Climate Change, Human Vulnerability, and Social Risk Management

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EXECUTIVE SUMMARY

This paper is motivated by what we perceive to be important gaps in the literature on climate change: lack of attention to how risks associated with climate change might affect households; inconsistent use of key terms such as risk, vulnerability, and adaptation; and lack of clarity on the relationship between risks associated with climate change, adaptation, and vulnerability. These factors limit the ability to effectively formulate adaptation strategies aimed at reducing human vulnerability.

Risks associated with climate changes could increase household vulnerability to poverty, hunger, disease, mortality, displacement, and violent conflict in many developing countries. Threats to household well-being stem from both the direct risks (changes in climate variables) and the indirect risks (e.g., increased prevalence of pests and diseases; degradation of natural resources; food price and employment risks; displacement; potential conflicts) associated with climate change. Many interventions, however, tend to focus on direct risks and direct impacts with insufficient attention to indirect risks and to impacts on households.

This paper proposes and applies a social risk management and asset-based conceptual framework to help design interventions that can *increase the capacity of society to manage climate risks with a view to reduce the vulnerability of households and maintain or increase the opportunities for development.* This framework offers a unifying lens to examine the links between risks, adaptation, and vulnerability and is consistent with IPCC definitions of vulnerability and adaptation (see Box 1 for key terms and definitions).

We apply the framework to identify adaptation interventions at household, local, national, and international levels, and their linkages. In particular, we clarify how several social policy interventions are "no-regrets" contributions to equitable risk management and springboards for growth, and discuss the role of social protection and insurance instruments in this context. We also propose a research agenda designed to inform future climate adaptation policies.

Our analysis leads us to the following conclusions with regard to adaptation policy, research, and institutional coordination:

Need for multisectorality
Adaptation to climate change should be multisectoral and strive for a balance between institutional development, infrastructure sectors, productive natural resource sectors, and social policy including social protection.

Need to prioritize and sequence interventions
The time lag until the full effects of climate change unfold gives scope for prioritizing and sequencing the policy response. We propose to begin by closing the existing adaptation gap—helping households and countries better manage *current* climate volatility to gear up for the expected increase in *future* volatility. This involves:

- Prioritize adaptation investments with long gestation periods before their benefits kick in (including research)
- Set up monitoring and early warning systems for baselining existing climate risks and tracking potential new climate risks and socio-economic responses
- Identify "no regrets" interventions with high payoffs for adaptation to the current climate risks as well as adaptation in a future with riskier climate
- Climate proof existing and new infrastructure with a long expected life

- Mainstream climate risk assessment and adaptation into new policies, projects and programs.

Support local adaptation
Covariate and potentially very large and irreversible risks imply a need for higher level (national and international) adaptation interventions aiming to support household and community adaptation. While adaptive actions often need to remain focused on local risks, support in the form of finance, technology, and capacity building will increasingly have to come from outside the community. Communities will serve as a critical link between households and higher levels, and need to improve their capacity to identify and mange risks.

The solutions to climate change require strong international cooperation, including development assistance. This assistance, however, should not be calibrated to finance just additional costs: There are many problems in measuring additional costs of adaptation which should not bias international finance toward specific purposes or sectors. Development assistance should flow to where it has the largest impact on poverty and vulnerability.

International burden sharing will need to go beyond development assistance and include, for example, labor and migration flows; easy remittances; trade policies and well-functioning international markets for food; financial markets and insurance systems; disaster risk insurance and contingency disaster financing; peace keeping; and research in new technologies for exposed sectors.

Scale up social policy for adaptation to climate change
Social policy interventions are needed to promote the ability to manage risks associated with climate change at the household and local level through, for example:

- Public health, food security, and nutrition;
- Clean water and sanitation;
- Access to skills, education and knowledge;
- Policies to help households stabilize consumption through deeper labor, assets, credit, and insurance markets; improved access by the poor to those markets; and better social safety nets and social insurance;
- Improved disaster preparedness and management, including better safety nets to prevent irreversible human damage and enable speedier recovery;
- Social and political conditions for collective action—help the poor develop voice and political capital to demand access to risk management instruments;
- Managing displacement and violent conflicts through, inter alia, strengthening the asset base of rural livelihoods; arrangements for orderly migration; and institutions for conflict resolution.

Insurance, and especially weather-indexed insurance, is not a panacea
Weather insurance through index-based insurance for farmers and for local and national governments appears to be increasingly important but it is not a panacea:

- Changes in climate and uncertainty about future climate can make insurance more expensive and less appropriate as a means to compensate for losses associated with climate variability and extreme events
- Insurance may not be appropriate for very slow-onset climate impacts, such as sea level rise and desertification.
- Insurance must be considered within an overall risk-management and adaptation strategy, where preventing losses will often be more cost effective than loss-based insurance.

- Many developing countries lack insurance markets and may not find insurance easily affordable.

However, there are interesting innovations for weather risk management that combine insurance and safety net approaches. Mexico and Ethiopia run programs that include weather indices as triggers for payouts to farmers and to mobilize safety net transfers. The poor do not pay premiums in these programs. Instead, local and national and governments access international re-insurance markets.

Support research

Research should seek consensus on basic terms and relationships between risk, vulnerability and adaptation to advance multi-disciplinary and multisectoral approaches. We propose a policy-oriented research agenda on adaptation with four pillars:

- Monitoring Household and community response to climate risks and climate changes,
- Understanding poverty and distributional implications of climate risks and climate changes,
- Assessing alternative interventions for adaptation to climate changes,
- Institutional arrangements, coordination, financing, and sharing the burden of adaptation.

Toward an integrated approach to climate risk management

We propose to seek greater cross-fertilization between the professional communities working on disasters, climate change, and social protection. We argue for shared platforms around definitions, concepts, data, monitoring, research, and capacity building. A good starting point would be adoption of shared basic definitions of key terms such as risk, vulnerability, and adaptation (see Box 1 on key terms and definitions).

Avoid the trap of "business as usual"

Climate change is, to an extent, a future problem which can make it difficult to get the attention of policymakers. "No regrets" responses are a useful way to address this challenge: attempting to close the adaptation gap to current climate variability. Although much of what we are proposing is really good development practice—for a pro-poor strategy that helps manage risks and promote opportunities for growth—it is more than business as usual. Some interventions will have to be designed in different ways in anticipation of changing risk patterns; appropriate technologies need be developed and disseminated; knowledge of specific threats and skills for coping need to be built; climate monitoring and prediction has to be improved; monitoring of direct and indirect risks and impacts associated with climate change needs to start; and, more than anything, the investments in local risk management that are required go far beyond current efforts in many countries.

Box 1: Definitions of key terms used in this paper

Livelihoods strategy: Household decisions to accumulate and allocate their assets. Risk management is part and parcel of household livelihood strategies.

Risk: The chance of danger, damage, loss, injury, or other undesirable consequences from risky events.

Exposure to risk: Assets and livelihoods that can be impacted by risk

Sensitivity to risk: Susceptibility of assets and livelihoods exposed to risk

Hazard: Expected losses associated with a risk (a function of the probability of a risky event occurring and exposure to that risky event and sensitivity of exposed assets)

Risk management strategies: Ex-ante (anticipatory) and ex-post (reactive) actions to manage risky events

Social risk management (SRM): How society manages risks. Instruments/arrangements/strategies that enable households to better manage risks

Risk prevention: Ex-ante actions to reduce the likelihood of a risk (e.g., reduction in emissions of greenhouse gasses)

Risk compensation / risk mitigation: Ex-ante actions taken before realization of risk to provide compensation in the case of a risk-generated loss (e.g., formal insurance)

Risk coping: Ex-post actions to make up for losses after a risky event

Vulnerability (our definition): An individual or household is vulnerable to risk(s) associated with climate change if these risk(s) will result in a loss of well-being that pushes the individual or household below a benchmark or threshold level of well-being. Vulnerability is a function of the risks, exposure and sensitivity to risks and adaptive capacity.

Vulnerability (IPCC definition): The degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Adaptation (our definition): Social risk management for reduction of risks and human vulnerability associated with climate change.

Adaptation (IPCC definition): Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm and exploits beneficial opportunities.

Resilience: Ability by households to resist the potential negative impacts of risky events and the extent to which households can recover from negative impacts of risky events.

INTRODUCTION

Climate risk is a fact of life, and throughout human history society has been adapting to climate risks and climate changes. Household asset portfolios and livelihood choices are reflections of risk management strategies and are profoundly shaped by climatic conditions. Recent evidence and predictions show that climate changes are accelerating and will result in changes to the characteristics of climate risks in terms of frequency, magnitude, timing, duration, and distribution over space, sectors, and households. As climate risks intensify, socioeconomic factors such as economic growth, demographics nutrition and health status are changing human exposure and sensitivity to these risks. Also, there is evidence that climate change is triggering changes in other risks (e.g., related to pests and disease, food prices). In addition, adaptive capacity (defined as ability to manage these risks) is changing as a result of changes in household assets and livelihoods, intra-household composition and dynamics, changes in social networks, and changes in policies and institutions at community, local, national, and international levels. Increased attention to human vulnerability associated with risks associated with climate change provides incentives to explore the opportunities for growth and development that could be generated by improved risk management in developing countries.

The consensus has long been that climate changes will impact the most in developing countries because of their geographic exposure, low incomes, greater reliance on climate sensitive sectors, and weaker capacity to adapt (e.g., Schelling, 1992; Stern, 2006). Not much is known, however, with any degree of precision about human vulnerability to climate change.[3] In particular, what are the dimensions and drivers of household-level vulnerability, and to what extent can this vulnerability be managed? To date, climate change models and policy discussion focused on the need to reduce emissions of greenhouse gasses and paid little attention to adaptation.[4] Today, however, donors, governments, and civil society are increasingly asking how they can start preparing for the climate changes that are under way, regardless of what happens to emissions. In particular, there has been increased attention to adaptation to climate change (Burton and Van Alst, 2004; OECD, 2006; UNDP, 2007; UNFCCC, 2007; USAID, 2007). To address these questions we need better understanding of the nature of the risks facing poor countries and households; how these risks might impact household well-being and broader social outcomes (e.g., stability and security); and what at community, local, national and international levels can be undertaken to lower household vulnerability to chronic and transient poverty.[5]

We are motivated by two seeming gaps in the current literature on climate change. One, there is a lack of attention to how risks associated with climate change affect household assets, livelihoods, and well-being. Second, the literature that does discuss vulnerability to climate change lacks clarity on definitions of key terms (risk, vulnerability and adaptation) and relationships between risks associated with climate change, adaptation and vulnerability. These two factors limit the ability to effectively formulate adaptation strategies aimed at reducing household poverty and vulnerability.

Threats to household well-being stem from both direct risks (changes in the mean, variance, and other characteristics of climate variables) and indirect risks (increased prevalence of pests and

[3] The focus of this paper is human-centric. We focus on the relation between climate change and human well-being.
[4] See Ringius et. al., (1996) for an early exception to this focus.
[5] Throughout the paper we relate to households as our basic unit of analysis. We realize that there are intra-household differences based on gender, age, health status, etc., and that these factors are also important in the design, targeting, and implementation of interventions.

diseases; degradation of the natural resource base; changes to food prices and employment; displacement; potential conflicts over increasing resource scarcity) associated with climate change. However, problem identification and policy or project interventions tend to focus on direct risks and direct impacts at global, national, or sectoral levels with insufficient attention to indirect risks and to impacts on households. Consequently, little rigorous research exists to substantiate the (admittedly intuitive) claim that the poor and excluded households are the most exposed and/or the most vulnerable to risks associated with climate changes. All of this leads us to propose a conceptual framework (with definitions consistent with those of the International Panel on Climate Change (IPCC)), policy agenda, and research directions to help address household vulnerability resulting from risks associated with climate changes.

We assert that risks associated with climate changes could increase household vulnerability to poverty, hunger, disease, mortality, displacement, and violent conflict in many developing countries. Many of these risks are complex and indirectly related to climate. If not appropriately managed, some of these risks can have potentially irreversible consequences at a scale that could threaten social stability and have international repercussions. As such, we propose and apply a social risk management analytical framework with the explicit goal to *increase the capacity of society to manage climate risks with a view to reduce the vulnerability of households and maintain or increase the opportunities for development.* We apply the framework to identify how adaptation interventions at local, national, and international levels can help households reduce vulnerability. We also point out how proactive "no-regrets" social protection policy interventions can contribute to adaptation strategies that are also growth-oriented. We close by proposing a research agenda to inform adaptation policy.

Instead of preaching a doomsday approach to climate change, we believe that serious—even catastrophic and irreversible—damage to natural systems associated with climate change need not result in catastrophic and irreversible damage to humans. In contrast, catastrophic and irreversible damage to humans (people and countries) can result even from modest changes in natural systems. It all depends on the effectiveness of societies' adaptive capacity, which is shaped by policies and institutions.

The major contributions of the paper are that we (a) summarize what little is known about expected economic and social impacts on households from the risks associated with climate change, and characterize the risks in a novel manner; (b) offer a unifying conceptual framework to rigorously examine the links between risks, adaptation, and vulnerability. The conceptual framework highlights the importance of the interface between household assets and livelihoods, and policies and institutions for adaptation; (c) apply this framework to help formulate equitable adaptation strategies, highlighting the need for risk management interventions at the community, local, national and international levels; and (d) identify some research gaps. Before continuing, we highlight the proposed goal of public interventions for adaptation to climate change that guide this paper:

> *Increase the capacity of society (households, firms, communities, NGOs, local and national government, and the international community) to manage climate risks with a view to reduce the vulnerability of households and maintain or increase the opportunities for development.*

Apart from this introduction, the paper has three main sections. The next section summarizes the risks associated with climate change and their possible socio-economic impacts. The following section presents and applies the social risk management (SRM) and asset-based approach to the risks associated with climate change and discusses implications for adaptation policy. The final section outlines a socioeconomic research agenda and presents concluding remarks.

A. RISKS AND IMPACTS ASSOCIATED WITH CLIMATE CHANGE

This section summarizes some of the main risks associated with climate change and discusses their possible socio-economic impacts. We assert that risks associated with climate change can adversely affect humans through a variety of direct and indirect pathways – changes in mean and variance of rainfall and temperature, extreme weather events, food and agriculture production and prices, water availability and access, nutrition and health status – and could trigger potentially dramatic increases in chronic poverty, vulnerability, hunger, disease, mortality, displacement, and violent conflict in many developing countries unless the risk management capacity of households, communities, and nations is strengthened.

1. A Changing Climate

The earth's climate is changing and is projected to continue to change under a variety of emissions scenarios. It is projected that average temperatures will continue to increase, rainfall patterns will change, and as a result sea levels will rise. Extreme weather events (hurricanes, storms, flooding, drought, heat waves) are likely to become more common (i.e., increased frequency), more widespread spatially, and of increased severity. Melting glaciers will increase flood risk during the wet season and reduce dry season water supply. Ocean acidification will have major effects on marine ecosystems and fish stocks could dwindle. Crop and livestock production patterns and productivity will be impacted by changing climate and expected changes in pests and diseases. Human mortality and morbidity from malnutrition, heat stress, and vector borne diseases are expected to increase. As ecosystems change a growing number of plant and animal species will probably face extinction, and some eco-systems might disappear or radically transform.

Climate models clearly suggest that the warming trend will continue and that the world could become 2-6 degree centigrade warmer over the coming century. This warming will place significant stress on water resources. Droughts could become more common in some parts of the world, although the climate models have difficulty predicting the magnitude and direction of regional changes,. In Africa, for example, we know that the climate is warmer than it was 100 years ago, but future predictions are difficult to make with some degree of certainty (Hulme et al, 2001). Many uncertainties remain and pose clear challenges to planning for adaptation—what will happen to present cropping patterns and farming systems? To settlement patterns? How much of Bangladesh will become uninhabitable, and when, due to rising sea levels and more frequent storms? When will glacier melting result in major cities in the Andes and in South Asia losing their drinking water supply?

While the early climate modeling efforts focused on predicting global climate changes, there is increasing emphasis on trying to improve predictions of climate change at regional, national, or sub-national levels, although many uncertainties remain. Better disaggregated predictions of climate change are needed to support locally differentiated adaptation efforts. Most importantly, we do not have a good sense of how these changes in climate and associated risks will impact on poor and vulnerable households, and when.

2. Economic and Social Impacts of Climate Change

Ongoing climate changes are predicted to accelerate during this century and, one can assume, so will the corresponding economic and social impacts. The problem is: we know very little about

these potential economic and social impacts in terms of local conditions and household-specific characteristics. The natural sciences have studied climate change for many years using long-term monitoring and complex geo-physical modeling, resulting in a rapidly deepening knowledge base on changes to climate and natural systems.[6] Contrast this with our limited understanding of likely impacts of climate change on social and economic systems and on adaptive responses by people, communities, and societies. Knowledge gaps abound, particularly for the developing world. Although there is limited information on future risks and impacts associated with climate change, there is increasing information on current practices to deal with climatic risks and changing climate: livelihood strategies, formal and informal credit, savings, insurance, and transfers, and social networks. There is concern, however, that many of these existing practices will be less effective under predicted scenarios of climate change (Burton and van Alst, 2004).

Attempts at quantifying the risks and their potential economic and social impacts are relatively few and often at high levels of aggregation. Examples include the Global Impact Models which consist of individual modules for different climate variables, sectoral features, and climate response functions for each sector.[7] These models use climate simulations to project country-specific market impacts, given the characteristics of the affected economic sectors and a response function for each sector. Results show that the 2°C global-mean warming projected for 2060 will result in net market benefits for most OECD countries and net market damages for most non-OECD countries. There has been limited attention to disaggregating the overall effects of climate change and consider economic and social impacts at the household level and how to manage those (World Bank, 2007). Little is known, therefore, with any degree of precision about disaggregated consequences within different countries, and between and within sectors, communities, households, or particular groups (women, children, elderly, disabled), and over time. Despite the uncertainty about how climate change will unfold, there is quite a lot of certainty about its inevitability. This is a cause for immediate concern. Below we highlight some evidence on the nature and expected impacts of different risks associated with climate change (e.g., changes in rainfall and temperature) on extreme weather risks, water related risks, agriculture and food prices, health, risks of displacement and conflict, and risk interactions**.**[8]

Extreme Weather Risks

Extreme weather events such as droughts, floods, storms and hurricanes, and spells of extremely high or low temperatures are becoming more frequent and more severe. Current observations indicate increased occurrence of such events[9], and model predictions suggest that this trend will continue. Famines, as pointed out by Amartya Sen (1981), are really man-made disasters that are the result of climatic risks (e.g., prolonged periods of low rainfall and high temperatures) and human failures to respond to resulting declines in food production and increased malnutrition. Humanitarian disasters caused by weather related shocks are therefore likely to increase in number and severity. For example, severe heat waves in North America and Europe have in recent summers killed thousands of people, many of them elderly citizens. Some European and North-American countries and cities have responded by improving weather advisories or early warning systems and enacting disaster preparedness and response plans, resulting in reduced mortality.

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[6] See, for example, the various IPCC reports.

7 See for example Tol (2002); Mendelsohn et al (1998); and Stern (2006) Chapter 6.

8 The selection of these risks is not intended to deny the importance of other risks and impacts (say, on gender relations or social capital) some of which we may not even be aware of yet.

[9] Models generally support the notion of increased variance of weather due to man-made or anthropogenic factors (i.e., the greenhouse effect). In contrast, it can be difficult to determine if any particular weather event is caused by global climate change.

Natural disasters are not just humanitarian disasters: they are a challenge to development.[10] Again and again, disasters wipe out the gains from development, destroying lives, assets and infrastructure (IEG, 2006). Extreme weather events are an example of covariate shocks (that is, they simultaneously affect entire communities and nations). Household's coping capacity is often thought to be lower for covariate than for idiosyncratic (affecting individual households) shocks because of reduced scope for community risk pooling when everybody in a locality are hit by the same shock. Households in low-income countries face high vulnerability to natural calamities and in fact, a major reason for high and persistent poverty lies in repeated severe shocks (both idiosyncratic and covariate) against which households and communities have little protection.[11] Studies of past shocks in developing countries have demonstrated that shocks often trigger substantial and sometimes irreversible losses in consumption and asset holdings.[12] Households enter into a variety of traditional and informal arrangements for managing these risks and spend both real and opportunity costs to this effect. However, although these informal risk management arrangements offer some protection the consensus is that they are at best partially successful at shielding households from risk. The ensuing volatility in consumption and assets has important adverse consequences for household well-being. Short run impacts include reductions in the quality and quantity of food, health, and nutrition; long-run impacts include destitution, landlessness, loss of productive assets, irreversible malnutrition, child labor, termination of schooling, and a host of other adverse social consequences. Recovery from shocks is often slow and incomplete, particular for the poor. Therefore, the increase in disaster risks associated with climate change will adversely—and potentially irreversibly—affect growth, well-being, inequality, and vulnerability, unless risk management is improved markedly. Both the current poor and the current non-poor will be affected.

Water Related Risks

Arguably, some of the most serious consequences of climate change could be transmitted through water systems, which are critical for the survival of natural and human systems. Increasing temperatures will have profound effects on the hydrologic cycle with more evapo-transpiration and precipitation and changes in soil moisture.[13] Pressures on water resources will increase most rapidly in Africa and parts of South Asia and Eastern Europe, compounded by saltwater intrusion and loss of groundwater in most parts of the world. Water supplies for drinking, sanitation, and irrigation will be adversely affected.[14] Changes in water availability, quality, and access are multi-dimensional and multisectoral; there are critical policy and institutional dimensions to water rights and water distribution. Proactive actions are needed to make sure that poorer and more marginalized households are protected. There is a need for more attention to intra-household dynamics, as women and children often shoulder the major burden of fetching water,

[10] The ProVention Consortium was formed in 2000 in recognition of the relationship between natural disasters, disaster management and development. See Annex 3.

[11] This is not to say that covariate shocks dominate the risk profile. Several studies have found that idiosyncratic shocks account for a large share of all shocks and a disproportionate share of the total increase in poverty due to shocks (Heltberg and Lund, forthcoming; Alderman 2007).

[12] Alderman (2007) and Dercon et al (2004) review the evidence.

[13] The additional precipitation is expected to be unequally distributed around the globe. Some parts of the world may see significant reductions in precipitation, or major alterations in the timing of wet and dry seasons (IPCC, 2001). Many wet areas are expected to become wetter, while some dry areas could become drier. Water resources stress due to climate change is likely to increase in southern and northern Africa, in the Mediterranean and in the Middle East, South Asia, Central America, and large parts of Europe

[14] Among other things, the loss of groundwater will hamper efforts to expand irrigation, which otherwise would be critical to mitigate the decline in agricultural productivity associated with climate change. See for example Arnell (1999) and (Ranjan, Kazama, and Sawamoto, 2006).

and children, elderly and disabled households members are more sensitive to water-borne pathogens. Droughts and floods will become more severe and could lead to the displacement of hundreds of million of people by the middle of the century (Stern, 2006). Furthermore, growing water scarcities could trigger conflicts.

Risks to Agriculture and Food

Some progress has been made in estimating the impacts of climate change on agricultural output and productivity, but less attention has been paid to the predicted economic and social impacts. This is striking considering the fact that some of the largest negative impacts to agricultural production and productivity are expected in regions where the poor derive a large share of their income from agriculture and many (rural and urban) households are vulnerable to food insecurity and hunger.

By late this century, the aggregate global effects on agricultural productivity are expected to be negative, and developing countries are expected to suffer sooner and worse. Cline (2007) applies agricultural impact models, combined with climate model projections, to develop estimates for agricultural impacts in more than 100 countries. Agricultural productivity for the entire world may decline from levels otherwise reached by between 3 and 16 percent by the 2080s. Developing countries, however, many of which have average temperatures that are already near or above crop tolerance levels, are predicted to experience an average 10 to 25 percent decline in agricultural productivity by the 2080s. Since agriculture constitutes a larger fraction of GDP in developing countries than in industrial countries, the projected decrease in productivity will impose larger relative income losses, with important micro-, meso- and macro-economic implications. Some developing countries face very large declines in productivity: India could see a drop of 30 to 40 percent in agricultural production potential; Sudan 56 percent reduction; Senegal 52 percent. The impact is projected to be the worst in Africa.[15] However, less attention has been paid to the poverty and social impacts of this expected agricultural decline. This is especially important in Africa where there are many smallholders, many of whom are actually semi-subsistence net consumers of food.

The expected decline in agricultural productivity will adversely impact the poor, as producers and consumers via reduced food production and higher food prices. Just as agricultural productivity gains have always been closely linked to poverty reduction, the decline in tropical and subtropical agriculture that will result from climate change can be expected to increase the depth and severity of poverty.[16] This potential income loss can trigger increased vulnerability to poverty and hunger for many households, with particularly negative impacts for women, children, elderly, disabled.[17] Although shortfalls in national grain production can possibly be met through imports (albeit depending on world market prices and availability of finance)[18], losses in real income of

15 Autonomous adaptation by farmers can be expected in the form of crop switching (i.e., crop diversification), and this is largely incorporated in the estimates above.

16 As the World Development Report 2008 (World Bank, 2007) points out (based on Ligon and Sadoulet, 2007), agricultural GDP growth disproportionately benefits the poor: a one percent increase in GDP due to agriculture results in a more than six percent increase in expenditure growth for the poorest decile, and has a significantly disproportionate effect on expenditure growth for all but the top two deciles.

17 Some model estimates suggest the additional number of people at risk of hunger due to climate changes to be about 80 million. Most (about 60 million new people at risk) of this expected increase in hunger is in Africa (Parry et al., 1999). Models also show that the larger the climate change, more people will be at risk of hunger (as well as mortality and other adverse effects). And for any increase in mean temperature, the number of people at risk grows over time because of population growth (Parry et al., 2001).

18 Price effects could further work against poor grain importing countries. Winters et al. (1996) constructed general equilibrium models of the impacts of global warming on a “representative” cereal importing nation,

agricultural laborers and other net food consumers (often among the poorest to start with) are harder to compensate unless adequate social safety nets are in place. Destitution, malnutrition, and a cycle of increased poverty and vulnerability could result. Box 2 illustrates these direct and indirect risks and impacts for different categories of households (net sellers and net buyers), making the point that interventions focused on crop yields might help some households adapt, but not others. Moreover, all of this would be further compounded by potential spread of vector-borne diseases, resulting in potential significant worsening of the health, nutrition, and food security situation in large parts of Africa.

Box 2: Food price risks and the exposure and sensitivity of different categories of households

Different types of rural and urban households will be affected very differently by possible changes in agricultural productivity (and crop selection) associated with climate change. The examples below illustrate the complex web of direct and indirect risks and impacts related to climate change and the limits of a sectoral focus on direct risks and impacts. Policies and investments focusing on declining crop yields of present crops might help some households adapt, but not others. Instead, adaptation strategies must focus on the broader goal of food security and include social protection and food trade interventions.

- Larger and more commercially oriented farmers growing a staple crop such as maize might have more land and cash exposed to declines in rainfall and increases in temperature, but they are less sensitive to climatic risks because they have better soils with higher water-holding capacity, are located closer to markets, and have better access to irrigation, extension services, and improved varieties. Furthermore, declining yields might result in increases in maize market prices that can help counter the negative impact of lower yields.
- Smaller poorly educated farmers (often women) who primarily produce for home consumption on lower quality lands farther away from markets will face similar risks and because of their exposure and sensitivity, experience yield losses that affect household consumption and nutritional status. Higher food prices for such households that are often net consumers of food staples could have a negative impact on household purchasing power and consumption. In addition, water and sanitation conditions might suffer, all contributing to declining nutritional status and increased exposure and sensitivity to health risks. Lacking access to markets, information, extension services, and insurance, their adaptive capacity could be very limited.
- Farm laborers are dependent on the production of large and small farmers for employment, and for purchase of their staple foods. Not only would their incomes decline from less demand for farm labor as yields decline, but their expenditures on food staples would rise, resulting in a double-negative impact on their well-being, and probable erosion of their asset base. Pressures on water, sanitation, health and nutrition could also be exacerbated. Members of this group could be the first to migrate elsewhere.
- Urban poor households would see their food bills rising, with uncertain impacts on the demand for their labor. Possible food price-led inflation combined with a surge in influx of migrants from rural areas seeking employment could depress job markets and real wages. The urban poor, with limited human assets, would need to depend on their political assets (and threats to social stability) to try and improve their adaptive capacity.
- Food processors would also be impacted by lower supplies and higher prices for foods that they use as inputs. However, food processors might be able to access international commodity markets and/or substitute different ingredients in their products and possibly pass off the increases in costs to consumers. On the other hand, angry poor households might threaten the food processors or lobby governments to impose price controls.

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concluding that these countries will suffer income losses. In their model, Africa would be worst hit and suffer the largest loss of income and consumption of low-income households, largely because of its high share of agriculture in GDP and low elasticity of supply in response to the expected future price increases in cereals.

Health Risks

Much of poverty and vulnerability in low income countries is rooted in health risks and could be aggravated by climate change. There is mounting evidence that health shocks—disease, injury, disability, death of a breadwinner—constitute a major source of poverty and vulnerability as households lack options fro managing these shocks. There is evidence from several countries, including India and Indonesia, that health shocks often dominate and impose severe coping costs in terms of medical expenses and loss of earnings that are not easily insurable (Kochar, 1995; Gertler and Gruber 2002; Gertler, Levine, and Moretti, 2006). In fact, by one estimate more than half of all households falling into poverty are due to health shocks (Alderman, 2007). In one study from Pakistan, health shocks constituted more than fifty percent of all shocks experienced by a sample of poor households and often resulted in food shortage, children withdrawn from school or put to paid work, or bonded labor; only few reported full recovery (Heltberg and Lund, forthcoming).[19] There is some evidence that children and women might bear the brunt of impacts because of their higher exposure and sensitivity to health risks and their lower adaptive capacity. Some damages, especially those affecting children, can be irreversible both in obvious ways (e.g., permanent loss of human assets via stunting or other systemic health impacts) and less obvious ways (e.g., attitudes and perceptions toward the future).

It is therefore a concern that climate changes are expected to magnify a number of health risks, particularly in tropical areas. In its Third Assessment Report the Intergovernmental Panel on Climate Change (IPCC, 2001) concluded that: "Overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries". Climate changes will impact human health negatively through heat stress (with reduced mortality from cold spells in the Northern hemisphere); increase in diarrhea due to food and water-borne disease; extension of the range of vector-borne diseases such as malaria and dengue; fatalities and injuries from natural disasters; and increased malnutrition resulting directly from declining yields and/or indirectly through increasing food prices or lower demand for agricultural labor. There are many uncertainties, and the impacts will be unevenly distributed around the world. Developing country populations, particularly in small islands, arid and high mountain zones, and in densely populated coastal areas, are considered to be particularly at risk. The increase in numbers at risk is very hard to estimate as climate interacts with other ecological factors, health care, socioeconomic development, and adaptive responses. Much of this health risk is avoidable through public health and nutrition programs, and programs to improve access to clean water and improved sanitation. Actions to strengthen key features of health (and allied) systems and to anticipate these risks can enhance public health now as well as reduce vulnerability to future climate change (Campbell-Lendrum and Woodruff, 2007).

Risks of Displacement and Conflict

Rising sea levels, more frequent flooding, and droughts could displace millions of people by the middle of the century.[20] Moreover, if the predictions of sharply declining productivity of agriculture, fisheries, and forestry come true, households will to an increasing extent choose to abandon rural areas in search of alternative livelihoods in less-affected regions (often urban) and sectors (services and manufacturing). It is expected that migration will be the adaptation strategy for many households. Migration can be voluntary or forced, and domestic or international. Clearly there are many push and pull factors that influence migration decisions, and many risks

[19] The evidence therefore suggests that idiosyncratic shocks are not as easily managed through community risk sharing arrangements as theory had predicted.

[20] Stern (2006) cites a figure of some 150-200 million people displaced, mostly from South and East Asia, the coastline of Africa, and small islands.

associated with climate change, so it will be difficult to attribute migration flows directly in response to climate change (except under extreme circumstances). On the other hand, it is expected that many existing migration corridors are likely to experience increased migratory flows, for example rural to urban areas; interior Sahel to coastal West Africa; or Pacific islands to Australia; and from Latin and South America northwards. But climate changes will also reshape migration patterns as some of today's destination areas (e.g., low-lying coastal areas) lose productivity or become unfit for settlement and are rendered sources of out-migration. There have been significant domestic and international migration flows in recent decades in response to climatic and economic and social factors, and these could be expected to expand and accelerate.

Conflict risk could also result, especially if large-scale population movements take place in response to climate change. As vast populations crowd into already congested urban areas, unemployment, crime, and violence would rise. And competition over those resources that are less directly impacted by climate change could greatly increase, resulting in violent conflicts (Box 3). Interventions to prevent some of these risks would include strengthening the asset base of rural livelihoods; arrangements for orderly migration; and institutions for conflict resolution.

Box 3: Conflict over Resource Scarcity in West Africa

A Nigerian study describes how migration in the West-African Sahel spurred by vulnerability to drought triggers conflict (Nyong, 2006). There is pronounced vulnerability to drought in West Africa's dry zone, and over the last century droughts have increased in magnitude and intensity while inter-annual and spatial variability has increased. As a consequence, pastoralists from the dry Northern zones are moving south into lands occupied by sedentary farmers. Conflicts result. Livestock and farmland is often destroyed in these conflicts, with adverse consequences for food and human security. Traditional institutions for managing conflicts, including climate-related conflicts, exist but have failed to prevent the escalation of pastoralist-farmer clashes. Formal mechanisms for settling disputes (police, courts) have also been tried but met with limited success. In contrast, NGO-supported efforts to mediate the conflict using consultative approaches and support for fodder production to alleviate the resource shortfall have had more success, at least locally. The study emphasizes the need for resolution strategies and capacity building for exposed communities.

Risk Interactions

Interactions between many of the climate change-related risks will result in increased human vulnerability over and above what would result from any of the individual risks. Many of the climate risk factors described above are mutually reinforcing: climate changes could also worsen pest and disease patterns, and threaten nutrition, health and food security, and generate a cycle of risks. These risks interact as poor health and nutritional status render some individuals, especially, infants and children more susceptible to disease. The same is true for increased sensitivity of crops and livestock to pests and diseases in marginal agro-ecological areas experiencing additional stress relation to changing rainfall and temperature patterns.. There are also important nexuses between the human health and protection of ecosystem services, as well as between human health and potable water and cleaner energy and transport solutions. Furthermore, risks to water supply and food production interact, along with risks associated with potable water quality and sanitation (see Box 4). While expansion of irrigation could be an important response by agriculturalists to increases in temperatures, water scarcities associated with higher temperatures can hamper efforts to expand irrigation and/or its effectiveness as evapo-transpiration increases. Thus, one can consider numerous examples where multiple risks associated with climate change interact with negative impacts on household assets, livelihoods, and well-being (i.e. the ability to provide minimal levels of food, health and nutrition, and water).

Box 4: Example of Risk Interactions Related to Water

Current variations in climate already cause major problems for many households and communities, resulting in lack of access to water for household consumption and irrigation. In several many areas water scarcity and related problems have been worsening because of population growth and increased use of water for irrigating agricultural crops. New problems have also arisen including pollution from chemicals associated with intensive crop production. Due to climate change, there is increased attention to the risks associated with agricultural intensification and water scarcity, and other risks associated with health and nutrition and environmental quality. That is, there is increasing appreciation of the inter-relationships between the different risks. Moreover, in many regions there is no sound policy and institutional foundation for dealing with current climate variability. In such cases, adapting to climate change will be even more complex.

Source: Hedger, M. (2008) "Climate Change Adaptation and Access to Water" News at IDS, February 11.

3. Household Vulnerability to Risks Associated with Climate Change

Summing up, ongoing climate changes will lead to increases in several risks related to, inter alia, agriculture and other natural resource intensive sectors; food prices; health and nutrition status; water availability and access; displacement and conflict. Many of these risks presently cause household vulnerability and account for much of observed poverty and malnutrition. Studies that attempt to separate total poverty into transient and chronic poverty typically find transient poverty to be the largest component; transient poverty is caused by temporary shortfalls in income and consumption induced by a shock of some sort. Climate change can exacerbate chronic poverty by lowering expected returns to assets and increase transient poverty because of declining expected returns to assets and/or increased variance in returns. Unless risk management is improved, climate change driven acceleration of these risks will increase household vulnerability and could erode development gains.

The most vulnerable households will be those with assets and livelihoods exposed and sensitive to climatic risks and who have weak risk management capacity. This means that smallholders and households engaged in fishing, hunting and gathering, and livestock rearing will be particularly impacted. Within households, impacts are likely to be felt disproportionately by particularly vulnerable individuals such as children, women, elderly, and disabled. The consequence of all of the above for households in many developing countries is therefore that global climate changes will translate into potentially:

- Lower mean returns to assets and livelihoods and lower expected levels of well-being;
- More variability in returns to assets and livelihoods with more frequent fluctuations and more severe shortfalls in well-being when affected by shocks; and, as a consequence:
- More difficulty maintaining and rebuilding assets and livelihoods after shocks.
- Negative impacts on household well-being in terms of increased perception of insecurity and concerns about the future.

Depending on what steps are taken to improve risk management, the above could result in:

- Increase in the rate and depth of chronic poverty;
- Increase in transient poverty;
- Increase in vulnerability to transient and chronic poverty;
- Increasing allocation of assets to low-risk low-return livelihoods;

- Increase in poverty and deprivation of future generations, since the cycle of risk and degradation of human, natural, and physical assets perpetuates poverty across generations.

As already mentioned, these stylized impacts are transmitted through households' risk management capacity, as reflected in their asset and livelihood strategies. The poorer households are the most at-risk because their assets and livelihoods tend to be highly exposed and/or sensitive to the direct and indirect risks associated with climate change and because they lack access to formal and informal risk management arrangements. Thus, they are "forced" to select livelihood strategies that focus on short-term adaptation and survival, but might have negative longer term implications. However, the non-poor are also exposed to risks associated with climate change and could also be rendered vulnerable.

There are both equity and efficiency arguments for interventions to better manage risks and help households stabilize consumption.[21] There is growing evidence of how the presence of uninsured risk prompts households to engage in low-risk low-return activities and holding liquid instead of productive assets; this constrains the ability of the poor to grow their incomes and escape poverty.[22] Policies to help households stabilize consumption can therefore help growth and development. Such policies include deepening the local markets for labor, assets, credit, and insurance and improving access by the poor to those markets. It also includes improved public provision of social safety nets and social insurance.

[21] A study in Southern India found that in the presence of high risk, poor farmers reaped lower returns to their assets than did the better-off farmers, while the reverse was true in low-risk settings (Rosenzweig and Binswanger, 1993). See also Elbers, Gunning, and Kinsey (2007) and Dercon (2004) and the papers therein.

B. ADAPTATION TO CLIMATE RISK AS SOCIAL RISK MANAGEMENT

This section presents and applies the social risk management and asset-based approaches to the context of climate change. The social risk management (SRM) and asset-based approaches provide a conceptual framework for understanding the sequential links between risks; human exposure and sensitivity; the impacts of risky events; and risk management (or adaptation) strategies. This provides a unifying conceptual framework to examine the characteristics of the risks faced by households; how adaptation responses at multiple levels depend on livelihoods, policies, and institutions; and household vulnerability outcomes. We highlight the importance of a multidimensional and equitable approach to adaptation policy and the need to include higher level (national and international) risk management interventions. This includes social policy and social protection interventions to build resilience at the household level through improved human and physical capital and access to risk management instruments such as safety nets and insurance. Social protection policies are "no-regrets" and would be a useful complement to sectoral interventions such as infrastructure 'climate proofing' to help ensure equitable adaptation.

This section makes four important contributions. First, we apply the SRM and asset-based approaches in the context of climate change and show its complimentarity to IPCC definitions of vulnerability.. Second, we propose a categorization of the risks associated with climate change along dimensions (such as direct/indirect, frequency, covariate, irreversibility, deviation from historical range, slow onset, and risk interactions) that cut across the direct pathways of impact and that offer important insights for policy. Third, we use the conceptual approach to consider the scope for adaptation at various levels from the household to the global level. Fourth, we offer a preliminary discussion of the role of social policy (and especially social protection interventions) for adaptation to the risks associated with climate change.

The section starts by presenting the conceptual framework and clarifying the main concepts of risk, vulnerability, and livelihoods. We then apply the framework to the risks associated with climate change, showing how it helps focus on the special aspects of those risks and to widen the policy debate on adaptation to climate change. Based on the framework we next discuss the appropriate level for adaptation interventions. Finally, we consider the role of social policy and especially social protection for equitable adaptation, and sum it all up.

1. Conceptual framework

This section presents the social risk management (SRM) and asset-based approaches to consider human vulnerability to risks related to global climate change and clarifies important definitions. This analytical framework helps focus on the sequential links between climate risks, human vulnerability, and interventions to help manage vulnerability to climate change.[23] The framework is consistent with IPCC (2001) definitions of vulnerability and adaptation and highlights that:

[23] The framework underpins the World Bank's Social Protection Strategy (World Bank, 2001), which draws on the social risk management (SRM) framework presented by Holzmann and Jorgensen (1999). Following the SRM framework, Heitzmann, Canagarajah, Siegel (2002), and Siegel, Alwang and Jorgensen (2003) introduced the concept of a *risk chain* that conceptualizes the relationship between risks, risk management and vulnerability. Siegel and Alwang (1999) present a SRM and asset-based approach. Other examples of the asset-based approach include: Moser (1998); Moser and Norton (2001); de Janvry and Sadoulet (2001). The asset-based approach underlies the livelihoods approach (Carney and others 1999) which has increasingly been applied by the World Bank and USAID (Siegel, 2005; USAID, 2007).

1) All households and individuals[24] face risks associated with climate change, but not all are vulnerable. Vulnerability is a function of risks, exposure and sensitivity and adaptive capacity, and depends on the relationship between losses and some benchmark indicator of household well-being (e.g., a poverty line).
2) The exposure and sensitivity of household assets and livelihoods to climate change and their adaptive capacity are to a large extent shaped by policies and investments outside of their direct control.
3) Risks related to climate change can impact household assets, livelihoods and well-being directly and indirectly, so a multi-dimensional approach to risk management is required.
4) Ex-ante management of climate related risks, especially those that lower exposure and sensitivity of assets and livelihoods, can strengthen household assets and increase returns on assets, thereby contributing to improved livelihoods and well-being.
5) Climate risk management (or adaptation) has to be multidimensional and span interventions at household, community, national, and (increasingly) international level.
6) Institutions and good governance are keys to a multidimensional and multisectoral approach to improved adaptation to climate change.

Asset-Based Approach

According to the asset-based (and livelihood) approach, household well-being is directly linked to household assets and livelihood strategies, where household assets include natural human, physical, financial, physical, social, and political assets. Asset-based approaches recognize that household well-being is multi-dimensional and also includes economic indicators such as income and consumption, and other social indicators such as health and nutritional status, physical and social security, hopefulness for the future. Following Siegel (2005), we group household assets into *productive assets*: human, natural, physical, and financial; *social and political assets*; and *locational assets*. The division of household assets into productive, social/political and locational assets can help conceptualize exposure and sensitivity to risks, and potential for adaptation (see Siegel, 2005; Annex 1 contains an overview of assets).

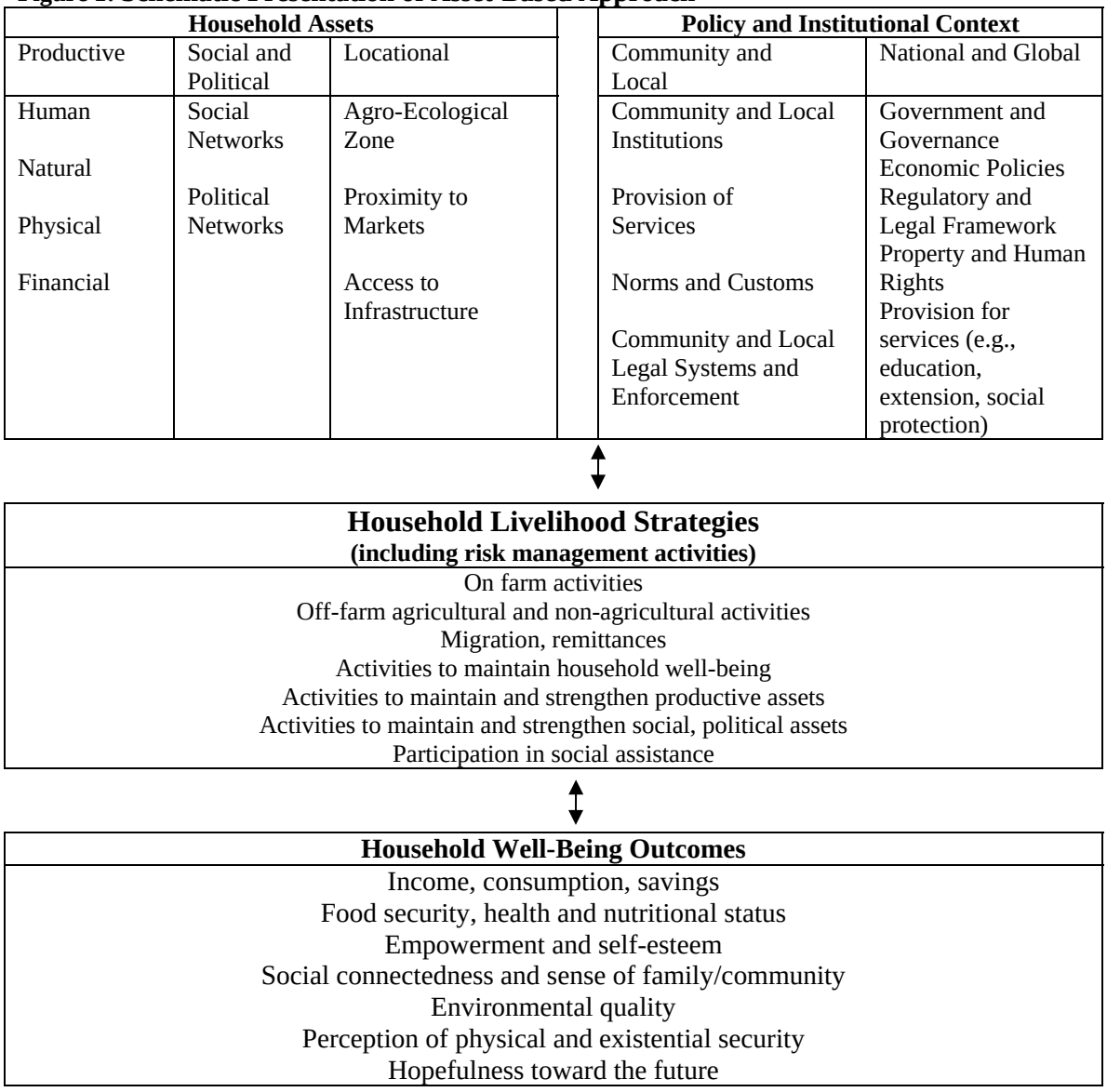
Household decisions to accumulate and allocate their assets—often called their livelihoods strategy—and returns to their *asset portfolio* (expected returns and variance of returns) are influenced by the external policy and institutional context, and by risks. Policies and institutions profoundly affect risks and risk management strategies (e.g., property rights, rules and regulations, investments in infrastructure, research and extension). Households can also draw upon the assets of their community (e.g., common natural resources, schools, health clinics, social safety nets); local and national governments (e.g., roads and communication infrastructure); private sector (e.g., financial and insurance markets); and international institutions (e.g., international research institutions).

Thus, household livelihoods and well-being depend on the interface between assets (broadly defined), the policy and institutional context, and risks (Figure 1). Risk affects the expected returns and variance of returns on assets and livelihood strategies, and therefore household well-being and future asset accumulation. Households are poor because they have limited quantity and quality of assets; and their assets have low expected returns and high variance of returns. The

[24] Through most of the paper we use the term "households" in order to focus on the human dimension, as opposed to communities, sectors, regions, or countries. We recognize that the focus should really be on individuals and that in many cases intra-household differences with respect to gender and age are important. Even when such age and gender differences are not explicitly spelled out, we hope readers will consider these differences when seeing the term "household". Moreover, impacts on communities are really aggregates of household-level impacts. See also the section on confusion over definitions of vulnerability.

combination and flexibility of assets also matters: Poor and vulnerable households tend to lack key assets and whatever assets they have are not mobile and of poor quality and location. Many poor rural households are also landless and depend on selling their labor, which is typically of low quality in terms of education, skills, and health and nutritional status. Furthermore, because of gender, class, or caste, some individuals and households can have limited access to markets and livelihood opportunities, including migration. This, in turn, limits labor productivity and returns to human assets.

Figure 1: Schematic Presentation of Asset-Based Approach



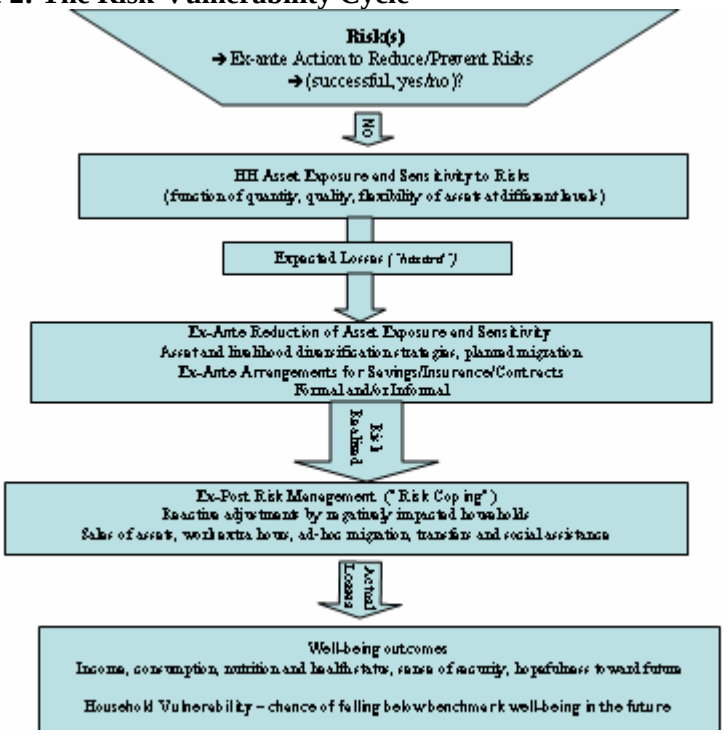
Low expected returns and the high variance of returns exacerbate the problems of poor households. In addition, at any given point in time, some households are vulnerable to risks, but not classified as poor; a significant number of households move in and out of poverty as a result of shocks. Households that are vulnerable to risks, but not currently poor, are not targeted by many anti-poverty programs. Poor households tend to accumulate and allocate their limited assets to lower-return, lower-risk livelihood strategies (i.e., ex-ante risk reduction or mitigation

strategies) as a means to generate a minimal level of well-being and to protect their limited asset portfolios for future periods. In response to the realization of different risks, asset-poor households often rely on coping strategies that degrade their assets and diminish their future livelihood options. As climate change related risks degrade or destroy the quality and quantity of assets or their returns, households will be forced to adopt new livelihoods. This will require new technologies, skills, finance, insurance, information about market opportunities, and will often involve migration. Both poor and vulnerable households will need assistance to adapt to risks associated to climate change.

SRM Risk-Vulnerability Cycle

The risk-vulnerability cycle is a schematic presentation of the relationship between risks, risk management arrangements, and household vulnerability. As illustrated in Figure 2, the causal chain consists of: (a) the risk, or uncertain event(s) and (b) the exposure and sensitivity to risk(s); (a) and (b) result in (c) expected losses/damages associated with the risk(s). Households' engage in a variety of (d) risk management strategies that are ex-ante (risk prevention, reduction, mitigation) or ex-post (coping) actions to manage risky events. Finally there is (e) the outcome in terms of actual losses of assets and shortfalls in well-being in terms of income/consumption, health/nutrition status, and feelings of security and hopefulness for the future.[25]

Figure 2: The Risk-Vulnerability Cycle



Risky Event. A risky event is something that can occur that potentially has a negative impact on household well-being. Risk is the chance of danger, damage, loss, injury, or any other negative or otherwise undesirable consequences for a household (or an individual or a community). Some climatic risks and climate change variables are independent, but in many cases they are linked, and their impacts are often inter-related. Moreover, risks associated with climate change interact

[25] In the disaster management literature the expected losses/damages are often referred to as the *hazard.* Also, in the disaster management literature, mitigation usually refers to prevention/reduction of the risk, whereas in SRM it refers to ex-ante actions to provide compensation for losses after a risk is realized.

with other risks stemming from, for example, markets or policy failures. Risk can be defined as imperfect knowledge where the probabilities are known; uncertainty is when these probabilities are not known. Many of the expected losses from climate change related risks are uncertain events for which there are no known probabilities, although subjective probabilities can be (and are being) generated by expert opinion.

Risks can be characterized by their: a) frequency (i.e., probability of occurrence), b) magnitude (low versus high impact), c) timing (slow versus rapid onset), d) duration (short versus long), e) geographic spread (idiosyncratic versus covariate), and f) reversibility (reversible versus irreversible). Catastrophic events are high impact and irreversible. As discussed in the next section, climate changes will alter the character of risks and their inter-relationships with implications for design of adaptation strategies.

Exposure and Sensitivity. Households' risk exposure and sensitivity is a function of a household's asset portfolio, asset allocation, and livelihood strategies (e.g., crop and livestock mix and varieties, diversification of farm and off-farm or non-farm activities). The policy and institutional context have a critical role in determining the risk exposure and sensitivity of households: assets, institutions, public infrastructure, financial markets, and many other factors outside the control of households shape their risk exposure and sensitivity.

Expected Losses. The expected losses (or damages or *hazard)* from a given risk are a function of the probability of a risky event actually occurring and household exposure to that risky event: what will happen to household well-being if the risk is realized? The expected losses denote the severity of potential negative impacts associated with a specific risk(s) before any ex- ante or ex-post risk management decisions are taken. However, it is important to judge the severity of an expected loss relative to the expected well-being indicator of the household: for example, does the expected loss cause risk of poverty, hunger, or homelessness?

Risk Management Strategies. Households and societies manage risks through multiple strategies. These strategies all have real and opportunity costs; the strategies are not mutually exclusive and in fact are often complementary. Risk management is normally separated into *ex-ante (*before a risky event occurs) and *ex-post* strategies (after the realization of an event). Risk management, if successful, results in *resilience*: ability to avoid the negative impacts of risky events and recover from them.[26] Annex 2 presents the SRM approach and its distinction between risk management strategies and approaches in more detail.

Ex-ante risk management includes:

- Prevention or risk reduction–actions taken to eliminate or reduce risky events from occurring (e.g., emissions reductions);
- Risk exposure and sensitivity reduction–given the existence of specific risks, these are actions to prevent or reduce household exposure to such risks (e.g. asset and livelihood diversification, improved health and nutrition, improved water and sanitation); and

[26] We define *resilience* as the ability to resist the potential negative impacts of risky events and the extent to which households can recover from negative impacts of risky events. We define resilience as the household's ability to maintain and/or increase their assets' value and potential to generate well-being and/or prevent the household from falling below the benchmark well-being indicators. Thus, a poor (and vulnerable) household can be resilient if it can maintain or improve its well-being in the face of climate change-related risks.

- Risk compensation arrangements (referred to as risk mitigation in the SRM literature[27])– actions that can be taken before realization of the risk to provide some compensation in the case of a risk-generated loss (e.g., formal insurance, holding of savings, social networks).

All of these ex-ante risk management strategies require real and opportunity costs before the risky event takes place. Yet there is no guarantee that the risk will take place and that the ex-ante actions will accomplish what they are supposed to do. Furthermore, when a risk event takes place, even with the best of ex-ante strategies, there is usually a need for some ex-post coping (e.g., insurance rarely compensates for all losses related to a give risky event, much less for multiple risks).

Ex-post risk management includes:

- Risk coping–actions taken to make up for losses after realization of a risky event. From household perspective, this is often an ad-hoc risk management strategy with negligible upfront costs, but with potential ex-post costs and damages to the household. These costs and damages are often not shared equally within households but are distributed in ways that reflect age, gender, and status (for example, poor households forced to sell off women's jewelry, withdraw boys or girls from school, or reduce food consumption of some members).

In this paper we focus on adaptation strategies, which include: a) risk exposure and sensitivity reduction, b) risk compensation arrangement, and c) risk coping.

Outcomes. Outcomes include households' well-being status ex-post once risky events are realized. Household well-being includes tangible and non-tangible indicators of well-being such as income/consumption levels, health/nutritional status, social connectedness, feelings of security/insecurity, hopefulness for the future. Benchmark or threshold measures of these form baselines for identifying household vulnerability. Household vulnerability is the forward-looking measure of household well-being relative to a given risk. Falling below the threshold would indicate a threat to the household's asset base and ability to achieve present and future well-being and survival.

We define human vulnerability to climate change in the following manner: *An individual or household is vulnerable to a risk (or risks) associated with climate change if it will result in a loss of well-being that pushes the individual or household below a benchmark or threshold level of well-being*. The degree of vulnerability to risk(s) depends on the characteristics of the risk(s); exposure and sensitivity to the risk(s); expected impacts and losses; and risk management capacity. The outcome of vulnerability is defined with respect to a benchmark norm of household well-being, such as a poverty line or health and nutritional status.[28] We focus on the vulnerability of humans, as opposed to the vulnerability of countries, places, or sectors. Falling below the benchmark indicates threat to human well-being. This definition of vulnerability is well-suited to address climate change because it is dynamic and forward looking, and because it considers households presently below benchmark indicators (e.g., households currently below the poverty line) and households that might fall below the benchmark in the future.

[27] Note the discrepancy between the terminology used in the risk management literature and in the global climate change literature. The climate change literature has established the term mitigation to mean emissions reductions in order to reduce the global warming associated with the greenhouse effect; this would be termed risk prevention in the SRM literature.

[28] This definition of vulnerability is based on: Prichett, Suryahadi, and Sumarto (2000); Alwang, Siegel, Jorgensen (2001); Heitzmann, Canagarajah, Siegel (2002), Siegel, Alwang, Jorgensen (2003); Cafiero and Vakis (2006); Lovendal and Knowles (2006).

Box 5: **Confusion over Definitions of Risk, Vulnerability and Adaptation**

There is an ongoing debate in the literature about definitions of risk, vulnerability and adaptation. Researchers and practitioners in different disciplines use the terms "risk", "vulnerability" and "adaptation" in different ways (see Alwang, Siegel, Jorgensen, 2001; Fussel, 2002; Siegel, Alwang, Jorgensen 2003; Adger, 2006). This causes confusion with adverse implications for adaptation research and policy (Fussel and Klein, 2006; Fussel, 2007). Sorting out the differences in semantics is important for identifying causal relationships between climate change related) risks and human vulnerability, and for designing interventions to help households manage climate change related risks and vulnerability. This paper tries to present a coherent approach and argues for a movement toward a unifying terminology to (climate) risk management across disciplines.

Our definition of vulnerability is focused on individuals and households. In contrast, some of the (model-based) climate change literature talks about "vulnerable countries", "vulnerable regions" or "vulnerable sectors". Meanwhile, some of the socially-oriented literature on climate change claims that the resulting risks and negative impacts will disproportionately fall upon specific "vulnerable groups": women, children, elderly, persons with disabilities, and tribal/ethnic/caste groups living in marginal and fragile environments. Sometimes even broader "vulnerable groups" are identified, such as the rural poor or the urban poor, or even "vulnerable communities." While we do not deny that special groups may require special consideration, we believe that households (and individuals within households) are the decision-making unit that is most germane to adaptation to climate change; and, after all, any group is made up of individuals that reside in households. In this paper we therefore present and apply a definition of vulnerability that is individual and household and context specific (in terms of policies and institutions and other local conditions). Consistent herewith, we also present a conceptual framework that links risks to adaptation and outcomes for individuals and households.[29]

2. Applying the SRM Framework to Climate Change

This section considers adaptation to climate change through an SRM lens. This lens allows us to offer a systematic way to characterize the risks associated with climate change and to consider broad implications for policy.

A Characterization of Risks Associated With Climate Change and Implications for Policy

The SRM framework can help examine the characteristics of risks and draw implications about possible impacts on households, and possible interventions that could reduce the negative impacts. In this section, we explore an alternative way to categorize the risks associated with climate change that differs from the pathways (agriculture, water, health, etc discussed in Section A). We also draw some tentative policy implications of these risk characteristics. The main idea is that while climate has always been risky, ongoing climate changes are changing the characteristics of climate risks and interactions with other risks. Pertinent characteristics include:

Direct and indirect risks. The direct impacts of changing climate will bring about a range of indirect risks. For example, impacts on the production patterns in agriculture and other natural resource sectors will have consequences for rural incomes, food prices, labor demand, health and nutrition, access to drinking water, deforestation and soil erosion, and settlement and migration. These indirect risks are hard to predict but could have wide-ranging economic,

[29] Related to this, measurement of vulnerability typically focuses on households. This is not to deny the importance of intra-household differences, but because most household surveys capture these differences so poorly. See also Davies et al (2007).

social, environmental and political impacts which could surpass the impacts of direct climate risks.

Higher frequency. Climate change will likely increase the frequency of climatic fluctuations, including extreme weather events. There will also be a higher frequency of less extreme climatic risks (e.g., dry spells) and the cumulative effect of these changes could actually results in more extreme risks and impacts of the same risk in the future (e.g., repeated dry-spells causes decreases in soil moisture and greater sensitivity to drought from minor rainfall shortages and/or natural disasters from droughts.

Covariate risks. Climate change will especially exacerbate covariate risks, both direct (disaster; yield declines over large areas) and indirect (vector-borne epidemics; price and employment effects at regional, national, or even international levels). Idiosyncratic risk (illness) could also increase and will need attention, but a particular aspect of climate change related risk is its more pervasive geographic spread, which will make local more difficult.

Uncertainty about risks. There is a great deal of uncertainty about when, where, and how much the predicted climate changes will be manifested. There is even uncertainty about the nature of some of the threats. Climate changes could result in catastrophic disasters, or it could bring about entirely unexpected changes that scientists have not yet begun to consider. Few, if any, problems confronted by social scientists and policy makers have such complex long term implications and are marked by so much uncertainty. Fear and insecurity stemming from uncertainty about potential catastrophic impacts, is another adverse social consequence of climate change.

Irreversibility. Several risks associated with climate change will entail irreversible damages to life and human, physical, social/cultural, natural, and political assets. In the absence of successful adaptation, climate change risks will result in degradation of household assets and decreased livelihood opportunities, thereby increasing the vulnerability of some households to poverty, hunger, sickness and mortality. When these shocks intensify in frequency and magnitude, households will increasingly find it hard or impossible to recover; inter-generational poverty links will become more pronounced. Irreversible damages to human assets, like taking children out of school and denying future opportunities are no less important than irreversible damages to natural and physical assets. There will also be irreversible destruction of habitats and species extinction which affects human well-being through material and intrinsic values.

Deviation from historical range. Historical information on climate variables is critical for adaptation decisions across informal and formal risk management instruments. Climate changes will cause some climatic risks to deviate, in an uncertain and unpredictable manner, from their known historical trends and ranges. Historical time-series climate data will therefore provide inadequate guidance to forecasting climate variables, with implications for how adaptation decisions are made. Traditional informal approaches to decision making in risky climatic environments used by farmers, pastoralists, fishermen, and forest dwellers and perfected over lifetimes of localized weather experience will increasingly lose value. But it will also challenge formal approaches. Insurance actuaries, for example, will find it much harder or impossible to calculate insurance premia, which are usually based on time series.

Slow onset. Although the climate is already changing in measurable ways, much more change is expected to come. Thus, we are dealing, to a large extent, with a future problem. The

upside of this is that some time is available to devise solutions; the downside is the difficulty of getting the attention of policymakers.

Risk interactions. Many of the direct and indirect risks associated with climate change are expected to interact in a manner that will potentially result in worsening of vulnerability over and above what would result from the individual risks. Risks therefore need to be considered in integrated fashion rather than individually or sector by sector.

Implications for Interventions of these Risk Characteristics

What implications can be derived from the risk patterns described above for interventions to reduce household vulnerability? We reiterate that vulnerability of households can be reduced by reducing the exposure and sensitivity of assets and livelihoods to climate risks, and by strengthening the adaptive capacity of households, communities, and governments.

Direct and indirect risks. Policy for adaptation to climate change will need to devote close attention to both direct and indirect risks and to directly and indirectly exposed sectors, regions, and households. This challenges us to look for solutions beyond the immediate risks and impacts and to strive for multisectoral development paths. To manage risk of malnutrition, for example, decision makers will need to consider both agricultural interventions (e.g., research and development in appropriate crops) and other interventions (e.g., social protection and international food trade). Monitoring systems are needed to help identify vulnerable households and inform adaptation strategies.

Higher frequency. More frequent, repetitive risky events will threaten to exhaust household, community, and national risk management options. For example, faced with more frequent destructive weather events, households will be forced to rebuild destroyed assets and livelihoods at shorter intervals. For poor households, communities and governments, this can be an almost impossible task, and will require risk management at higher levels, including internationally through for example development assistance, disaster risk insurance, and remittances.

Covariate risks. The relative increasing of covariate risks associated with climate change implies that localized risk management based on risk pooling or transfers can be expected to be inefficient and possibly collapse: informal household and community and even national strategies are likely to fall short. Instead, risk pooling or transfers over larger areas—nationally or internationally—using more formal public or market-based instruments will be required (also given the increase in extreme weather events). Examples of such instruments include formal insurance and re-insurance, public safety nets, international transfers, and orderly international migration. Some responses have to be of global nature: climate early-warning systems, research in new technologies, well-functioning international markets for food, cross-border migration, disaster assistance, and international finance and insurance are examples.

Uncertainty about the risks should not delay public or private action. In some areas (such as health, food security, or the threat of terrorism) the response to uncertainty is not inaction: governments need to respond in a timely and appropriate manner to minimize the risk of significant or catastrophic loss. The same should be our response to climate change risk.

Irreversibility. There is a priority to avoiding potentially irreversible and catastrophic losses to natural and human systems. Improved disaster preparedness and management, including better safety nets, prevent irreversible damages to human assets caused by climate change

related risks and to help households cope with and recover from disaster. Likewise, the economic and non-economic (existence) values of eco-systems and species dependent on them call for public (including global) conservation interventions.

Deviation from historical range. Availability of accurate and disaggregated climate predictions will have to form the basis for decision making in an unprecedented manner. This poses a challenge for the science community to accurately communicate climate predictions and their degree of uncertainty (Moss, 2007). Moreover, the ability of non-scientists—peasants, pastoralists, and policymakers not the least—to understand and act upon climate forecasts will increase in importance. Capacity building, information dissemination, and education will be required to help individuals make informed adaptation decisions. Furthermore, insurance will face limitations resulting in either higher risk premia on insurance policies (to compensate for uncertainty about risks and impacts) or the withdrawal of insurance firms from underwriting certain types of risk(s). This will constrain the ability to manage risks through market-based insurance instruments paid for by households and firms. Innovative public interventions may be needed to overcome this (e.g., subsidies for insurance instruments targeted to households and communities and funded by higher levels).

Slow onset of (some) climate risks, combined with potentially catastrophic and irreversible impacts, mean that extra efforts have to be taken to attract the attention of decision makers. Action is needed immediately. This being said, the time lag until the full effects of climate change unfold gives scope for sequencing the policy response: some adaptation responses must be started now, while other will have to wait because of budget constraints and limits to the implementation capacity of relevant agencies.[30]

A useful way to think about this sequencing is to begin closing the adaptation gap—helping households and countries better manage *current* climate volatility is a good way to gear up for the expected increase in *future* volatility. Moreover, planned investments in infrastructure (roads, housing, irrigation, power supply, and other physical structures) with a long expected life should be climate proofed. In fact, any adaptation investments with long gestation periods before their benefits kick in are relatively more urgent: Developing heat and drought resistant crops, supporting an educated workforce, and establishing institutions to manage conflict will take far longer than, say, adjusting insurance regulations, and are therefore more immediate priorities. Finally, combined with uncertainty, delayed onset of risks adds a premium to "no regrets" interventions: investments and policies with high payoff under the current climate risks as well as in a future with riskier climate should be assigned higher priority everything else equal.

Risk interactions, as already mentioned, risks need to be considered in integrated manner rather than sector by sector. This is consistent with the multisectoral and multi-instrument approach of the integrated social risk management already discussed.

In summarizing the above, the characteristics of climate change risks imply a need for an integrated multisectoral approach to manage direct and indirect risks. This includes social policy components such as improved disaster management, better safety nets, and knowledge building with a focus on "no regrets" interventions. The next section discusses how the SRM framework offers a platform to achieve just this.

[30] This argument holds true even as many policies for adaptation are no regrets and would constitute good development practice also in the absence of climate change. Budget and capacity constraints mean that not everything can be done at once.

The SRM Policy Matrix for Climate Change

Table 1 gives an overview of SRM instruments and strategies relevant for adapting to climate change. The matrix conveys the message that adaptation can take place at different stages of the risk-vulnerability cycle (ex-ante and ex-post), at different levels (from household to global), and different levels of formality.

Social risk management comprises a range of interventions and strategies at the household, community, national, and international levels aiming to prevent risk, reduce exposure, mitigate the impact of adverse events, or cope ex-post. These potential interventions generate a menu of formal or informal instruments, and no single instrument alone offers complete protection from risks. As Table 1 demonstrates, efforts by households, communities, and nations need to be complemented by international responses. The policy menu should also balance between ex-ante risk prevention, exposure reduction, and risk compensation/mitigation with support for ex-post coping. Box 6 provides an example of how the SRM framework might be applied to thinking through one particular risk, namely that of malaria.

Social risk management is multisectoral and should strive for a balance of efforts aimed at infrastructure sectors, productive natural resource sectors, and social policy such as health, education, social protection, migration policies, and conflict resolution (Bendokat and Tovo, 1999). In many ways this balance represents good development practice even in the absence of climate change, but it is not “business as usual”: climate change adds impetus to scale up “no regrets” risk management interventions and to re-focus them toward potentially irreversible covariate risks. That is, the assessment of potential risks associated with climate change should be mainstreamed into policy, planning, and investment.

Table 1: SRM Policy Matrix of Interventions and Strategies to Manage Risks Associated with Climate Change

	Individual and Household Level	Community Level	National Level	International Level
Ex-ante				
Risk Prevention	Reduce emissions of greenhouse gasses	Reduce emissions of greenhouse gasses	Reduce emissions of greenhouse gasses	Reduce emissions of greenhouse gasses.
Reduction Of Exposure or Sensitivity	Investments to protect and enhance household assets; Adopt new technologies; Adjust assets and livelihoods; Permanent migration; Health and education.	Investments to protect and enhance community assets; Investments in physical and social infrastructure; Social capital; Rights and security; Water and sanitation.	Climate proof technologies and infrastructure; Climate predictions and weather forecasts; Public goods, physical and social infrastructure; Finance, technology, knowledge for producers; Human capital; Safety nets (to build household assets / adaptive capacity).	Research in climate proof technologies; Well-functioning international markets (e.g., in food); Options for permanent international migration; Climate predictions.
Risk Mitigation ("Compensatory measures")	Insurance; Adjust asset portfolio and livelihood activities; Precautionary savings; Seasonal migration.	Mutual insurance Markets for households' assets; Physical and social infrastructure; Community savings and insurance.	Markets for household assets; Finance and insurance services development; Formal insurance. Migration	International insurance; Predictable disaster assistance (with funds and rules for targeting & delivery); Options for temporary migration.
Ex-post (after risky events)				
Ex-post coping	Sell or draw down assets; Increase labor supply; Credit; Receive transfers.	Draw down community assets; Transfers from outside community.	Safety nets; Social funds/ community driven development.	International disaster assistance (ex-post).

Source: Adapted from Siegel and Alwang (1999) by the authors

Box 6: Example of SRM Applied to Adaptation to Malaria

In recent years there have been great advances in battling malaria in some Sub-Saharan African countries. However, malaria remains a major health problem and could be aggravated by climate changes. There are concerns that changing rainfall and temperatures, and stresses on water and sanitation systems, might lead to a spread in the location of the mosquito vector. This could be a major health problem, especially in areas

not previously exposed to malaria-bearing mosquitoes. Individuals in such areas, lacking resistance to malaria, would be more sensitive to the disease. In addition, some individuals in traditional high-risk malaria areas could become more sensitive to malaria as their health and nutrition status declines due to risks associated with climatic change.

Current anti-malaria risk management programs include ex-ante reduction of the risk itself through spraying programs and programs aimed at reducing mosquito breeding grounds (e.g., community-based programs to improve waste disposal and sanitation systems, and eliminate standing water). In addition to reducing the risk itself, the major innovation for reducing risks of being bitten by a malaria-carrying mosquito has been the distribution of nets that have been sprayed with insect repellent combined with malaria prophylaxis. Both of these are ex-ante strategies that reduce risk exposure. Less exposure to malaria can lead to improved health and nutrition status and less sensitivity to malaria. In addition, there has been an increase in the availability of malaria treatment medicines. This is an example of an ex-post coping strategy that could potentially be financed by health insurance and promoted through health clinics. Government programs and donors provide most of the funding for these ex-ante actions. Ex-post actions for people infected by malaria include health care and assistance in cash or kind to help smooth consumption. This assistance is often depending on social capital and informal insurance arrangements.

How does the SRM approach help lead us in the direction of a solution? One strategy would be to set up monitoring and early warning systems for climate and health variables and to screen for malaria even in areas not currently infected. In addition, a response plan for dealing with malaria would be needed that included: a) mosquito eradication, b) risk reduction with nets and medicines, and c) malaria treatment. Ideally, the monitoring and early warning systems would be collecting a range of information to help in the wider adaptation to climate change, and the capacity-building would also have broader benefits for households, communities and other different levels of government. International donors, researchers, and pharmaceutical companies could contribute to this effort.

3. Implications of the SRM Framework for Climate Risk Management at Various Levels

An important question that climate change adaptation strategies need to address is at what level—households, communities, local governments, national governments, or internationally—to focus adaptation interventions. In this section, we apply the SRM lens to this question, emphasizing that because of the nature of the risks (covariate and potentially very large and irreversible) the need for higher level (national and international) adaptation (or risk management) interventions.

Before proceeding, we reiterate from Table 1 that risks can be managed at different levels, with implications for who implements, finances, and benefits from adaptation (or risk management) interventions. These levels comprise (a) household level through asset portfolio, asset allocation, and livelihood strategies; (b) community level through collective action with other households in community groups, producer groups, civic associations, etc; (c) national level where external actors such as firms, broad civil society, and governments transfer or share or pay for some or all of risk management efforts; and (d) international level through development assistance and international migration and remittances, and international institutions. The choice between risk management arrangements at various levels is both technical (who is best placed to manage a given risk?), financial (who pays?), and political (distribution of winners and losers).

Local Level Risk Management Is Necessary but not Sufficient

Households will do their best to adapt to perceived climate changes, but there is considerable evidence of imperfect management of current (and recent past) climate risks and climate changes. Households and communities will make adaptations to climate changes they perceive, even in the absence of facilitating government policy. This has been termed *autonomous adaptation* in the climate change literature. Some producers will seek out investment opportunities in assets, technologies, and livelihood strategies better suited for the changing climate conditions. They will

do so both by choice and by necessity: if the government does not invest in adaptation, households and producers will need to do it on their own. Agricultural producers, for example, will seek to reduce their risk exposure by adjusting the crop and livestock mix toward more heat and drought-resistant crops and livestock breeds, or by investing in irrigation. Labor will shift into new sectors, giving rise to new opportunities. Many communities will continue to rely on informal risk management arrangements to help households manage risks ex-ante and ex-post. Adgers (2003) studies informal collective decision making for coastal risk management in Vietnam, noting how local-level social networks substituted for the loss of state-led actions there. When governments do not have the resources to provide protection against environmental risks, indigenous management practices are needed instead. Adgers' research from Vietnam suggests that these types of self-help strategies could become more prevalent and necessary for some marginalized communities.

But it remains to be seen to what extent community institutions and organizations can adapt to the new challenges posed by climate change risks. It is plausible that, in some places, large covariate and repetitive risky events could overwhelm community institutions and organizations. Thus, although households will do their best to adapt autonomously, past experience with managing climatic variation demonstrates the (informational, asset-based, technological, and social) constraints to effective adaptation without public sector interventions that help households adapt (Box 7). Moreover, household and community adaptation is not always equitable, sustainable, or desirable. In fact, left on their own, many poor households and communities tend to adopt adaptation strategies that are destructive to their asset portfolios.

Box 7: The Long Road to Recover from Disasters

Many low-income households coping with a shock are faced with the terrible dilemma between reducing consumption and drawing down their (human, physical, or financial) assets. The dilemma is less pronounced in areas with well-functioning markets for labor and credit that permit households faced with a shock to expand labor supply or borrow. The dilemma is also ameliorated in some settings and for some people with good social capital where community risk sharing offers some assistance. But all too often, families are forced to rely on destructive coping options that perpetuate poverty and vulnerability because effective coping options lack. Instead, households use self-insurance and informal credit and many shocks result in food insecurity, informal debts, child and bonded labor. These are major setbacks to households that keep them in poverty, sometimes for generations. Some of this coping irreversibly reduces human capital: Reducing food consumption and pulling children out of school are believed to be common coping responses in low income settings, although there are few estimates of their prevalence. A unique longitudinal study in Zimbabwe made clear the irreversibility of some impacts. The study followed children that were less than two years old (the age where children are most susceptible to malnutrition) when a severe drought hit in the early 1980s. Those that survived the famine were found to be stunted, translating into lower schooling achievements, inferior adult health, and an estimated 14 percent reduction in lifetime earnings (Alderman, Hoddinott, and Kinsey, 2006).

Loss of productive assets is another major consequence of shocks that often has long-term consequences for livelihoods and asset distribution. A study in Honduras followed households hit by Hurricane Mitch. Asset losses were higher for the better-off: 68 percent of households in the highest wealth quartile suffered loss of productive household assets, compared to 22 percent in the lowest wealth quartile. However, among households suffering asset losses, poorer households lost a greater share of their wealth (31 percent) than the better-off (8 percent). After Mitch, growth in assets was far higher for households that did not suffer asset losses: asset recovery was faster among the upper wealth quartile than in the lower wealth quartile. In other words, the hurricane exacerbated asset inequalities as the poor lost a greater share of assets in the disaster and recovered at a slower rate than the non-poor. Analysis of rural Ethiopian households stricken by drought during 1999-2000 reveals a similar pattern: While better-off households sold livestock to finance consumption, the poorer often tried to hold on to their livestock (at the expense of food

consumption) in order to preserve their options for eventually rebuilding herds. Meanwhile, those poor households who exited the shock with few assets experienced difficulty rebuilding assets. Membership in social and community organizations was of some help to limit the loss and increase the speed of recovery of livestock, but primarily for households in the higher wealth groups (Carter et al, 2005).

Information and perceptions of risk matter to people's ability to manage risks through household or community mechanisms: in order to begin adaptation people must first have perceived a change and they must have information on how to seek out new opportunities and avoid risk. The cognitive links between climatic change and adaptive behavior are only just beginning to receive attention: early results suggest that merely perceiving change does not guarantee an adaptive response and that expansion of education would help households take the steps needed to manage climate risk (see Box 8). But can publicly provided information help speed up adaptive actions by households and producers? This issue has been studied in the context of whether information in the form of weather forecasts help rural producers manage short-term climate risk in Eastern Africa. Although only a minority of pastoralists in the study area received weather forecasts, those that received them did in fact update their perceptions of the coming season's rainfall. Thus, it seems that supplying climate information can be potentially useful. Here, however, the problem was not so much one of perceptions (in contrast to the study mentioned above) but of the shortcoming of weather forecasts which fail to deliver the information most needed by pastoralists, namely the onset date and the total amount of rain at the household's location.

Box 8: The Links between Perceptions, Information, and Adaptive Action

Perceptions and Adaptive Action
Maddison (2007) studies agriculturalists' perceptions of climate change based on a large-scale survey of agriculturalists in 11 African countries, asking whether farmers already perceive climate change? And if so, whether they have started to adapt? The survey reveals that significant numbers of farmers believe that temperatures have already increased and that precipitation has declined. Those with the greatest experience of farming are more likely to notice climate change, and neighboring farmers tell a consistent story. There are important differences in the propensity of farmers living in different locations to adapt. Large numbers of farmers perceive no barriers to adaptation but those that do perceive them tend to cite poverty and inability to borrow. Few if any farmers mentioned lack of appropriate seed, security of tenure, or market accessibility as problems. Although experienced farmers are more likely to perceive climate change, it is educated farmers who are more likely to respond by making at least one adaptation. This indicates that expansion of education would be helpful to better equip households to manage climate risk.

Weather Forecasts: potentially useful to pastoralists
Studies of pastoralists in Eastern Africa shed some light on the potential usefulness of climate forecasts in helping communities cope with climate risk. Luseno et al (2003) present interesting work on how pastoralists in Northern Kenya and South Ethiopia use weather forecasts and find some hopeful points. Pastoralists readily understand probabilistic seasonal climate forecasts. Although only a minority of herders herd the forecasts, the probability of hearing forecasts was strongly correlated with education, market access, and ownership of radio. Increasing commercialization over time should therefore bring greater penetration of forecast information. Moreover, the vast majority of those who hear forecasts find them at least somewhat useful and update their subjective beliefs on the coming season's rainfall. In a different paper, Lybbert et al (2007) find that herders who receive forecasts use them to update their beliefs on the downside risk (of below-normal rainfall) but not of the upside (of above-normal rainfall); this suggests a preoccupation with minimizing risk. The research concludes that the most pressing shortcoming of climate forecasts in Eastern Africa is that they fail to deliver the information most needed by pastoralists: the onset date and the total amount of rain at the location of the household. The information is presently provided at too aggregated a spatio-temporal scale for the use of pastoralists and is better suited for farming communities.

Risk management at the household or community level does not substitute for public efforts (and vice versa). Managing climate risks, in particular, has mostly been regarded as the responsibility of households, except for the largest extreme weather events and natural disasters where governments have taken on responsibilities for risk management. Poor households lack capacity for costly and complex ex-ante management and usually fall back on ex-post coping, often with adverse consequences for their long-term well-being through responses that degrade (human, physical, and environmental) assets and contribute to long-term poverty as discussed in Box 7. Thus, household and community management of climate change needs to be augmented and complemented with higher-level efforts. This is the basic principle of social protection and safety nets.

There are both potential costs and benefits to household/community adaptation. The goals of public adaptation interventions should both seek to enable potential benefits and to avoid the downside of household and community adaptation. *Enabling interventions* (mix of policies and investments) aim to catalyze the potential benefits to household/community adaptation, for example by removing constraints by proving education and information, technology, credit, property rights, and institutional support. This would help households respond more flexibly and maximize returns and minimize the variance of returns. For example, ensuring access to finance and insurance could facilitate investments in climate-proof assets and technologies, especially when combined with access to public goods and relevant technologies such as climate resistant farming systems for different regions and types of producers. Securing property rights to natural resources should provide incentives to producers to make investments that maximize returns and safeguard these assets. Other interventions, however, need to be more defensive and seek to prevent the most pernicious indirect risks from being realized and manage the potential conflicts, for example through better arrangements for domestic and international migration, property rights, rule of law, and conflict resolution.

Challenges to National Action

At the country level, some but not all risks associated with climate change seem amenable to integrated risk management. There are a number of options for risk management interventions in sectors such as health care, social protection, infrastructure, technology, crop switching, and disaster preparedness. Many of these interventions are “no regrets” propositions that bring benefits both now and in a future with changed climate. But to bring them about requires adequate (domestic and international) institutional support and finance, and domestic growth and development. It also requires responsive and accountable institutions. The challenge ahead is that some of the most vulnerable households are in communities and countries that have the weakest institutional capacity, and the fewest resources, to respond. International institutions will have to find ways to provide not only resources but also incentives and information for adaptive actions in the context of low institutional capacity, the long term nature of the threat, and the extraordinary international collaboration required. Finally, social policies for risk management need to ensure that the poor gain from and participate in adaptation.

The Need for International Efforts

At the regional level, some risks are potentially catastrophic: major declines of food production in entire regions of Africa, advanced desertification of large regions, or the drying up of rivers that supply entire regions and major cities with drinking water. Such regional disasters would overwhelm the risk management capacity of individual countries and require international collaboration around, for example, water sharing, food trade, development assistance, and migration. Moreover, the consequences of climate change will most probably exacerbate economic, social, and political inequalities and tensions. Developing countries’ perception of lacking access to influence and technology will be accentuated, and the sense of unfair “rules-of-

the-game" at the global level will grow as poor households and countries suffer the most from a problem they have done the least to create. Adaptation to climate change requires strong international cooperation, including financing.

International efforts to share the burden for adaptation need to be informed by equity and fairness considerations. As has often been emphasized, the poor stand to lose the most from a problem which they have done the least to create. Equity and fairness perspectives therefore dictate that a substantial part of the burden for adaptation ought to come from the international community: this is after all a global issue. Concerns with social justice and the fate of the world's poorest also motivate the developed world to assist as some of the most adversely affected countries stand at risk of dramatic upheavals without help. Donors have started financing adaptation efforts, including through support for National Adaptation Plans of Action (NAPAs), disaster risk management efforts (more on this below), and stand-alone projects. Several donors are currently considering scaling up their financial support (although more than finance is needed, see below).

Scaling up financial assistance for adaptation should be driven by clear social and developmental objectives. This perspective entails challenges in its own right. Some donors are arguing that development assistance should finance only additional costs of adapting to climate change (that is, costs over and above what the developing countries would have incurred in the absence of climate change). More research on this may be needed though: it is unclear how to calculate these additional costs since much adaptation is only "good development anyway". For example, countries need disaster management capacity regardless of global warming. The same can be said of health care, nutrition and food security, secure water supplies, and social safety nets (additional costs of climate proofing particular infrastructure installations may be easier to calculate). These measurement problems ideally should not bias international finance toward specific purposes or sectors simply on the basis of the relative simplicity of measuring additional costs of adaptation; instead, development assistance should flow to where it has the largest impact on poverty.

International sharing of burdens of adapting to climate change will need to go beyond development assistance and include policies for freer labor and migration flows, innovative and more accessible trade, financial markets and insurance systems, and expanded peace keeping duties in areas degraded by impacts of climate change. Global climate change, in other words, is a truly global social and environmental issue with spillovers for a range of contested international issues, not the least cross-border migration. However, moving toward a comprehensive global agenda for adaptation will require a substantial evolution of international policy and institutional perspectives, rooted in equity and fairness considerations. There are some precedents for this, for example in the evolution of international support for dealing with natural disasters and with conflicts (Cammack, 2007).

4. SRM, Social Policy, and Social Protection for Adaptation

This section discusses how social policy interventions (health, education, community-driven development, migration arrangements, and in particular social protection interventions such as safety nets and insurance) can contribute to adaptation within the SRM context. In some sense, the "social contract for climate action" needs to be underpinned by a principle of protecting poor and vulnerable households from extreme impacts. We argue that social policies are needed to this end and that these policies are often "no-regrets" and justified even under current climate variation to address human vulnerability. Furthermore, social policy can help make other adaptation policies and investments more equitable.

Social policy interventions are needed to help promote the ability of poorer households and communities to manage climate risks at the household and local level. Households and communities can and will take many steps to manage climate risks, given appropriate enabling social policies. Policies should seek to reduce constraints for local level risk management through, for example, access to skills, education and knowledge; public health, food security, and nutrition; credit and financial instruments; and social/political conditions that enable collective action (i.e., good governance and fair and transparent institutions). All of this would seem to be "no regrets" options. Interventions need to provide higher level (national or international) support to household and community risk management efforts. In addition, social protection interventions (discussed more below) are particularly needed to prevent serious adverse consequences of shocks. As mentioned above, this will help underpin the "social contract for climate action" with protection of poor and vulnerable households.

Social policy approaches can also contribute by making sectoral interventions (e.g., in infrastructure, early warning systems, adaptable farming systems) more equitable by making them more accessible and pro-actively targeted to vulnerable households. Interventions for adaptation have often addressed direct risks and impacts at global, national or sectoral levels. This has led to a focus on climate proofing specific projects or pieces of infrastructure (e.g., roads, communication, water reservoirs, energy) to protect them against direct climatic risks. Valuable as this is, there has sometimes been insufficient attention to indirect risks and impacts on vulnerability: which types of infrastructure are more important for fighting poverty? How can we ensure that sea walls are built not just for the rich, and that climate proof agricultural technologies and cropping systems are designed for the poor, and reach them? In addition, agriculture sector policies do little to address food insecurity of the urban poor, for which international food trade and social safety nets will be needed. Moreover, there is also a role for social policy to empower the poor and help them develop the 'voice' and political assets needed to demand access to risk management instruments. The bottom-line in all of this is that social policy approaches complement other interventions through a more holistic assessment of the risks facing the poor and by ensuring the inclusiveness and equity of these efforts.

Risk-Focused Social Protection Programs

This section discusses the role of social protection programs. Some particular attention is devoted to insurance, for adaptation. Index-based insurance and combinations of insurance and safety net approaches hold some promise to help manage current and future climate associated risks but the inherent limits to what insurance can achieve need to be kept in mind.

One of the recurrent characteristics of human activity is an attempt to reduce the degree of uncertainty that surrounds the future. This can lead to sub-optimal decisions in the present. This suggests two important means to improve human well-being and decision-making under uncertainty, namely improved information about the uncertainty to make it more certain, and reduced losses from the uncertain event. With improved information and improved risk management, households can be more efficient in the accumulation and allocation of assets and in their selection of livelihood strategies.[31] Thus, concerns about household vulnerability to risk can justify public interventions aimed at preventing risks and compensating households for losses ex-post. This is because individuals will make inefficient and costly choices that lower overall social

[31] However, it is also widely recognized that humans are not necessarily good risk managers: even when information about risks, risk exposure, expected losses, and risk management options are available, people do not always make optimal decisions (for various reasons including lack of education, social-cultural traditions, and attitudes toward risk).

welfare. As such, "since insecurity is welfare reducing, public actions to ensure a minimum level of security for everyone may be necessary Cafiero and Vakis, 2006, p.1)."

Social protection measures are also needed to improve the management of adverse weather events, including major disasters. Cash transfers, both conditional and unconditional, workfare programs, and disaster insurance are some of the available options. Cash and in-kind transfers based on objective and measurable trigger events are already used to help affected households cope with disaster related losses, especially after major disasters. Despite inconsistencies in the way they have been applied and their lack of built-in ex-ante guarantee, these instruments have met with success and helped affected communities cope and recover (Box 9). There is also scope for wider use of new innovative instruments used for weather insurance such as index-based insurance for farmers and for local and national governments (more on this below). Donors could establish ex-ante funding for strategies to cope with climate risks through contingency disaster financing. Moreover, social funds and community driven development approaches can be useful vehicles for local risk management: both ex-ante through community projects to reduce exposure to risks and climate-proof local assets, and ex-post through support for coping and recovery from disasters.

Box 9: **Safety Nets to Cope With Natural Disasters**

Effective safety net responses are crucial for avoiding post-disaster famine and in assisting affected households and communities cope and recover from disaster. While some countries already have designated national agencies with mandate and budget to support households in the event of disasters, in other countries the humanitarian and the medium-term support to households affected by disaster is more ad hoc and slower. The international community is making efforts to improve disaster response. This includes attempts by the World Bank and others to streamline donor-supported post-disaster income support (as also recommended by the World Development Report 2000/01 (World Bank, 2001) and to help improve the capacity of national safety net agencies to respond better and faster to disaster events. For example, the Global Facility for Disaster Reduction and Recovery[32] supports efforts to improve the capacity of several countries to systematically assist households affected by disasters. Post-disaster social protection support has worked well in many major disasters and complements well other components (e.g., reconstruction and rehabilitation) of disaster support operations.

However, to become effective vehicles for better risk coping, these safety nets need to be more risk responsive and more generous than they are at present (Heltberg, 2007).[33] As discussed by de Janvry et al (2006), options exist for designing safety nets with uninsured risk more explicitly in mind as a way to provide insurance substitutes that would permit vulnerable households to engage in riskier higher-return activities. These ideas are being put to the test in operational contexts. In Nicaragua, for example, the World Bank and bilateral donors support an innovative pilot program that combines conditional cash transfers with additional transfers aimed at increasing the income generating capacity of poor rural households exposed to weather risk.

Insurance against risks associated with climate change may hold some promise, but there are inherent limitations to its usefulness which need to be kept in mind. Insurance is often proposed as a cornerstone of adaptation. After all, insurance is a way to pool risks across larger areas. This meets the need for higher-level risk management instruments discussed above. However, for a risk to be actuarially insurable the following conditions should be met: a) probability of the risky event must be quantifiable, b) damage caused by the risky event must be quantifiable and able to

[32] See http://gfdrr.org/

[33] While there is quite widespread agreement on the need for safety nets in response to (large) covariate shocks such as natural disasters and progress on their implementation, there is no consensus on safety nets for idiosyncratic shocks (see de Janvry et al, 2006).

be valued, and c) neither occurrence of the risky event nor the damage it causes should be affected by the insured party's behavior (i.e., no *moral hazard*). To be economically viable by private insurers, there should not be *adverse selection* (high participation by higher risk/loss parties), nor high transaction costs (e.g., contracting, monitoring, loss assessment, payments of fees and redemptions). These conditions are rarely met in the case of global climate change, where climate variables are changing and historical time-series data on trends and variance are less useful for forecasting future climatic patterns.

At a recent conference on Insurance Instruments for Adaptation to Climate Risks (IIASA, 2007) it was concluded that although insurance appears to be an increasingly important instrument for managing weather-related risks in developing countries, it is not a panacea for adapting to climate change for several reasons:

- Insurance is not appropriate for very slow-onset climate impacts, such as sea level rise and desertification, which are considered uninsurable;
- Insurance must be considered within an overall risk-management and adaptation strategy, where preventing losses will often be more cost effective than coping with them through loss-based insurance instruments;
- Developing countries generally lack an insurance culture and market;
- Insurance is not easily affordable in highly exposed developing countries, nor is it often the least cost alternative. Because of the insurer's cost of risk capital required to support the underwritten risks, which can be significant due to co-variant claims, people can pay significantly more for disaster insurance than their anticipated losses over the long term. This distinguishes it from life, health and other types of micro-insurance.

Weather and climate are critical variables for the insurance industry. When weather patterns are reasonably stable, the magnitude of possible losses from storms, droughts and floods can be predicted. The industry can then price and spread weather-related risk across multiple policy-holders. But a warmer and more volatile climate will bring unpredictable losses, undermining the insurers' capacity to calculate, price and spread weather-related risk. Despite (or because of) the challenges, the insurance industry is moving ahead to adjust existing products and design new products that take climate change into account (DFID, 2004b; Mills, 2007).[34]

Weather-based index insurance is being considered as a substitute for traditional crop insurance (Skees and Barnett, 1999; Skees et. al., 1999; Hess, 2003). Weather-based index insurance uses objectively defined "trigger events" (e.g., rainfall, soil moisture) in an area to set contingent damage payments according to an index (contracts and indemnity payments are the same for all buyers per unit of insurance) rather than field- or household-specific damage and loss data. This discourages moral hazard and cheating, avoids adverse selection problems, and lowers transaction costs of individual contracts and on-site inspections. It also makes the insurance instrument accessible to the broader rural population. The same basic weather-based insurance product, using the same "trigger events", can be "packaged" for national governments (e.g., catastrophe bonds); for the meso level (e.g., to insure a micro-finance institution's loan portfolio; sub-national governments); and for households (e.g., loan insurance, rainfall lottery tickets) (Skees, et al., 2002; Alderman and Haque, 2007).

[34] The current interest in weather-index insurance should be exploited to advocate for increased numbers of weather monitoring stations in areas not well served at present, to be accompanied by accurate collection, storage and analysis of climate data. Also, we would propose setting up socio-economic monitoring systems in conjunction with select weather stations for monitoring of economic and social impacts (see Section C.1).

There are interesting innovations for weather risk management that combine insurance and safety net approaches. Mexico has a program in place for natural disaster management that includes weather indices as "triggers" for payouts to farmers and to mobilize safety net programs such as public works and feeding programs (Skees et. al., 2002). Specific ranges of rainfall, temperature and wind speeds for specific regions serve as proxies for high expected household and smallholder losses. Ethiopia is adopting a similar approach in its "productive safety nets" project which relies on weather indicators as triggers for safety net transfers; other countries are also exploring this option. What is interesting about these safety net programs is that the triggers are transparent and known by poor and vulnerable households, and they do not need to be directly insured. The poor therefore do not pay premiums. Instead, governments either purchase insurance from national or international insurers and re-insurers, or maintain disaster funds in savings accounts. As such, there is scope to combine safety net programs with insurance markets, and to allow households to manage their assets and livelihoods knowing that they will have ex-post assistance for coping activities, whereas state and national governments pay ex-ante to set up the risk response strategy. However, as noted, index-based weather insurance might become more costly as climate change take places and lowers the predictive power of past climate trends and variation.

A global social protection system that guarantees a minimal level of income or security for everyone is an equitable, efficient, and human-centric means to deal with global poverty and vulnerability stemming from climate change. Considering the global dimensions, the uncertainty about climate change related risks, and the wide potential for increased perceived (and real) insecurity, there is compelling logic for global actions to ensure a minimal level of security for everyone. Such global social protection could also help promote global efficiency, equity, and growth. The program would provide guaranteed minimal levels of well-being and guaranteed compensation when major risks are realized, leading to increased security and decreased vulnerability. The program could involve formal insurance (contributory) schemes and/or a means to target (non-contributory) social assistance to vulnerable households.

5. Summing up Key Implications for Guiding Thinking about Climatic Risk, Human Vulnerability, and Adaptation

In summing up this section, the conceptual framework and subsequent discussions have highlighted the following:

1) Climate change is a fact of life, but the manifestation of climate change is uncertain in terms of frequency, magnitude, timing, duration, and spread over space, sectors, and households.
2) All households face risks associated with climate change, but not all are vulnerable.
3) Human vulnerability is a function of direct and indirect risks associated with climate change (and their characteristics), exposure and sensitivity of assets and livelihoods to the risks, and adaptive capacity. The exposure and sensitivity of household assets and livelihoods to climate change and their adaptive capacity are largely shaped by policies and investments outside of households' direct control.
4) Since risks related to climate change can impact household assets, livelihoods and well-being directly and indirectly, a multi-dimensional and multisectoral approach to risk management is required.
5) Ex-ante management of risks associated with climate change (especially lowering the exposure and sensitivity of assets and livelihoods) can strengthen household assets and

increase returns on assets, thereby contributing to improved livelihood options and improvements in well-being. This is a “no-regrets” approach.

6) Climatic risk management needs to be mainstreamed into the development agenda. An integrated risk management approach to climatic risks and climate change is called for and should be consistent with growth and poverty reduction efforts.
7) Institutions and good governance are key to improved adaptation.
8) Although what we are proposing is only good development practice and might sound like “business as usual”, it is important to emphasize that mainstreaming risk management into planning at household, community, local, national and international levels should lead to growth and development that is more efficient, equitable, and sustainable.
9) Global dimensions of climate change require global approaches to managing the direct and indirect risks. Social justice and equity concerns, along with growth and efficiency concerns converge to justify a global social risk management approach to climate change.

C. RESEARCH AGENDA, ORGANIZING FOR ADAPTATION, AND CONCLUDING REMARKS

This final section proposes a research agenda for informing effective design and implementation of social policy interventions for climate change. We also consider some institutional implications for the World Bank of the need for multisectoral climate risk management. We further offer closing remarks considering how adaptation strategies may emphasize "no-regrets" interventions without following a "business-as-usual" approach to development.

1. Toward a Research Agenda

There is much we don't know about the socioeconomic implications of climate change and how best to design policy to promote adaptation and reduce household vulnerability. Social scientists need to step up to this agenda. First, however, it will be important to settle the confusion over definitions of human vulnerability (including relations to risk and adaptation) and we would recommend all the disciplines to adopt the IPCC definition: vulnerability is "the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." Adaptation is defined as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm and exploits beneficial opportunities (IPCC, 2001)." As we demonstrated in this paper, the SRM and asset-based approaches provide a consistent conceptual framework to apply this definition and can help make the causal relationships explicit and provide an integrated framework for considering policies and investments.

We propose four distinct pillars for the social science research agenda on adaptation: (1) monitoring change; (2) predicting the consequences; (3) assessing policy alternatives; and (4) institutional arrangements and sharing the costs internationally.

(1) Monitoring Household and Community Response to Climate Changes
Meteorologists systematically monitor weather variables (defined and measured in a comparable manner) in specific locations over many years. Social scientists have little or no comparable monitoring of the impact of that weather and how households and societies respond to it over time. To start build that body of information, we propose a long-term international monitoring program on climate and socioeconomic impacts and responses.

This data collection would combine longitudinal information on weather; panel surveys of household production, consumption, migration, health, and well-being; and surveys of community responses in selected locations. It would result in the collection of spatially referenced climate, community, and household data (health, assets, livelihoods, and well-being). A mix of quantitative and qualitative information should be collected from sample sites, at regular intervals over a long period (say 15-20 years). Sites should be sampled to represent communities that are projected to become increasingly exposed and vulnerable social groups in multiple countries. If possible, attention should be paid to gender and other intrahousehold differences. Existing panel data may be of use, as a starting point: to save on time and costs, the proposed program could build on and extend some of the pre-existing panel data collection efforts. This kind of data would be an important global public good and could greatly facilitate real-time monitoring of threats—poverty, hunger, health, conflict, etc—and empirical policy research on impacts and responses to climate change in poor communities and for particular vulnerable groups (by age, gender, ethnicity, disability, livelihood). Such research is essential to support community-led

adaptation and the design and targeting of effective adaptation policies. As tasks of this magnitude, duration, and budget[35] are not well-suited for individual researchers, international organizations with a public goods research mandate should consider taking it on.

(2) Understanding Poverty and Distributional Implications of Climate Change
Trying to link climate risk and impacts to households is a start in the right direction. However, there is also a need to better understand and predict the socioeconomic impacts of climate change at disaggregated levels, especially at the household and intra-household levels. The longitudinal monitoring approach proposed above could help provide data, but modeling efforts will also be required and could, in fact, complement monitoring. One approach to modeling could aim to better predict poverty and vulnerability effects by combining agronomic models, climate predictions, and distributive analysis at spatial, sectoral and household levels, and for different social groups. It would be useful to offer model results that are more near-term (10-25 years forecasts) rather than the usual long-term scenarios (going to 2050 or 2080). Another approach could try to combine general equilibrium analysis of economy-wide or global effects with disaggregated impacts.

Whatever the approach taken, models are ideal for considering direct and indirect risks related to climate changes and look beyond average effects to vulnerability at the household level. There is a long way to go, but the data proposed to be collected above could help inform and validate this kind of modeling. We would expect that, eventually, this type of analysis would find its way into World Bank and other analytical work on exposed countries. Before this can happen, however, improvements are needed in data, modeling techniques, and skills to address the issue.

(3) Assessing Alternative Interventions for Climate Change Adaptation
There is a need to systematically study adaptation interventions to guide the design and prioritization. We propose to study the benefits and costs of different adaptation policies and investment so as to capture lessons learned as adaptation interventions are increasingly implemented around the world. This should look at policy design, implementation, and governance issues, seeking to assess the cost-effectiveness of alternative interventions, and the distributional consequences for particular groups (e.g. across class, gender, age, and ethnicity). There is a big need to assess policy implications across multiple sectors and types of interventions; for example, how should trade policies be affected by the changing risks to domestic and international food prices? What is the best way to design and finance safety net and social insurance instruments for climate risks? What can community-based adaptation achieve, and what types of support may be needed? Clearly it is not possible to generalize across localities as there are huge differences in institutional capacity and governance within and between countries. Just as we have proposed a more household-focused approach, a closely linked institutional approach should be pursued. The monitoring efforts mentioned above should include data and analyses on institutions.

While the ultimate goal of measuring the vulnerability reduction per dollar or euro or kwacha spent may not be achievable, this kind of research should help policymakers prioritize, sequence, and finance adaptation interventions at local, national, or international level. Policy research should also consider issues of access and voice by the poor: do they gain from new technology? from policy interventions? do they influence policy? This would help identify “no-regrets” opportunities, and improve the timing and targeting of interventions.

[35] The time frame for this kind of monitoring would be long (ideally decades), which is exceptional in social sciences (but not in meteorology). The budget required would also be unusually large (depending on time horizon) and should, ideally, be committed upfront to permit long-term planning.

(4) Institutional Arrangements, Coordination, Financing, And Sharing The Burden Of Adaptation

There is a need to explore institutional arrangements for climate risk management. Given its crosscutting multisectoral, and global nature, these arrangements may need to be complex. Arrangements should seek to ensure coordination between many different actors and sectors, and involve many different types of knowledge (scientific, social sciences, traditional knowledge, etc). There are also many issues related to fair, equitable, and effective ways to finance the costs of adaptation in developing (especially low-income) countries and to share the non-financial burdens. Concerns with ethics and social justice will need to feature here, as would issues of political economy (who pays for adaptation and who benefits from it are very political topics).

Areas of research would include what shares of adaptation costs, for which communities, local and national governments to finance (the problem of additional costs); how to deal with cross-border spillover effects such as migration or shared rivers; how to provide incentives for adaptive action; and how to develop international policies and institutions so they can handle the challenge of climate change perspectives. These institutions might consider the global negative externalities associated with climate change, and the global positive externalities associated with successful adaptation to climate change.

2. Getting Organized for Adaptation: The Institutional Fragmentation of Natural Disaster, Climate Change, and Risk Management at the World Bank

The institutional fragmentation of risk management is not conducive to mainstreaming of a multisectoral approach to adaptation in development assistance. The SRM framework implies a need to consider risk in a cross-cutting manner. However, the institutional fragmentation of work related to risk management in the donor community does not facilitate this. This institutional fragmentation is driven by a certain logic, and our aim is not to propose mergers or new institutional structures. Rather, we argue for the need for shared platforms around definitions, concepts, data, monitoring, research, and capacity building.

The World Bank Group, for example, has several departments dealing with issues related to risk management, natural disasters and climate change (the same may apply to other donors). The Bank is also involved in a number of coalitions on these topics. These groups and coalitions include the Global Environmental Fund (GEF), ProVention Consortium, Vulnerability and Adaptation Resource Group (VARG), Global Facility for Disaster Reduction and Recovery (GFDRR), Social Protection Unit (SP Unit), Commodity Risk Management Group (CRMG), Financial Markets for Social Safety Nets (FMSSN), and Global Index Reinsurance Facility (GIRIF), all presented in Annex 3. This is not an exhaustive list, but rather indicative of the varied initiatives and actors.[36]

It would seem that there are potential synergies between these different initiatives and actors, especially to improve the knowledge base on potential negative impacts of climate change and on adaptation interventions. As noted by Davies et al (2007), there has been little cross-fertilization between the professional communities working on disaster, climate change, and social protection. Several observations lead us to believe there is scope for synergies: a) there are increasing attempts to deal with natural disasters and climate change from a global perspective; b) the potential negative impacts of natural disasters and climate change are recognized along with an

[36] For example, we have not included the Prototype Carbon Fund (PCF) that supports reduction of pollutants that cause climate change. Nor have we dealt with different contingency financing options.

appreciation for more ex-ante interventions; c) there is increased attention to the need for more comprehensive safety nets to deal with natural disasters and climate change; and d) there is a need to consider innovative public-private sector partnerships and global risk transfer mechanisms, including innovative insurance (especially index-based) instruments.

Collaboration is easily thwarted by institutional silos and by differences in objectives, philosophies, and vocabularies. A more integrated approach to managing risks associated with climate change is needed. Such an approach would span sector-specific approaches, disaster management and social protection. A good starting point would be adoption of universally shared basic operational definitions of key terms such as risk, vulnerability, and adaptation. This would help these different departments and coalitions communicate better and discover commonalities. Moreover, there is also a need for collaboration on issues related to data collection, monitoring of climate changes and their impacts, policy research, and capacity building.

3. Concluding Remarks

Over time, climate changes will aggravate a number of risks that households face, many of which will manifest as large, covariate, interactive slow-onset and rapid-onset risks. Climate risks will impact the most on households in low income countries in the tropics and sub-tropics because of the greater exposure and weaker response capacity of those countries. The result could be a potentially dramatic increase in household vulnerability to poverty, hunger, disease, mortality, displacement, and violent conflict. There is potential for irreversible damages to humans at a magnitude that could threaten social stability and have serious international repercussions. To address this situation, we have advocated for an integrated social risk management approach that balances social policy, sectoral, and infrastructure interventions and that relies increasingly on national and international risk management arrangements. Fairness and equity considerations, as well as the many potential cross-border impacts, imply a need for international risk management arrangements, and finance. Social policy interventions, including safety nets and insurance, can contribute to effective and equitable adaptation and are needed to protect the poor against large risk. However, more policy research is needed to better inform and prioritize adaptation policy design.

This paper proposed and applied a social risk management and asset-based analytical framework to increase the capacity of society to manage climate risks with a view to reduce the vulnerability of households and maintain or increase the opportunities for development. This framework offers a unifying lens to examine the links between risks, adaptation, and vulnerability and is consistent with IPCC definitions of vulnerability and adaptation.

Applying the conceptual framework, it seems fairly apparent that good risk management practices even in the absence of climate change, is germane to the development agenda, but it is not “business as usual.” First of all, the required levels of spending in many of the social sectors (health, nutrition, education, social protection, and water and sanitation) are not currently taking place in many countries, and ex-ante management of climate change adds impetus to promote this agenda. This would represent a “no regrets” response and help close the adaptation gap to current variability. It would not even require very precise climate predictions. Second, some interventions ought to be designed in different ways in anticipation of the changed risk pattern associated with climate change. For example, monitoring of climate change related risks need to start in some sectors such as health (for early detection of changes in disease vectors) or for complex issues such as conflict and displacement; technologies for new climates need be invented and disseminated; knowledge of specific threats and skills for coping need to be built; and climate monitoring and prediction has to be improved. Third, risk management will have to use more

formal instruments and take place at higher (national and international) levels involving active international collaboration as household and community response options are increasingly exhausted.

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ANNEX 1: ASSETS AT MANY LEVELS

Households Depend on Assets at Many Levels

Asset Type	*Household Level*	*Community and Local Level*	*National, Level*	*International Level*
Natural	"Private" land, pasture, forests, fisheries, water: quality and quantity	"Common" land, pasture, forests, fisheries, water	Regional, national commons, rivers and watersheds, lakes, seas, oceans, air	Global commons, rivers and watersheds, lakes, seas, oceans, air
Human	HH composition and size Health and nutritional status Education and skills	Information, knowledge Labor pool and markets	Information, knowledge Early warning systems Labor pool and markets	Information, knowledge Early warning systems Labor pool and markets
Physical	Select productive assets (tools, equipment, work animals) Household assets (e.g. housing, household goods and utensils) Stocks (e.g., livestock, food, jewelry)	Select productive assets (communal and private) Stocks (e.g., livestock, food)	Select productive assets (regional, national) Stocks (e.g., buffer stocks)	Select productive assets (global) Stocks (e.g., livestock, food)
Financial	Cash, savings, access to credit, and insurance markets	Cash, savings, access to credit and insurance markets	Finance and insurance systems Access to national finance and insurance markets	Finance and insurance systems Access to international finance and insurance markets
Social	HH social ties and networks Intra-household dynamics	Community social ties and networks	Regional and national social ties and networks	Global social networks
Political	Participation in household decision-making (including power relationships related to gender and age)	Participation in community decision-making Governance Security of person and property	Political stability Political participation Effectiveness of collective action Governance Human rights and security of person and property	Globally oriented organizations working on GCC Global development institutions, UN, World Bank, IMF, etc.
Locational	Proximity and access to water and sanitation, education and health, marketplace, storage, roads	Water and sanitation, schools, health centers, marketplace, storage facilities, roads Proximity to transport and communication infrastructure	Distance to markets Transportation, communication, information infrastructure	Health and education infrastructure Transportation, communication, information infrastructure

Adapted from Siegel and Alwang (1999); Siegel (2005).

ANNEX 2: THE SOCIAL RISK MANAGEMENT APPROACH

The following explanation of social risk management (SRM) is reproduced from the website of the World Bank's Social Protection Unit.[37] The SRM approach is the foundation of the Social Protection Sector Strategy.

I. What is Social Risk Management?

The main idea behind SRM is that all individuals, households and communities are exposed to multiple risks from different sources. Yet, the poor are more vulnerable since they are typically more exposed to risks and have access to fewer risk management instruments that can allow them to deal with these risks. This exposure to risks and lack of addressing it has two important consequences: (i) the poor are severely affected when shocks do occur, accentuating their poverty; and (ii) the poor become more risk averse and unwilling (or unable) to engage in risky but higher return activities. As such, social risk management aims at providing instruments that allow the poor or vulnerable to minimize the impact of exposure to risk and change their behavior in a way that helps them exit poverty and lower their vulnerability.

II. What are Social Risk Management Strategies?

Risk management can take place at different moments – both before and after the risk occurs. The goal of ex ante measures is to prevent the risk from occurring, or, if this is not possible, to mitigate its effects. Individual efforts and choices including migration, irrigation or crop portfolio, can help prevent risks, but in many cases they require government support (such as disaster prevention, crop development). Mitigating the effects of risk through risk pooling requires interaction among individuals and good information and enforcement mechanisms. In practice formal insurances against many risks are not offered and informal risk pools are small and hence less effective. This leaves most poor (and non-poor) households with the residual option of coping with the risk once it occurred. Such risk coping strategies may be very costly (for instance when productive assets are sold, or when children are pulled out of school) which is one reason there for public intervention in risk coping.

Prevention strategies are strategies implemented before a risk event occurs. Reducing the probability of an adverse risk has intrinsic welfare benefits and increases people's expected income and reduces their income variance. Preventive social protection interventions include measures designed to reduce risks in the labor market (the risk of unemployment for instance), preventive health care (such as vaccination or information campaign) or standards (such as building standards in areas prone to earthquakes). Prevention strategies implemented by households or individuals may be very costly and could even be a cause for (income) poverty, for instance when farmers grow low-return, but drought resistant crops or when people seek protection from violence by moving to displaced persons camps.

Mitigation strategies aim to address the risk before it occurs. Whereas preventive strategies reduce the probability of the risk occurring, mitigation strategies help individuals reduce the impact of a future risky event. For example, households may pool uncorrelated risks through informal or formal insurance mechanisms. Whereas formal insurance mechanisms are best placed to pool a large number of risks over many participants, information and enforcement constraints

[37] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALPROTECTION/EXTSRM/0,,menuPK:390683~pagePK:149018~piPK:149093~theSitePK:390677,00.html

limit the coverage actually offered (both geographically and by type of risk). Many people therefore participate in informal insurance mechanisms that are less successful in pooling risk, but are more effective in sharing information and in enforcement. Mitigation strategies can also be implemented in isolation, for instance when a household or individuals save money as a precaution for a rainy day, or when food is stored in preparation for an adverse weather event.

Coping strategies are designed to relieve the impact of the risk once it has occurred. The main forms of coping consist of individual dis-saving, borrowing or relying on public or private transfers. The government has an important role to play when individuals or households have not saved enough to handle repeated or catastrophic risks, when coping mechanisms turn ineffective, for instance when (asset) prices plummet (and food prices soar) because everybody is selling assets to get money to buy food following a covariate shock, or by providing health care to people struck by illness.

III. What are Social Risk Management Arrangements?

Different kinds of arrangements to deal with vulnerability exist. They fall into three main categories: (i) informal; (ii) market based; and (iii) public arrangements on a large scale. In an ideal world with perfectly symmetrical information and complete and well-functioning markets, all risk management arrangements can be market based. However, in reality, all risk management arrangements will play important roles that are likely to change over time.

Informal arrangements have existed for a long time and still constitute the main source of risk management for the majority of the world's population. In the absence of (or with incomplete) market institutions and public provision of support, individual households respond to risk by protecting themselves through informal and personal arrangements. Although they sidestep most of the information and coordination problems that cause market failure, they may not be very effective in helping the household weather adverse events. Nonetheless, the introduction of market or public arrangements may have negative consequences for the functioning of informal arrangements. For instance the introduction of a public arrangement like a food for work program, may lead to the withdrawal from an informal insurance arrangement of able bodied individual, leaving less able bodied individuals (such as the elderly) uninsured.

Market based arrangements have great potential and, where available, households and individuals take advantage of the financial products offered by insurance companies and banks. In practice many of these financial instruments are not available due to market failures, so that their usage is restricted, until financial markets become more developed. Because formal market institutions have difficulty to lend to households (or to provide insurance) without secured earnings and improved access to information, micro-credit and insurance arrangements are potentially interesting instruments for social risk management.

Public arrangements take various forms. When informal or market-based risk management arrangements do not exist the government can provide or mandate (social) insurance programs for risks such as unemployment, old age, work injury, disability, widowhood and sickness. The mandatory participation in a risk pool can circumvent issues of adverse selection, in which individuals with low-risk profiles avoid participation in insurance pools due to premiums while individuals with high-risk profiles join in order to gain access to payouts. Because these programs typically apply to those in formal employment, their coverage in developing countries is generally low. Additionally, governments have a whole array of instruments to help households cope after a shock hits, such as social assistance, subsidies on basic goods and services and public works programs. Through its legislative abilities, government is also able to introduce prevention

strategies (such as building codes in disaster prone areas; protection of widows' rights to assets). Many government programs (health, education, infrastructure), also play an important role in risk prevention.

ANNEX 3: DEPARTMENTS AND COALITIONS WORKING ON NATURAL DISASTER, CLIMATE CHANGE, AND RISK MANAGEMENT AT THE WORLD BANK

Global Environmental Fund (GEF)
The Global Environmental Fund (GEF) was set up in 1991. The GEF funds initiatives that help developing countries meet the objectives of the conventions: Convention on Biological Diversity; United Nations Framework Convention on Climate Change; Stockholm Convention on Persistent Organic Pollutants; and United Nations Convention to Combat Desertification. GEF also collaborates closely with other treaties and agreements. GEF projects are managed by the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and the World Bank. GEF projects address six major global environmental issues: a) biodiversity, b) climate change, c) international waters, d) land degradation, e) ozone layer, and f) persistent organic pollutants. All of these issues are related to climate change. In fact, climate change is receiving more and more attention from the GEF, and more GEF funding is going toward climate change related projects.
http://www.gefweb.org/What_is_the_GEF/what_is_the_gef.html

ProVention Consortium
The ProVention Consortium was established by the World Bank in 2000 to address the increasing frequency and severity of natural disasters and their social, economic and environmental impacts on developing countries. ProVention is a global coalition of international organizations, governments, the private sector, civil society organizations and academic institutions dedicated to increasing the safety of vulnerable communities and to reducing the impacts of natural disasters in developing countries. It provides a forum for multi-stakeholder dialogue on disaster risk reduction and a framework for collective action. The ProVention Secretariat is hosted at the International Federation of the Red Cross and Red Crescent Societies in Geneva. As part of its work on natural disasters, ProVention has examines adaptation strategies to climate change in developing countries. The ProVention publication *Working with the Winds of Change. Towards Strategies for Responding to the Risks Associated with Climate Change and other Hazards* (ProVention, 2007) presents some case studies on traditional climate adaptation strategies in countries in South Asia.
http://www.proventionconsortium.org/?pageid=57&q=climate+change&cx=00895539414336514 6621%3A7izgxfeu-ua&cof=FORID%3A11&pageid=2147483647#1003

Vulnerability and Adaptation Resource Group (VARG)
The Vulnerability and Adaptation Resource Group (VARG**)** was formed in 2003 as an informal network of multilateral and bi-lateral institutions. The VARG Secretariat is based at the World Bank, with the Climate Change team, in the Environment Department (ENV). The mission of VARG is to facilitate the integration of climate change adaptation in the development process through the sharing, assessment, synthesis, and dissemination of existing knowledge and experience.
http://www.climatevarg.org/essd/env/varg.nsf/42ec25f6537f5eff85256dab0048d8e9/ae9a7c23ac1 1dcd485256dab0059b391?OpenDocument

Global Facility for Disaster Reduction and Recovery (GFDRR)
The Global Facility for Disaster Reduction and Recovery (GFDRR) was launched in the end of 2006 and is managed by the World Bank. The GFDDR replaces the World Bank's Disaster Management Facility (DMF) that was created in 2000 along with ProVention. GFDDR is a

partnership of donors and the International Strategy for Disaster Reduction (ISDR) system to support implementation of the Hyogo Framework for Action (HFA).[38] The GFDRR promotes global and regional cooperation in disaster reduction and recovery. In particular, the GFDDR is trying to help mainstream disaster reduction and climate change adaptation in country development strategies, such as poverty reduction strategies (PRSs), country assistance strategies (CASs), United Nations Development Assistance Frameworks (UNDAFs), and National Adaptation Plans of Action (NAPAs), to reduce vulnerabilities to natural hazards.
http://gfdrr.org/index.cfm?Page=About%20the%20GFDRR&ItemID=2

Social Protection Unit
The World Bank's Social Protection (SP) Unit, is part of the Human Development Department. The focus of attention is to assist individuals, households and communities to better manage the income and welfare risks that affect vulnerable households. The SP Unit develops concepts and strategies for policies and investments, mostly in the areas of Child Labor, Disability, Labor Markets, Pensions, Safety Nets, Social Funds, and Social Risk Management. In all these areas, the unit provides operational support to the regions and leadership for sector strategy development, knowledge management, and training.
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALPROTECTION/EXTSRM/0,,contentMDK:20265174~menuPK:390683~pagePK:148956~piPK:216618~theSitePK:390677,00.html

Commodity Risk Management Group (CRMG)
The Commodity Risk Management Group (CRMG) was created in 1999 and has been located in the World Bank's Agriculture and Rural Development Department (ARD) since 2001. It is a consortium of several donors and the private sector. CRMG was created in response to changes in market conditions and climate that were altering the incidence and severity of 'traditional' risks facing the agricultural sector, while generating new risks and uncertainties that affect agri-food supply chain participants. The desire to develop and apply market-based risk management to the agricultural sector was a primary objective behind the creation of the CRMG. Increasingly, CRMG has been shifting its focus to the macro level and developing innovative index-based insurance instruments to help manage major natural and economic risks and disasters that primarily impact the agricultural sector.
http://www-esd.worldbank.org/crmg/home.htm

Financial Markets for Social Safety Nets (FMSSN)
Financial Markets for Social Safety Nets (FMSSN) group (in the Finance and Private Sector Development Department) supports the development of social safety nets using market-based instruments for pensions, insurance systems, and low-income housing. This work aims to increase household and small business access to key non-bank financial markets. The insurance market work emphasizes health, life, and livestock for idiosyncratic risk and earthquake, drought, freeze, flood, and windstorm for systemic risk.
http://164.114.129.64/ifcint/psdvp.nsf/Content/3AFEAC9E98CF1EE38525726E0050B694?OpenDocument

[38] HFA was formulated following the UN World Conference on Disaster Reduction held in January 2005 in Kobe, Hyogo, Japan. The principal strategic goal of the HFA is to "effectively integrate, in a coherent manner, disaster risk considerations into sustainable development policies, planning, programming, and financing at all levels of government."

Global Index Reinsurance Facility (GIRIF)

In November 2007 the International Finance Corporation (IFC) of the World Bank Group got approval for a project to establish a Global Index Reinsurance Facility (GIRIF or the company). IFC's Global Markets Group and the World Bank's FMSSN and CRMG are in collaboration to develop the project, and coordinating with donor agencies for funding. GIRIF uses an international re-insurance company to underwrite indexable weather and other indexable natural catastrophe risks in developing countries; and a technical assistance/donor funding pool to develop the technical parameters of the business. The commercial risk-taking (re-insurance) company will structure, underwrite and transfer the risks for the protection of private entities and government, local farmers and financial intermediaries. The company will reinsure weather and catastrophic events.

http://www.ifc.org/ifcext/spiwebsite1.nsf/f451ebbe34a9a8ca85256a550073ff10/0c3e26c0a76328ec85257235005bad08?OpenDocument