education, and health facilities. In fact, reconstruction and rehabilitation are ideal openings for starting a process of learning and reflecting about risk and then applying these lessons in decisions of what, how and with whom to rebuild. The immediate post-disaster period is the obvious time to entrench measures to prepare for and mitigate the next disaster. However, this does not always work. Development polemics may displace concerns about risk and the rush to move money may

discourage taking the time to analyse risk and integrate such analysis in reconstruction planning, even in seemingly self-evident areas such as housing (Frühling, 2001).

Finally, many of the social funds projects are labor intensive by nature; hence they can benefit communities by creating temporary jobs through workfare program at critical times when normal sources of income and employment had been badly disrupted. For example, the social fund in Honduras approved 2100 projects within 100 days of Hurricane Mitch; the speed of implementation was four times pre-Mitch averages. This helped to restore infrastructure, but also created employment in a manner not dissimilar to workfare programs, such as Argentina's Trabajar (Alderman and Haque, 2006). At the same time, choices made following a disaster could have long-term implications. For instance, the presence of social funds could end up influencing and informing decisions regarding longer term developmental objectives, such as beneficiary ownership and accountability for maintenance of civil works constructed (Vakis, 2006).

At the macro level as well, more recently conceived initiatives are the Calamity Funds in countries like Mexico, India, and the Philippines which are reserve budgetary funds which can be accessed to avoid the need for sudden borrowing or disruption of development plans after a disaster, without restriction (unlike many aid flows and insurance). In addition, bigger microfinance organizations like Grameen Bank in Bangladesh are setting aside a part of their funds for meeting the contingencies of natural disasters. International financing mechanisms for direct budgetary support to affected countries can also mitigate the impact of disasters on foreign exchange or fiscal budgets. In this regard, one of the main instruments to respond to the financing of imports following a shock has been the IMF's compensatory financing facility (CFF), and more recently the poverty reduction and growth facility (PRGF) which allows countries to borrow money for cushioning a shock while deferring repayments (Alderman and Haque, 2006).

Microfinance

Governments and other actors can also enhance the adoption of preventive measures against natural disasters at the micro-level. Given that asset-based self-insurance mechanisms seems insufficient for most households, the alternative courses of action devised are to provide households with safer assets and/or to avoid asset-based risk management strategies at all and focus on the provision of credit for productive purposes and insurance products.

Micro Financial Institutions (MFIs) can assist their clients long before a natural disaster strikes and continue long after the event has passed. Pre-disaster activities would include adapting current lending and compulsory savings products, home improvement loans; leasing assets; providing money transfer services; as well as insurance and voluntary savings and non-financial services such as training for disasters.

To date, very few MFIs have taken the path of disaster preparedness activities or products. On the financial side, loans to encourage diversification into disaster-proof activities or safer housing are still rare. Other products which include efforts to link loan clients to institutions that can provide voluntary savings or remittances are also uncommon. Lines-of-credit and remittance services are only now appearing in the microfinance world. The most comprehensive efforts to help clients in risk reduction and mitigation activities have taken place in Bangladesh, where some of the large institutions such as Proshika and the Association for Social Advancement (ASA) actually started as relief organizations. In fact, Bangladeshi MFIs have led the industry in insurance, credit, and savings services, and have also taken the lead in loans for disaster-proof housing, as well as in small emergency loans and larger asset replacement loans.

Emergency relief in the immediate aftermath as well as recovery efforts or long-term post-disaster rehabilitation would comprise carrying out rapid portfolio reviews; restructuring and writing-off loans; switching from group-based liability to individual liability during the disaster; providing emergency loans; allowing withdrawal of forced savings; modifying loan product terms; and providing non-financial emergency services.

Yet again, in terms of disaster response, only a few of the larger, better-capitalized, and regulated MFIs have been able to match their post-disaster services to the preferred

coping mechanisms requested by their clients. Specifically, these MFIs have provided their clients with post-disaster savings and loan services making them less likely to resort to distress sales of assets after disaster strikes (Brown and Nagarajan, 2000). Unfortunately, very few MFIs have the institutional structure or capital base required to provide these services —microfinance remains primarily a credit-based activity and most institutions are undercapitalized usually to allow maximum possible lending reach (Parker and Nagarajan, 2000).

Savings

It is safe to assert that providing households with more and better assets in terms of their divisibility and value-holding properties in times of stress should help them to deal better with natural disasters. The best possible alternative for households to adopt assets insensitive to price and survival risks (i.e., livestock) brought about by climate shocks are low-cost saving accounts. This financial asset is highly divisible and could maintain a fixed value and positive returns all at once during a regional drought for instance (World Bank, 2001; Morduch, 1999).

Savings can allow households to avoid borrowing from moneylenders that could charge high interest rates when emergency funds are needed and can be especially valuable during a crisis. The most well documented example of demand for access to compulsory savings comes from the Bangladesh flood of 1998. Grameen Bank reported that 95 percent of compulsory savings were withdrawn during the massive 1998 flood, while 67 percent of BRAC clients withdrew more than half of their compulsory savings. (Rapid-Onset Natural Disasters Technical Briefs: Using Compulsory Savings for Natural Disaster Response) However, replenishing these savings proved challenging. By 2000 only half of the 660,000 clients of BRAC in Bangladesh who withdrew compulsory savings during the 1998 flood had re-deposited these funds (Pantoja, 2002).

Surprisingly, there appears to be limited evidence on the promotion of savings for precautionary purposes against climatic -shocks in general (Dercon 2005). Clients know that larger savings deposits within micro-finance institutions mean access to larger loans. Therefore, most saving instruments still appear to be mostly used as means for developing reputation and commitment for accessing micro-credit.

Overall, some of the keys to success of savings programs rest in the provision of long-term security and convenience, hedge against inflation, minimize costs, and relend deposits safely but profitably (Morduch, 1999).

Credit

An alternative route to limit the asset-based risk management strategies of households is to provide access to credit. This seems a more convenient and widespread mechanism to help the poor protect themselves.

Households use loans in a number of ways. One channel is the asset-creation associated with a series of loan-financed investments. A household who has taken several loans would typically have focussed its asset building on the creation or expansion of one or more income-earning assets and would also have invested in improving housing conditions. A second channel would be to smooth income flows rather than consumption. In rural areas this occurs through the creation of non-farm sources of income as well as by saving part of the loan disbursed for the lean season. In urban areas this takes place through investing in home-based enterprises. This could have both direct and indirect effects on the household's resilience against weather vagaries. The accumulation of assets and income could lead to an increase in savings as well allow some employment diversification reducing the exposure to risk (Dercon 2005).

However, caution is necessary when assuming that credit-driven asset-creation will automatically reduce vulnerability as returns to assets would still face the usual difficulties associated with the covariance of climate shocks. In addition, income diversification would not always be effective, especially in rural areas where diversification takes place by getting involved in non-agricultural activities and engaging in local farm wage employment, among

other ways, but the spatial distribution of farm and non-farm activities alike is often limited (Morduch 1995; Dercon 2005). A study of farmer responses to drought in Burkina Faso between 1981 and 1985 showed that non-farm income was positively correlated with crop income in the presence of the drought. This was consistent with Sen's analysis of famines where a crop failure sometimes leads to a collapse in demand for local services and crafts, limiting the capacity of this other professions to compensate the drop in incomes (Fafchamps, et al. 1998).

The more traditional constraint of working capital needed to enter into nonfarm business in rural areas or informal activities in urban areas would be covered by credit. By doing so, credit could become a highly priced instrument for reducing vulnerability, especially facilitating the adoption of risk mitigating strategies. For instance, in the aftermath of the 1998 floods in Bangladesh households served by several MFIs institutions were aware that the most resounding effect that access to credit brought to them was in terms of planning income-diversification activities for mitigating risk. Hence as clients were aware of this benefit they continued to repay loans during and after the flood so that the credit sources remained open for them in the aftermath (Zamman, 1999).

Paradoxically, the degree to which credit can help to cope with disasters depends not only on having access to it, but also on the circumstances under which households can resort to it. The same assessment of the role of micro-credit during the 1998 floods in Bangladesh through one of the largest micro-credit providers in that country illustrates how in the immediate aftermath of the natural disaster, many micro-finance organizations –BRAC along with Tangail and SafeSave– turned into de-facto relief agencies and delivered post-disaster rehabilitation assistance, in terms of both financial and other services. For instance, BRAC provided several non-financial emergency services to the flood victims. These included disease control measures, seeds to farmers and input replacement for other economic activities. They also helped repair schools and basic infrastructure (Sebstad and Cohen, 2000). BRAC also purchased 364 tons of rice on the open market and sold it at subsidized rates to clients (Pantoja, 2002). However, membership in BRAC's credit program offered only partial insurance to flood-affected households. Despite having access to their savings all three different organizations reported low withdrawal rates in affected regions and households resorted to a wide variety of coping mechanisms including cutting down the number of meals. This was due to physical inaccessibility to local branches, but also because the clients desired to keep larger savings deposits within the MFIs as a means to access larger loans (Zamman, 1999).[11] If asking for credit for food consumption is perceived to compromise long-term prospects household might be willing to avoid so. They should not be confronted against this sort of dilemmas. This brings an anticipated policy conclusion: micro-credit may be a more effective remedy against vulnerability if it is complemented with other interventions, say a micro-credit cum food-relief program.

The revealed preference for savings and especially micro-credit as the main engine for accumulating assets as a way to diversify economic activities and exposure to risks rather than for consumption smoothing purposes reaffirms the fact that policy responses should give priority to risk mitigation strategies over coping.

An additional measure that could strengthen the effectiveness of micro-credit programs is to combine microcredit with saving and insurance products. The linkage of credit with insurance products would allow households not to take out loans to cope with transitory emergencies, but to accumulate productive assets that could be destined to income-mitigating activities without having to worry about short-term needs. Simultaneously, as disaster risk poses a risk to the operation of MFIs the provision of insurance could guarantee loan repayments by poor households., Proshika, one of the largest NGOs and MFIs in the world with more than two million clients in Bangladesh, offers a savings scheme to rural and poor urban households. As a result of wide-scale defaults in the massive 1988 floods, this scheme introduced since 1997 compulsory group-based insurance proving to be relatively effective until today. Under this program 2% of the savings balance is annually transferred to a fund that will pay twice the amount of the savings deposit in the case of property damage due to disasters, while savings stay intact. In the life policy component, a minimum of twice the

savings balance will be paid out, depending on the number of years of membership of the savings scheme (the outstanding loan will be recovered) (Pantoja, 2002).

It is also increasingly recognized that microfinance can play a role in large-scale disasters by offering emergency loans, housing loans and asset replacement loans; by allowing loan forgiveness/ rescheduling in the areas affected by disasters, better targeting of relief programs through established microfinance networks, better flow of information among the clientele of microfinance organizations, and through the empowerment of women and their capacity to build social capital. But the main challenges for micro-finance remain the potentially high transaction costs that could arise from reaching areas with low population densities and targeting families with non-diversified income sources; and the need for credibility of the institution (Morduch, 1999).

Insurance

Only 1% and 3% of households and businesses in low- and middle-income countries, respectively, have catastrophe insurance coverage, compared with 30% in high-income countries (Provention 2005). A recent review of micro-insurance schemes[12] providing coverage for disaster risks enumerates four aspects that will determine their viability for managing climate shocks. These criteria include the contribution of micro-insurance to risk reduction, the financial robustness of the schemes, their affordability, and their governance (Mechler et al., 2006).

Contribution to risk reduction

Insurance alone or linked to credit can allow households to adopt higher-return activities and thus reduce their exposure to risk. The evidence in this respect is still very limited, and to date there is no clear evidence of the relationship between micro-insurance and shifts to higher-risk/higher-yield activities either through bundling insurance with credit loans or standing alone (Gine et al., 2006). One of the few ongoing natural-experiment program evaluations that looks at take-up and possible impact of a new rainfall insurance scheme offered to smallholder farmers in the Andhra Pradesh region of southern India offers a mixed picture in this respect.[13] On the one hand, there was an unanticipated high take-up of insurance for both 2004 and 2005 main crop seasons mainly for security reasons (exposure to rain or large cultivation of castor or groundnut which are more profitable than other crops, but also more sensitive to droughts). However, no change on household behaviour (labour supply, input usage, area devoted to cash crops, savings or consumption, etc) was observed in response to insurance purchases. These results are preliminary and most likely indicate that as households in the sample are purchasing insurance for the first time they might still be experimenting with it.[14]

Insurance can also contribute to reduce risk by helping households to recover fast from a disaster. Substantial compensation can be provided post-disaster as a result of insurance or if the compensation forthcoming reaches beneficiaries quickly the recovery can be facilitated. For instance, the Self-Employed Women's Association (SEWA) in India started providing health, property, and life insurance to its clients since 1992. After the earthquake in 2001 and floods in 2003-04 in Gujarat the insured received payouts for the loss equipment and huts that enable them to quickly restore their livelihood and return to income-generating activities. Similarly, WINCROP (Windward Islands Crop Insurance) program established in 1998 by the banana marketing organizations of Dominica, Grenada, St. Vincent and St. Lucia offers insurance against windstorms affecting banana crops in any on the four countries. By statute, WINCROP is required to settle claims within 38 days of the storm date. Until 2004, 267 events have been settled and even though payout is limited, the quick access to cash is reported to have helped farmers to re-establish their situation relatively quickly (Mechler et al. 2006).

It has been assumed that although disaster insurance might not be fully conceived a mitigation strategy per se –as it redistributes rather than reduces losses–, a well designed insurance program should promote the adoption of loss reduction measures by insurees. A recent review of micro-insurance schemes in Bangladesh, India, Malawi, Nepal, Pakistan and

the Caribbean countries of Dominica, Grenada, St. Vincent and St. Lucia found, however, that none of these schemes fully equates premiums to risk, nor offers reduced premiums based on the adoption of preventive measures or collects any extra-premiums for a risk-mitigation fund Obviously, for poor segments of the population the additional administrative costs involved would make disaster-insurance inaccessible, but it remains to see whether such instruments can help to reduce the vulnerability and risk-exposure of households through their inbuilt incentives (Mechler et al., 2006).

Financial robustness

During climate shocks, once risk is transferred from small farmers to a local insurance provider the risk cannot be reduced further by pooling because of the high covariance of rainfall and other climatic factors across regions and countries.[15] There has to be some mechanism to transfer the risk out of the region or country for the provider to be willing to offer insurance. Otherwise, disaster insurers face the possibility of very large losses and even insolvency when the events that affect entire communities or regions have a high-impact.

Even though reinsurance is essential to keep the costs of disaster insurance provision low, there are no global reinsurance facilities for insuring weather in developing countries – some of the reasons could be that primary insurers in many cases lack the scale and sophistication to appeal international reinsurers who could also make more money in the US market which is heavily subsidized (Morduch; 2006; World Bank, 2005). The same review of micro-insurance schemes in Bangladesh, India, Malawi, Nepal, Pakistan and the Caribbean countries of Dominica, Grenada, St. Vincent and St. Lucia found that indeed with the exception of index-based weather schemes in Malawi and India and WINCROP in the Caribbean the rest of the schemes involved little reinsurance (Mechler et al., 2006).

One solution is the government: their deep credit capacity as the largest credit entity in the country makes governments a natural candidate to pool risk and then facilitate risk transfer. Government risk pooling is also a good strategy to bring down the premium paid by reducing the transaction costs associated with the risk transfer. Alternatively, instead of pooling risk themselves governments can design index reinsurance contracts for catastrophic risks and transfer them to international capital markets. This would mean that the government reinsures itself through international capital markets.

The experience of the current national insurance system for the rural sector in Mexico is illustrative in this respect. The system consists of Agroasemex, the state-owned insurance company established in 1990, the Fondos de Aseguramiento, or Insurance Funds, and private insurance companies.[16] Between 2003 and 2005, 1.5 million hectares have been insured using this scheme, scattered among 186 weather stations, with a sum insured of 88.1 million dollars, premiums for 13.3 million dollars and indemnities for 10.5 million dollars. International risk transference began in 2004 placing the risk under quota share and excess of loss reinsurance schemes. This risk transfer process involves a very strong participation of international reinsurance in the mitigation of the costs of damaging events and has allowed Agroasemex in 2006 to expand its protection to a surface of 2.3 million hectares related to 237 weather stations, a sum insured of 131.9 million dollars and premiums for 17.3 million dollars (Agroasemex, 2006).

The other important feature for achieving financial robustness in insurance mechanisms is the adoption of a partner-agent model which has been identified as the most financially sustainable mechanism through which insurance products could be offered to the poor as it allows each of the parties involved to focus on its strengths. The partner is an established insurer with experience and interest in broadening its insurance portfolio and the agent are likely to be financial institutions with close contacts with lower-income segments of the market, including grassroots organizations and NGOs (Dercon et al., 2006). Most disaster micro-insurers are operating as partner-agents in fact (Mechler et al., 2006).

Within the agent-partner model there is also great scope for government intervention, but not through direct provision. Insurance purchasers appear less likely to take precautions and even default on loans when the government acts as insurer and governments tend to tolerate defaults for the sake of political expediency (Morduch, 1999). For these reasons, the

government can foster a pro-poor insurance scheme creating a favourable policy environment (i.e., facilitating establishment of Micro-Financial Institutions (MFIs) and making more attractive the provision of insurance to established insurers). In this case, government involvement is not about large scale subsidies, but rather about establishing necessary infrastructure, institutions and regulatory environment (Morduch 1999, Dercon et al. 2006). For instance, since 2000 the Indian regulatory authority has made it mandatory for formal insurance providers to service the low-income segment of society. Furthermore, there is a provision that regulated insurers must increase their shares of low-income clients over time. Insurers wishing to operate in India are fined for noncompliance and appear willing to incur a loss on their low-income micro-insurance business in order to access the broader market. Insurers have thus made insurance affordable (lower premiums) for the poor communities with cross-subsidies from their other lines of business and wealthier clients (Mechler et al., 2006).

The international donor community can also play an important role to ensure financial sustainability by aggregating and pooling risk from different developing countries to allow for improved pricing and risk transfer into the global reinsurance and capital markets. The Global Index Insurance Facility (GIIF) under preparation by the World Bank and the European Commission is one step in this direction.[17]

Affordability

Insurance markets are usually incomplete or missing due to asymmetric information and high transaction costs, but in agriculture for example this situation is compounded as the events that bring risk are infrequent and covariate.[18] All this problems eventually translate into a higher premium charge making insurance unaffordable to low-income clients. The high costs associated with the verification process of settling claims on a case-by-case basis after weather events is what made crop insurance -the traditional agricultural insurance risk strategy followed by governments- to fail (Hess and Syroka, 2005).[19]

For developing countries, one recent innovation seems to be particularly promising to mitigate some of these problems. The idea is to supply insurance based on weather indexes (i.e., insure the source of loss) rather than losses themselves. In doing so, the trigger event for payment is exogenous to the individual policyholder –could be area yield-level, rainfall/temperature, winds, earthquake magnitude, hurricane trajectories, vegetative indices– but has a strong correlation with the losses. Therefore verification is straightforward as there is no need to carry on-site inspections or individual loss assessments. This makes deductibles and copayments less needed and insurance in general easy to administer and more affordable. In addition, there is no need to restrict the amount of individual purchases as contracts and indemnity payments are the same for everyone per unit of insurance (World Bank, 2005).

If the expansion of coverage demonstrates the affordability of weather-based insurance products, the experience of the current national insurance system for the rural sector in Mexico would also be illustrative in this respect. After proving the conceptual and methodological soundness of introducing a index-based insurance by means of a pilot test in 2002,[20] a scheme to hedge the weather catastrophic exposure of agriculture was formally launched in 2003 in one state of Mexico (Guanajuato) being the first commercial weather index insurance applied to the rural sector (sanctioned by a local regulator). For the 2006 spring-summer cycle, with the most mature index insurance program worldwide from a technical perspective, the program will offer coverage to 2.3 million hectares, associated to 297 weather stations scattered across the 32 states of the country (Agroasemex, 2006; Ibarra, 2003, 2006). Yet, part of the relative success of the system is due to its focus on the highly productive and financially viable sector of commercial agriculture (the covered surface only represents 28 percent of the un-irrigated crop surface). Subsistence and poor non-commercial farmers are covered through the government's national disaster scheme called *Fonden*.[21]

The scope of the Mexican rural productive safety net holds strong parallels with the other mostly publicised index-based crop insurance schemes launched in India in 2003 whose coverage now extends to about 250,000 clients, without being directly subsidized. Yet, these schemes are mostly offered to farmers taking loans that will increase their productivity; thus,

there may be a bias toward more affluent rural farmers. Indeed, a couple of cases where index-based products have been introduced the premiums can be substantial. In Malawi where micro-lending coupled with mandatory crop insurance was introduced in November 2005, farmers pay from 6 to 10% of their insured crop values; in India in the BASIX scheme farmers pay up to 3% (Mechler, et al. 2006). In the impact evaluation of the BASIX microinsurance project it was found that only 7% of buyers cited low premium as the driving force to get insurance well below security reasons (40%), but is also true that the growing uptake of voluntary contracts under this scheme might indicate their affordability.

Perhaps a more worrying aspect is that take-up rates increased in household wealth and membership to CBOs -members of a borewell user association was the single most important determinant of whether household purchase insurance (Giné, et al., 2006). The influence of both aspects – wealth and social networks on insurance participation outcomes could have negative distributional effects: if rainfall insurance is only purchased by wealthier households, then those households may have additional income to bid up the price of local non-traded goods during periods of drought, making non-purchasers worse off. In addition formal rainfall insurance may undermine existing risk-sharing mechanisms, by raising the threat point of households who seek to withdraw from implicit risk sharing arrangements (Morduch, 2006). In addition, providing more insurance can remove the risk of worsening poverty or poverty traps, but it would not resolve the initial inequality that might exist across the beneficiary communities. In this sense, insurance is not substitute for redistribution and any insurance scheme should remain vigilant of not exacerbating any embedded inequalities (Fafchamps, 2006).

Weather-based index contracts can have other uses beyond insurance. They can serve as contingent ex ante funding for government disaster relief and safety net policies and to provide reinsurance for the private or government as in the Mexican case. Current funding for emergency activities in food insecure countries is based on an appeals-based system that delivers food well after the crop failures and weather shocks with the consequence that by this time people may have already sold productive assets and/or migrated. Providing ex ante funding would give more certainty and timelier provision of assistance. Under the same logic that index-based insurance is triggered by the source of loss, funding can become available well before the loss actually manifests and payments could be distributed early to districts affected by a contingency (say a drought) to scale up the existing safety nets based on where the rainfall measures indicate where shortfalls will occur. Once in the district, communities are expected to use local knowledge to allocate the quota of assistance received or some proxy means targeting to the household would be used to determine which individuals should receive the payment. This is, for instance, how the World Food Program (WFP) uses existing vulnerability assessments (Alderman and Haque, 2006). The other advantage with rainfall data as a trigger to social protection programs is that it remains a form of dynamic geographic targeting that bases allocations on area of residence making it suitable for covariate shocks. It is the case that more than one targeting modality is often used while implementing a counter-cyclical safety net.

Although rainfall during the 2005 monsoon season in Andrah Pradesh was normal, farmers under the BASIX insurance scheme received a payout because of a delay in rainfall that affected sowing time. Claims were quickly serviced within 15 days of the end of the policy period, which contrasted with the 12–18 months for the national crop insurance scheme with its conventional loss inspection and settling (Mechler, et al., 2006). A similar thing is expected from the strategy implemented by the Ethiopian government in the last couple of years to provide food security to its population. In January 2005 a productive safety net was introduced in an effort to change the vulnerability profile of the chronically poor. In addition, as part of this ex-ante risk-management system to protect the livelihoods of Ethiopians vulnerable to severe and catastrophic weather risks, the government started to pilot in 2006 an index-based insurance to fund emergency relief operations in the event of a well-defined rainfall deficit at harvest time. It is estimated that this insurance approach would allow interventions four months earlier than the traditional appeals-based system (WFP, 2005; World Bank, 2005).

The attractiveness of weather-indexed insurance is reflected in the explosion of pilot projects in countries as diverse as Ukraine, India, Malawi, Nicaragua, Peru, Ethiopia, China, and Thailand. However, only since 2005 a systematic approach for scaling up their design, implementation, operation and evaluation has been taking place. Therefore given the limited scale of the pilot programs to date it is premature to draw definitive conclusions on the performance and impact of weather insurance.

Moreover, there are cases where index insurance might be inappropriate. By design, the correlation between the index measure and local outputs (i.e., yields) needs to be high, but this could not happen in places where agricultural commodities are grown in microclimates with large differences in weather patterns within a few miles (World Bank 2005). More fundamentally, rainfall stations might simply not be there or have low quality and insufficient data in regions with low potential and limited commercial farming interests. Finally, the sustainability of the scheme could be compromised by weather cycles that change the probability of the insured events, most notably rainfall and temperature. In this regard, phenomena as El Niño or global warming are especially relevant as they are not yet fully understood (Dercon, et al. 2006). All three factors combined can create a potential mismatch between index triggered payouts and actual losses, even if this are substantial (basis risk). This problem is not insurmountable, but certainly takes time to collect better data and more generally to develop a scheme of this nature. In Nicaragua, for instance, rainfall insurance was first seriously considered in 1998, but the pilot was just introduced seven years later in early 2005 (World Bank, 2005).

Another alternative for national governments and/or the international donor community to make insurance affordable is to co-finance insurance purchasing with premium subsidies or reimbursing primary insurers for administrative or product development costs or even providing reinsurance below market premium rates. For instance, donor assistance to the disaster insurance program – Afat Vimo – offered since 2004 by the NGO, All India Disaster Mitigation Institute (AIDMI), to cover households and micro-businesses in the state of Gujarat has kept the premiums in one of the cities Bhuj at about at about 0.5% of annual income (the cost of a box of matches per day).

In addition, as noted before, governments can bring down premium costs for the poor without large scale subsidies, but establishing a pro-poor regulatory environment. Take the disaster insurance program in Gujarat as a relevant case again: because of the pro-poor regulatory requirements in India, premiums have been kept low and affordable as confirmed by a survey conducted before the start of the scheme. It is estimated that by 2004 about 12% of the poor in Bhuj, the worst affected city by the 2001 earthquake, were covered (Aysan, 2005).

But because of the disincentives and distortions that direct subsidies can bring about as well as their unreliability in the long term, many international donors advocate technical support instead of subsidies in the start-up phases. External support can come in the form of technical/organizational assistance, for example, for conducting feasibility studies, providing access to data, carrying out risk assessments, designing products, and facilitating public-private partnerships.

Governance

One of the most important factors leading to the viability of disaster insurance is the trust of the stakeholders in the system. In this respect, not surprisingly, recent payouts in the case of Indian weather derivatives appear to have increased trust in the insurance product. Most farmers in the treatment villages of the BASIX program evaluation said they would like to purchase insurance for the next monsoon season in June 2005 with 60 percent citing security reasons, but another 30 percent citing the experience of the payout in 2004. Moreover, participants at meetings were the insurance scheme was explained understood the link of insurance to the crops and the idea of payouts and premiums reinforcing the confidence on the product (Giné, et al., 2006).

However, such motivation for purchasing insurance could be problematic, as disaster insurance does not work if substantial claims occur every year. Moreover, in conjunction with

the basis risk, individual trigger failures may pose a serious risk to the viability and up-scaling of the scheme. In fact, the BASIX evaluation also found that risk-averse households were somewhat less likely to take up rainfall insurance, partly due to uncertainty about the insurance product itself.

Trust can also be enhanced by stakeholder early participation in the design and implementation of insurance systems and products, such as demand surveys, product development, and/or product modification. For instance, based on household interviews, the decisive factor for uptake in the insurance program offered to households and micro-businesses in Gujarat was the long-standing relationship that the intermediary NGO AIDMI had with the communities—all participants in the micro-insurance scheme have received support from it in the past. Otherwise, the scheme might have failed as the initial demand survey given to small businesses affected by earthquakes in the past revealed: there was a general mistrust of insurers, reluctance to pay for uncertain benefits in the future, and the belief that claims might not be settled properly. AIMDI is working on these issues by demonstrating prior payouts and highlighting successes (Aysan, 2005).

Overall, the key aspects that governments should assess prior to any intervention in insurance schemes are the cost-benefit analysis of such projects, fiscal constraints; potential rent-seeking and regressive effects; the level of development of the financial sector; the possibility to bring in local partners that can bring groups of smallholders together; and the existing regulatory constraints (World Bank, 2005).

Private-public interventions: scope for complementarities?

It has been shown that public policy interventions are needed to put in place an effective safety net for high-risk poor communities. The obvious question that follows is to what extent these interventions are complimentary/substitutes to underlying traditional schemes and ways of responding to climate shocks.

Provided some crowding out of informal risk sharing mechanism by public transfers is observed two broad answers have been provided in this respect: scaled up formal interventions superseding more traditional forms of coping with risk might be irrelevant if the social protection obtained is more complete. The weaknesses of existing schemes, in terms of limited coverage of some of the poorest groups and the most catastrophic risks, and the lack of full insurance offered, may be a sufficient reason to let formal social protection crowd out informal systems (Morduch and Sharma, 2002). To assess the impact of formal schemes in this respect therefore it is necessary to know the direct and indirect costs associated with the private efforts (for instance if they create poverty traps or not), what is the scale and incidence of crowding-out by age, region, ethnicity and household structure; and whether the government can provide the same services more cheaply after factoring the two previous considerations (Morduch and Sharma, 2002).

On the other hand, to the extent that traditional institutions play a broader role, say as mechanisms for building up social capital by encouraging more interaction and trust within these networks, rather than merely risk transfer functions, crowding-out might have higher welfare costs than could be calculated via standard approaches. In this case, even if traditional institutions were not able to cope well with the changes brought about by a climate shock, it may be worth keeping the risk pool to cover natural disasters as it stands. Otherwise this may lead to the loss of social capital creation that characterizes them and thus undermine their sustainability (Dercon 2005).

Sometimes there is clear ground for complimentary public-private initiatives. The case of micro-insurance products provision through MFIs is exemplary. Governments should try to crowd them in given their close contacts with the direct beneficiaries. Similarly, the provision of emergency relief could be greatly enhanced by the participation of informal community-based organizations and targeting could be improved if local risk sharing groups are taken into account.

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Notes

[1] Other terminology to classify different types of strategies that households call on while dealing with hardships is between 'non-erosive' and 'erosive' coping strategies, in order to differentiate those strategies which use extra sources of income and do not erode the subsistence base of the household, from those which do not entail such costs. (De Waal, 1989; Corbett, 1988) For instance, the sort of tradeoffs involved could be keeping children in school as an investment for the future as opposed to taking them out to put them to work; or staying in a formal sector job as opposed to self-employment. A more popular distinction that has been formalized within the food security literature is distinguishing between *coping* understood as a set of short-term responses to unusual food stress, and *adaptation* representing coping strategies that have become part of the normal cycle of activities of households. (Davies, 1996) It is important to mention that all these are analytical distinctions. In practice many strategies have elements of the different categories.

[2] Obstacles to the use of appropriate cash are partly institutional, in the sense that some donors continue to tie assistance to food aid. Reluctance to use cash is also a function of the individual attitudes of aid providers, and the sense that cash is threatening because it implies handing over power from the agency to the beneficiary.

[3] WFP's cash transfer pilot program (CTPP) in Sri Lanka was implemented as part of the Tsunami emergency. The core evaluation conducted by the International Food Policy Research Institute (IFPRI) comprised an econometric assessment that included a baseline survey (October-November 2005) and a follow up survey done in February 2006. The follow up included a sample of 1360 cash and food-receiving households.

[4] The project achieved its main aim of diversifying household income sources (villages that received cash were able to plant and harvest more and purchase more seeds than villages where the project was not implemented). It also increased access to water as the beneficiaries worked on water catchments, although progress toward restocking was more limited. Other positive secondary effects noted were that cash was used to repay debt, invest in seeds and tools and improve access to credit. More cash was spent on food during the hunger gap and only a small amount on livestock.

[5] In Aceh, in the aftermath of the tsunami the wage rate established by UNDP for its CFW programs was set at the typical urban casual labour wage for Banda Aceh. In some locations this exceeded the local rate for unskilled agricultural labour compromising the risk of crops being looked after. Similarly, in Killinochi, Oxfam suspended its cash for work program to free up labourers to secure the harvest (Harvey, 2007; Adams, 2007). A recent review of the Productive Safety Nets Program in Ethiopia found that some households were spending large amounts of time on public works projects at the expense of working on their own land (Kebede, 2006).

[6] This seem to be downplayed by the study as child labor is done at no cost in terms of schooling due to the price effect of the conditional transfer, but other outputs on school attainment could be compromised posing further questions into the viability of the transfer scheme.

[7] Emergency Needs Assessments (ENAs) are promoted by the United Nations' World Food Programme to incorporate basic market components that will help inform on the impact of shocks and food aid on markets, as well as the potential for markets to respond in an emergency.

[8] For some organizations, a final reason why ex ante measures should be encouraged is because the technologies to predict climate risks are becoming more reliable and hence counter-cyclical planning is feasible. It is possible to predict generally where an event is likely to occur at some time in the near future (but not precisely when or its magnitude); and second, it is possible to know the sensitivity of human settlements to determine how exposed they will be to potentially destructive natural events. Therefore, disasters could be anticipated as more predicable events, with human and financial risks calculated in advance. Two recent studies on natural disaster risks confirm this pattern: the UNDP report *Reducing Disaster Risk: A Challenge for Development* (UNDP, 2004), and the World Bank's *Natural Disaster Hotspots: A Global Risk Analysis* (World Bank, 2005).

[9] The Social Risk Management Framework (SRM) developed in the World Bank is an example (Holzmann, 2001).

[10] Given the vast diversity of hazards facing Nicaragua (floods, droughts, volcanoes, earthquakes, hurricanes, tsunamis and landslides) and the limited capacity of small individual NGOs in the face of such threats this seems to be the more effective use of resources.

[11] Incidentally, micro-finance services also have an indirect impact on the vulnerability faced by women to climate shocks in a patriarchal society. The evidence shows that a woman's control over her assets and her knowledge of social issues is enhanced after borrowing from BRAC's micro-credit program.

[12] Two broad categories of micro-insurance can be distinguished: micro-insurance as an extension to microcredit and micro-savings operations because disasters pose a risk of default to the operations of MFIs or community-based organizations (CBOs). Micro disaster insurance is introduced either bundled with these other services or on a voluntary basis. And second, stand-alone insurance programs designed to deal with disaster risks. These instruments usually are embedded within a more broad disaster risk management strategy (Mechler, 2006).

[13] The insurance product is accessible to farmers of modest income, and pays a return based on rainfall during three phases of the main growing season. The product is sold to farmers by BASIX, a microfinance institution, and rainfall risk is underwritten by ICICI, a large diversified Indian bank. For its evaluation, a household survey is currently being fielded by ICRISAT and World Bank. The sample comprises 1,052 farming households, including 267 buyers, 186 non-buyers that attended the marketing meeting, and 299 non attendees in the treated villages. In addition, 300 farming households were interviewed in control villages. Take-up and impact is analyzed comparing buyers and non-buyers in marketed villages, but for impact even more important to compare buyers with potential buyers in control villages. At this stage only the 2004 round of data collection is available (Giné, et al., 2006; Lilleor, et al., 2005).

[14] Households were asked qualitatively if purchasing insurance modified their labour supply, input usage and so on. Then using both treatment and control villages it was estimated through preliminary regressions whether insurance participation on the right-hand side and being properly instrumented had any statistically significant effect on saving or consumption.

[15] The principle of pooling is that the more uncorrelated risks added to a portfolio the lower the variance in the outcomes of the overall portfolio.

[16] Agroasemex is a state-owned institution which provides reinsurance to private companies and to self-Insurance Funds (*fondos* are mutualist schemes among the producers themselves, which by means of collecting premiums, allow the creation of reserves to pay indemnities and operation expenses). It also acts as a Development Agency to drive the growth of the agricultural insurance industry by means of designing and operating risk management products.

[17] The Global Index Insurance Facility (GIIF) will have three functions: 1) supporting the technical assistance and infrastructure that are needed to develop index-based insurance; 2) aggregating and pooling risk from different developing countries to allow for improved pricing and risk transfer into the global reinsurance and capital markets; and 3) co-financing certain insurance products on a bilateral basis from donor to developing country (World Bank, 2005).

[18] The usual failures of insurance markets are asymmetric information that causes adverse selection (farmers have better knowledge than insurers about probability distribution of losses hence those bearing great risk purchase insurance) and moral hazard (incentive to take care of crop diminish once insured, but insurer cannot monitor this hazardous behavior) which in turn are often solved through higher transaction costs, such as co-payments and deductibles. However, offering insurance against climate shocks creates additional burdens as they are infrequent and covariate. Insurance contracts work better when risks are spreadable across the population so that only some put in a claim at the same time. The problem with infrequency is that purchasers are unwilling to pay full costs as it is proven that rare events are underestimated (tend to forget extreme low-yield events) while insurers tend to charge high premium rates (when risk estimates are ambiguous loads on insurance premiums can get 1.8 times higher that insuring events where probability and loss estimates are well specified) (World Bank, 2005).

[19] From the convergence of traditional insurance markets and capital markets new insurance products have resulted, particularly in developed countries. These include catastrophe bonds, insurance contracts and even derivative financial instruments like an active weather market.

[20] Back in 2000, a study on rainfall contracts to insure against drought during the critical crop growing season in four states of Mexico found that such contracts can reduce the variance of revenues (compensate revenue shortfalls) from the crops. Both rainfall and yield data were collected for the period 1980-99. To assess how well the rainfall contracts worked, the study assumed that insured farmer would purchase a value that would equal the mean yield value within a given production extension. The study then developed estimates of gross yield for the production extension with no insurance and with rainfall insurance. Results showed that for about 40 percent of the planted area in the four states, rainfall contracts could reduce relative yield risk by up to 30 percent (Skees et al. 2005).

[21] *Fonden* is a Calamity Fund that allows to transfer risk associated with natural disasters through insuring public infrastructure and private assets in world financial markets that offer opportunities to pool large volumes of covariate risk on a global scale.