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How do Poor People Adapt to Weather Variability and Natural Disasters Today?

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Poor people in much of the world are constantly threatened by the variability of the weather that they experience from year to year. Even without the effects of climate change, weather variability threatens the livelihoods of poor people. Poor people have become very good at adapting to the vicissitudes of their weather, and the capacities that they have developed to cope with current variability are indicative of those that will be needed to adapt to the effects of climate change. Unfortunately, poor people are already close to the limits of their capacities to cope, and the added effects of climate change may push them beyond their coping capacities unless real efforts are made to prepare for changes in climate.

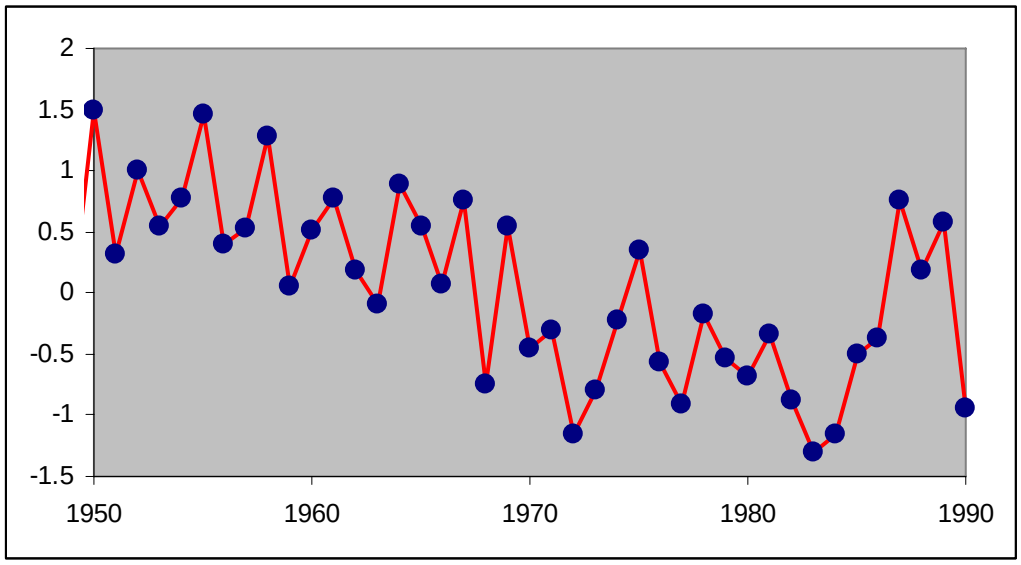


Figure 1 shows the variability in rainfall across the Western Sahel from 1949 to 1990. The data are averages of measurements taken at 38 weather stations and are expressed as standard deviations around the long-term mean. There was a long-term decrease in mean rainfall between 1950 and 1970, but what is more important is the year-to-year variability in rainfall that has occurred throughout the period. Even during the years of worst drought, between 1970 and 1985, there were years when the rainfall was close to or above average. During the "good" years of the 1950s rainfall varied drastically from year to year. This variation is an indication of the situation that is expected to be exacerbated by climate change: an increase in catastrophic events – in this case periodic drought years. The effects in the Sahel of this drying associated with year-to-year variability have been serious. During the wetter periods, the occurrence of dry years made it very difficult for farmers to predict what would happen to different kinds of crops. Root crops that would grow in a

good year and provide a valuable addition to the diet would fail in dry years. Maize began to be grown increasingly in areas that had traditionally been used for the more drought-tolerant sorghum or millet, but maize now fails frequently during dryer years. By the 1970s crop options became reduced in much of the rainfed Sahel to the truly drought-tolerant crops, but even they did poorly in the worst years. Farmers found it more and more difficult to survive poor years without selling assets, which reduced the ability of farmers to recover in subsequent years. The 1970s saw severe food shortages and considerable numbers of people moving permanently from their homes.

However, despite these pressures, the 1980s and 19990s were marked by a remarkable turn-around in the economy of the Sahel, with Mali at one point becoming Africa's main producer of cotton. The people of the Sahel are clearly extremely good at managing very difficult conditions.

Mobile Pastoralism

All around the dryer parts of the developing world, herders move their flocks over vast distances every year. Mobile pastoralism is an ancient and effective and efficient way of deriving benefit from the arid and semi-arid parts of the world. Where water is lacking and droughts frequent, livestock always feature in farming systems. By being mobile, herders can make the best use of scarce rainfall. Mobility allows herders to use centuries of accumulated knowledge to drive their animals to where they know the best pasture will be at any time. It also allows flexibility to search for good pasture in poor years. While often regarded as a primitive and backward way of life, mobile pastoralism is actually a very efficient way of using scarce resources, and while appearing anarchic and uncontrolled, is actually managed through complex and proven societal norms that determine when resources can be used, by whom and by how much. In this way ecosystems are managed sustainably while maximizing the benefits to the pastoral communities.

If pastoralism is to play a major role in adapting to climate change in the future, it will be extremely important not to repeat policy mistakes of the past. When governments and development agencies began to turn their attention to pastoral communities in the 1970s, their lack of understanding of the efficiencies of mobility led to a number of serious mistakes being made. It was assumed that the ranching models of the USA and other places would be more efficient than the "primitive nomadic" systems found around the developing world. Governments (often backed by laws that declared the government to be the sole owner of land) began to control the movement of pastoralists and encourage them to settle down in one place. This was resisted by most pastoralists, who saw their herds being kept away from perfectly good sources of grass and water that they had used for centuries. The "scientific" application of ranching usually simply did not work. Scientists from a ranching background applied "linear" models that calculated the carrying capacity of an area of rangeland. Mobile pastoral systems are inherently non-linear, with

complex and important interactions involving animals, people, landscapes, numerous possible movements and knowledge. Shifting from an essentially sustainable non-linear model to a simplified linear model in difficult dry conditions proved disastrous, and projects failed as animals died and the environment was ruined. These failures were exacerbated by other errors such as introducing improved breeds of animals that could not withstand the harsh conditions of a mobile life. Even now, pastoralists get little help. They are impeded by national barriers, they remain ignored in national planning and their land rights are not recognized and their ancestral rangelands are increasingly being turned over to farming. If pastoralists are to contribute to adaptation to a world affected by climate change there will need to be much better understanding of the potential and limitations of pastoralism and a much better policy response.

Box 1
Pastoralists adapt to changing conditions and new pressures

Pastoralists around the world are proving their ability to adapt to changing conditions. Governments often place huge pressures on the pastoralists to "modernize", in the mistaken belief that the pastoral lifestyle is not viable. In fact, pastoralism is viable, and good policy can help to optimize livelihoods. The challenge under conditions of climate change will be to learn that pastoralists are good at adapting, and their main need is for policies that help them and not policies that try to change them.

Land tenure can be particularly vexing for pastoralists. They depend upon mobility as a prime adaptive strategy, but governments constantly try to settle them. Colonial and post-colonial governments have usually regarded mobile pastoralism as primitive, and settled life on a plot of land with individual title as modern. In the highlands of Bolivia, for example, the government put great pressure on communal pastoral communities to follow Bolivia's land reform process of the 1950s and sub-divide the land into individually-owned plots. The pastoralists knew that this would threaten their efficient customary practices where entry to the land, herd sizes and seasonal use are all controlled. However, during the 1970s the pastoralists finally conceded and their land was divided into plots around small villages, and people were given title to the land. Fortunately, the community at large did not change their ways, and continue to manage the land according to traditional ways. A very similar situation has evolved in Kenya, where the Maasai conceded to a system of group ranches where individuals own individual plots. However, ecology triumphed over tenure, and the Maasai generally still manage their land communally, which holds great promise for setting communal land aside for earning income from wildlife tourism. However, the existence of individual title is placing great pressures on the system, for example where owners have leased out their land to wheat farmers who quickly destroyed it or near to Nairobi where roadside plots can be sold at a high price.

Pastoralists are often poorly provided with social service, if they receive any service at all. Few pastoral children receive adequate education, even though education will be vital if pastoral communities are to be able to demand rights and adapt to the changing world. Iran and Mongolia have both demonstrated that it is possible for governments to provide good quality social services to mobile communities. Both countries have provided mobile schools that follow communities around. In Mongolia this has resulted in remarkably high literacy rates [Insert from HDR]. In Iran, communities have been provided with tented primary schools – white tents to distinguish them from the normal black of the community. Most schooling takes place during the seasons when the communities do not move much. In the spring, when the community's tents are packed and the community moves, the school tents follow them. The teachers are drawn from pastoral communities, so they are very aware of the special needs of their communities.

Box 2
Hope in the face of disaster – the case of Baringo

Lake Baringo is one of Africa's large Rift Valley lakes. Never particularly deep, it is now suffering from siltation caused by severe run-off from the basin surrounding it. Scientists give it little more that 20 years before it fills up and becomes a swamp. The fishing industry has collapsed, the fish factory has closed, and the formerly benign population of fish-eating crocodiles has begun to prey on goats and have become a danger to people. The cause of this ecological and human disaster is severe over-grazing in the basin exacerbated by a reduction in river flow from the highlands. The hills surrounding the basin and the flatlands around the lake have mostly been grazed to a red dust where extensive herds of goats browse on the few surviving *Acacia* bushes. Local people report that the rains are now more erratic that previously and last for a much shorter time each year. The main cause of the overgrazing is that the various groups of people around the lake have been forced to abandon their former mobile ways of life and become sedentary. Some of the reasons can be traced back to misguided colonial experiments in ranching and now to conflict among the tribes of the region. Food aid policies that rewarded sedentarism and lack of productivity have also played their part. The now non-mobile animal owners still manage the land communally, but now cannot take their herds to where grass and water are available, nor control the pressure on the land. The future of Baringo has never looked bleaker.

Fortunately, the fate of the people of Baringo is turning. For the last twenty years communities have been working with a local non governmental organization – the Rehabilitation of Arid Environments (RAE) Trust – to restore the land and improve their livelihoods. The social and physical history of Baringo is preventing people from returning to their former efficient use of the environment, and the costs of losing mobility have been huge. The communities have now agreed that the only way to protect the land will be to reduce grazing, and to do this people will have to learn to manage fenced enclosures instead of manage the land communally. The communities have decided to fence off plots of 10 acres or more to be managed by families, shareholders and women's groups. The RAE Trust, building on many years of research, is able to recommend the best grass species for restoration and prepare the land for seeding. With grazing animals excluded, the barren soils of Baringo produce healthy grass cover in 2 – 3 years. People can then use that grass as a basis for money-making enterprises. Some keep a few high value animals. Others charge fees for fattening animals bound for market. All sell the grass seed to others interested in land rehabilitation and the grass itself is used for thatching or sold as hay. Once the grass is growing it holds rainwater well, and trees naturally return to the landscape. These attract birds and insects, can be cut and sold as firewood and allow a honey industry to be set up.

UNDP's Drylands Development Centre, the RAE Trust and the World Agroforestry Centre are now investigating how much additional carbon is sequestered when bare soil is replace by grass and trees. Farmers, like those in Baringo, have the potential to contribute to the mitigation of atmospheric carbon levels by adopting land management practices that sequester carbon. At present, bio-sequestration of this kind is not covered by the Kyoto Protocol. Improved carbon trading norms are needed to allow poor farmers to become part of a truly global carbon trading regime. The people of Baringo have demonstrated a remarkable ability to adapt to deteriorating conditions, developing new technologies that, with the right support, can be extended to other communities.

Agriculture in dry areas

Examples of farming systems in dryland Africa, Middle East, and Asia

Sub-Saharan Africa

The Sahel forms the northernmost edge of cropped land in sub-Saharan Africa, stretching in a latitudinal band along the southern edge of the Sahara Desert. Low and unreliable rainfall (approximately 200-800 mm per annum) is a major constraint for agricultural production, although other factors also play a major role, especially low soil fertility (Sanders 1989) and the poverty of rural inhabitants, which greatly limits their ability to take drought-protective measures. Off-farm migration of males for employment during dry seasons and droughts is a common coping mechanism, although it creates hardship for families left behind.

In the driest, parts of the Sahel, extremely drought-tolerant millet/cowpea cropping systems predominate; moving southwards, rainfall increases and sorghum/groundnut systems increase in frequency. In southern Africa along the fringes of the Kalahari Desert, these same cropping systems are found although there is a stronger demand for maize in the diet. As a result, maize is often cropped in very dry areas in southern Africa despite its greater drought susceptibility, leading to frequent crop failures. In Ethiopia, teff is often grown in the drylands.

Livestock are equally important as crops in most of dryland Africa. Nomadic herding is a traditional mechanism for reducing drought risk. Livestock are mobile, unlike crops so when drought strikes they can move to greener pastures and water sources. However, the nomadic lifestyle is under increasing pressure from the expansion of cropland as well as urban and state land uses (roads, industries, borders). These trends restrict herd movements, exposing them to greater drought risk and considerable suffering.

Middle East-North Africa-West Asia

Most land in the Middle East and North Africa is desert, and population densities are high on the narrow coastal strips of arable dryland. Most countries cannot produce enough food to feed their populations, and are net food importers. Because of their long history of intensive cultivation, much of the land is degraded from erosion, or salinized as a result of irrigation (Winslow and Thomas 2006).

Around the edges of the Mediterranean Sea, a marginal 200-350 mm of winter rainfall is sufficient to cultivate only drought-hardy cereal (barley, wheat), legume (chickpea, faba bean, forage legume) and tree (olives, fruits, nuts) crops, together with sheep and goat herding. Rangelands are degraded due to excessive livestock populations relative the low primary productivity of these

rainfed grasslands. Herders are increasingly required to purchase livestock feed and fodder to stay in operation.

Nile River Valley agriculture is based on intensively-managed irrigation. The enormous population pressure and lack of rainfall in this zone makes it heavily dependent on intensive cultivation, which causes salinity buildup, water pollution and water shortages. Climate change could wreak major havoc if it affects the hydrology of the Nile basin.

In the Arabian Peninsula, agriculture depends on groundwater but in many areas non-renewable aquifers are being depleted. In Iran and Pakistan, rugged mountainous terrain and extreme temperature variability, especially cold winters impact agriculture. Irrigation in steep terraces, ravines and mountain areas often scars the land with erosion gullies. Salinity is widespread in inter-mountain basin areas due to difficulty in draining salt-laden water from the field.

South Asia

The central spine of the Indian sub-continent running from its southern midsection north to Pakistan's Himalayas is a dryland zone that is home to about half a billion people. The delicate balance between the desert and people is breaking down due to increasing populations of humans and livestock, unchecked deforestation, over-grazing, over-cultivation and soil erosion. Growing populations lead to land subdivision through inheritance, leaving successive generations entrenched in poverty.

Almost every year, India experiences drought somewhere. In dryland areas across India, water tables are falling due to over-pumping, prompting government investments to improve community watershed management and in large-scale irrigation systems. Millet, chickpea, sorghum, pigeonpea, cotton, groundnut, mustard, maize castor bean and soybean are important dryland crops, in order of increasing moisture requirement.

<u>Small-scale water management systems</u>

In the Sahel, water harvesting is often practiced using small bunds or dikes made of dirt, stone or living vegetation along slope contours. Terracing and trenching are used in some steeply sloped areas in Ethiopia. Burkina Faso, with World Bank assistance encouraged the construction of earthen and stone contour dikes across 60,000 hectares in the heavily-degraded Yatenga area during the 1970s/80s (Sanders et al. 1996).

More than 100,000 laterite-encrusted hectares in the Central Plateau of Burkina Faso and in Niger have been recovered for agriculture by smallholders using the zaï technique, which involves the digging small circular pits in the soil surface and adding organic matter to both capture runoff water and stimulate

biological activity and tree regeneration. Small check dams are sometimes constructed to slow runoff and increase water infiltration into the soil. Recently in Niger, millions of hectares of 'farmer-managed natural regeneration' of native trees has been reported; although more trees consume more water, they also increase soil organic matter and infiltration, causing water tables to rise in some villages (Chris Reij, Univ. of Wageningen, unpublished data).

In the drylands of Ethiopia and Sudan, smallholders have evolved indigenous techniques for water harvesting (Krüger et al. 1996; Niemeijer 1999). For World Bank reviews of different techniques utilized in Sub-Saharan Africa see Reij et al. 1988; and Critchley et al. 1994.)

In hilly and mountainous areas of the Middle East, North Africa and West Asia, canyons, valleys and slopes are utilized by dryland peoples to capture water through ingenious but labor-intensive water harvesting techniques such as 'aflaj', 'qanats' and 'spate irrigation'. In India, major government backing has encouraged community watershed management to capture runoff water and increase local groundwater recharge, along with the adoption of modern agricultural technologies and the recycling of organic wastes to raise soil fertility.

<u>The future of drylands farming under scenarios of climate change: what will be needed to adapt?</u>

Climate change predictions are still too coarse to give highly specific guidance about rainfall levels, but several models suggest that hot, dry areas will get hotter and drier, along with increased weather variability and more extreme weather events (floods, droughts, winds). The Intergovernmental Panel on Climate Change, Working Group II on Impacts, Adaptation and Vulnerability recently consolidated global scientific opinion to conclude that dryland areas, particularly along the desert margins of Africa face great risk. Drought-affected areas are likely to expand, and the poor have the least capacity to adapt to the increasing severity of weather events that are expected (IPCC 2007).

To adapt to increasing weather variability, buffering and diversification strategies are needed, as described below.

Cropping systems change

If climates change, farmers will shift cropping patterns to adapt, as long as markets can be found for their produce (Tiffen 2002, 2003). If the drylands become wetter, increased maize, rice and wheat cultivation is likely; if they become drier, millet production may rise, although its market potential is limited by low human consumption rates. Livestock grazing may be the only remaining dryland use in areas that become too dry for crops, although impediments to nomadic herding discussed earlier will probably constrain its

resurgence. Marginalized farmers will most likely migrate to wetter areas as landless laborers or in search of low-wage urban employment, incurring considerable suffering for their families in the process.

Water harvesting and small-scale irrigation
Improved water management can sequester the excess expected from extreme rainfall events to be used later during the worsening droughts. Water harvesting can be increased through development assistance to promote community watershed management, build small check-dams, and similar interventions. While the Middle East and North Africa have almost fully exploited their scarce water resources, irrigation efficiency can be increased by modernizing systems (e.g. drip irrigation, needs-based supplemental irrigation) (World Bank 2007). There is more potential for the expansion of irrigation in the Sahel (Sonou 1994) if it can be made affordable for poverty-stricken smallholders. High-value crops grown using affordable, water-saving technologies such as gravity-flow drip irrigation on small areas of land (e.g. 0.1 hectare) can substantially increase incomes (IPALAC, 2003).

Integrated crop management
Drought tolerance has been a major breeding objective worldwide for decades, but progress has been relatively modest. Genetic changes that reduce water use also reduce biomass production and yield, reducing economic competitiveness. More success has been achieved through increasing plant adaptation to dryland agro-ecological niches, such as adjusting phenology (time required to mature) to better fit prevailing rainfall patterns, and increasing disease resistance (diseases weaken plant drought hardiness and water use efficiency).

Apart from solving basic adaptation and disease/pest resistance problems, breeding-only strategies for dryland cropping systems do not have a strong track record of success (e.g. Ahmed et al. 2000) because drought and low soil fertility constrain the expression of higher genetic yield potential. The correction of nutrient deficiencies (especially phosphorus, nitrogen and soil organic matter) and small-scale water harvesting provide synergistic effects in combination with improved varieties; these three improvements should be pursued in an integrated fashion to reduce drought losses and buffer against weather variability.

Diversification with higher-value crops
The addition of high-value crops to dryland farming systems can boost incomes while diversifying the farm enterprise to reduce risk. The integration of tree, crop and livestock systems increases biodiversity while raising productivity through greater re-cycling of nutrients. Trees mediate wind and water erosion, and often tap groundwater resources through deep roots.

Policies

Emergency grain reserves can reduce food price spikes that create hunger following droughts. Minimum guaranteed prices can reduce farmers' risk of price collapse during favorable years. Policies that connect smallholders to foreign markets and input supplies and protect against unfair foreign subsidies raise dryland incomes and reduce dependence on the local climate. Better educational services can increase off-farm employment opportunities, especially for the next generation that is likely to face even more serious weather variability.

Longer-term development pathways

Rainfed agriculture in the drylands is already a risky, marginal enterprise. Farm families' main objective is to produce enough food to survive. Occasional production surpluses are viewed as fortuitous events when they occur, but not to be relied upon for survival. Droughts every 3-5 years demolish welfare gains achieved during the interim.

Hundreds of millions of poor dryland inhabitants worldwide are highly exposed to the increasing vicissitudes of climate change. The poorest are dependent on rainfed subsistence agriculture and need urgent and continuing humanitarian assistance to ease their plight. But they also need development pathways that help them escape from this trap.

Two opposite paths have been postulated. In the downward spiral hypothesis (Cleaver and Schreiber 1994) ever-increasing populations degrade fragile lands, compelling the poor to degrade those lands even further to scratch out a living. In the 'induced innovation' scenario (Boserup 1965), on the other hand, social organization and competitive pressures force innovation towards higher-value livelihoods.

Both views can cite supporting evidence (Winslow et al. 2004). Surveys of the literature indicate that favorable outcomes through induced innovation tend to be associated with the realization of local comparative advantages; access to productivity-enhancing technologies that outpace increases in labor; and improved access to growing markets (Hazell and Haddad 2001; Mortimore 2005; Pender, 1998; Pender et al. 2001).

As populations increase, urban centers tend to coalesce and generate meaningful non-farm employment. This transition is occurring more rapidly in Africa than many realize (Tiffen 2003) and provides an outlet for the transition of farm labor into the urban sector, if accompanied by education and supportive policies.

Farmers need urban areas as customers, and urban areas will trade their cash for the food they cannot grow themselves. The two sectors are mutually

supportive. The increased income that can be earned from agricultural sales to growing urban markets motivates investments in more productive technologies such as small-scale supplementary irrigation, soil fertility improvement, terracing and other practices that buffer against weather fluctuations (Tiffen 2002).

The effect of connections to urban markets, then is to raise farm incomes, increase access to knowledge and technology, and to provide youth with opportunities to escape rural poverty through urban employment. The buying power of urban areas, in a sense thus helps insulate them from climate change. Policies that encourage this rural-to-urban transition can thus enhance resilience to climate change.

Since urban areas have purchasing power and political influence, they can also source their foodstuffs internationally if local crops fail due to weather variability, although this should be done in ways that do not undermine local farmers. Higher prices resulting from drought-induced production shortfalls help compensate farmers for their drought losses. However an influx of subsidized imports can eliminate that compensatory buffer, and cause rural areas to sink further into poverty.

Although some argue that subsidies and protections should be avoided, others point out that no dryland society in history has ever emerged from poverty without supportive government policies. Defensive measures seem justifiable as long as developed countries continue to strongly subsidize their exports to the developing world.

Ultimately the most efficient global adjustment would be to foster the inherent advantages of different regions. The latest IPCC conclusions suggest that crop productivity may increase in large areas of the temperate latitudes, while being adversely affected in the tropics, especially in the drylands (IPCC 2007).

However, comparative advantage analysis should include more than just biophysical factors; cultural, economic and other considerations must also be taken into account; and social goals such as equity and poverty alleviation are also important. The developing-world drylands hold certain advantages such as relatively low-cost land and labor, and unique local biodiversity. Many specialty crops and products adapted to warm, dry, sunny environments could deliver increased incomes to the poor, if local, regional and international markets were opened to them and fostered.

Box 3
Science to the rescue – stress resistant crops

In ancient time, before Europeans knew Africa, an important source of food on the continent was African rice (*Oryza glaberrima*). This tough, weed-like plant was quickly supplanted by the higher-yielding Asian rice (*Oryza sativa*) when it was introduced to Africa. However, Asian rice needs very specific conditions to thrive – plenty of water and careful weed control being most important. During the 1990s scientists at the African Rice Centre (WARDA), supported by the Government of Japan and UNDP, discovered ways of crossing the African and Asian species, creating a remarkable "New Rice for Africa", or NERICA. NERICA combines the yield and quality of Asian rice with the toughness of African rice. NERICA smothers competing weeds, resists drought and other stresses and resists attack by insects. As a result of an accelerated breeding programme, NERICAs are already available throughout Africa and are becoming the preferred varieties for many farmers.

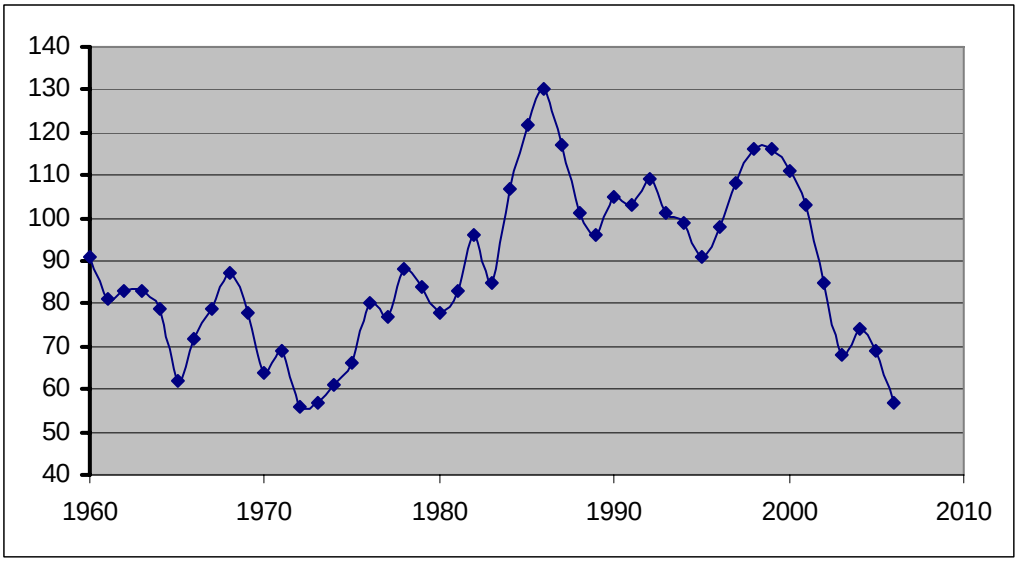
Meanwhile, similar efforts are under way to make maize more resistant to drought and other stresses. Even today, outside of the temperate zones, 15% of potential maize yields are lost to drought. This amounts to 19 million tonnes of food each year. The International Maize and Wheat Improvement Centre (CIMMYT), and the International Institute of Tropical Agriculture (IITA), with funding from the Gates Foundation, have selected varieties of drought-resistant maize that are already planted on approaching one million hectares of land in Africa, leading to yield increases of 25 – 30%.

The excellent progress already made to increase the resistance of crops to climate stress has demonstrated how important agricultural research will be in adapting to climate change. The scientists involved have mobilized their full armoury of skills. Some of the work has identified the many underlying physical and physiological traits that result in drought tolerance. Meanwhile, field scientists have recognized that farmers are the best qualified to identify the best varieties, and have carried out their research with the full participation of farming communities. This is an excellent example of building new adaptive approaches on the current knowledge of farmers of how to deal with today's weather. Unfortunately, despite the obvious value of agricultural research, the amount of money spent worldwide on agricultural development has been falling since the 1980s. CIMMYT, IITA, WARDA and 13 other vital international research organizations receive about $500 million per year: an amount that is totally inadequate. Developing countries follow this example. Even where 60 – 80% of populations depend upon farming, countries typically invest 2 – 4% of national budget to agriculture, within which the amount for research is miniscule. It is difficult to comprehend a world where so little is invested into the science that will of such great importance to future survival.

Responding to increasing food crises

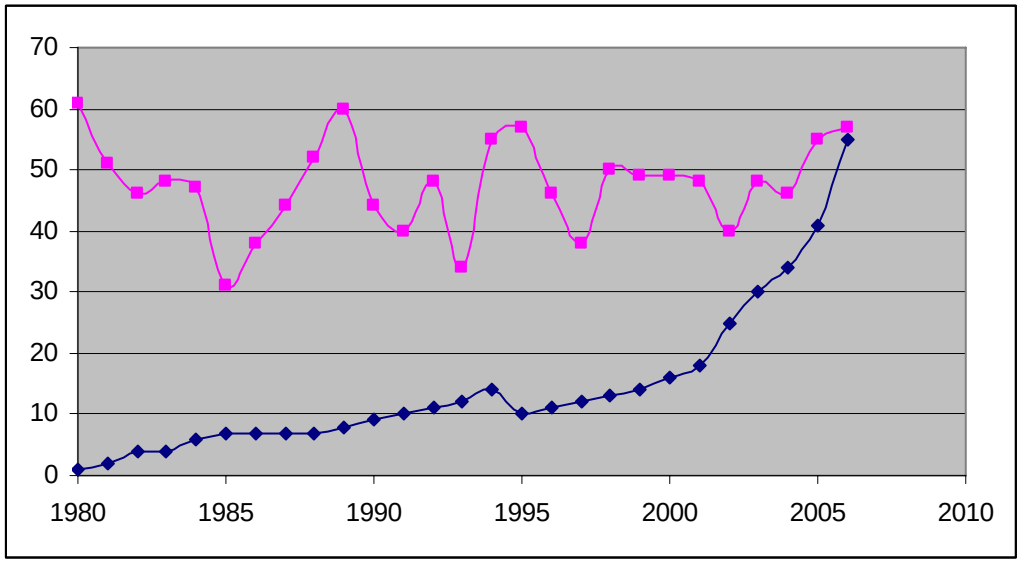
The more apocalyptic predictions of climate change anticipate a world where levels of hunger will increase catastrophically. This assumes that food production will decrease worldwide, that there will be areas of famine caused by crop failure and that world trade will not compensate for local crop failure. The sections above have indicated that considerable resilience can be built into livestock and crop production systems. However, it is probable that overall global food production systems will be affected by climate change, and it will be important to understand the strengths and weaknesses of current models used to ensure global food security and make sure that the right policies are adopted to cope with the threats of climate change and other changes.

Food supply is becoming increasingly globalized in today's world. Large producer subsidies in the OECD have driven down world prices and made huge amounts of basic foods available for trade on the world market. Whether this situation will continue into the future is a matter of some debate. Models used by FAO and the OECD predict cereal prices will remain more or les steady until 2015. They expect falling rates of global population to keep demand down. Others, particularly in the NGO community point out that rising demands for meat and luxury foods in the growing markets of Asia will push prices up. If the OECD follows through on plans to remove producer subsidies, this will also drive up world prices. Those who worry that today's supply of cheap food will disappear in the future point out that recent world harvests have not met global demand, and that global cereal stocks are at their lowest since the early 1970s when food production was considered to be in crisis. Figure 2 shows world cereal stocks expressed as days of consumption in reserve.



The direct effects of climate change on food production are difficult to predict [cross reference wherever in the HDR this is discussed]. One unexpected effect might be if significant amount of land and resources are used to create bio-fuels rather than food. Figure 3 shows the amount of maize exported from the

USA (red line) and the remarkable increase in maize used in the USA for bio-fuel. This mirrors a rapid increase in the global production of ethanol for transport fuel from a negligible level in 1975 to about 12,000 million gallons in 2006.



The international model applied to deal with natural disasters has been based for the last 30 years on an assumption that there will be a surplus of relatively cheap food in the world. The dominant model has been for the official and non-governmental agencies involved to maximize their readiness to rush relief supplies to affected areas after a disaster has occurred. Little has been done to increase the resilience of people to risk, as evidenced by the continuing destruction caused by droughts and storms in areas regularly affected. In view of any risk that the supply of cheap food on the world market might be reduced, it will be important to develop other ways of dealing with crisies. Even without the full effects of climate change, the number of disasters has risen in recent decades, growing from fewer than 100 global events in 1975 to 426 in 2006 (World Bank 2006; CRED 2007). At the same time, the scale of many disasters has grown, such that the number of people affected increased from 1.6 billion in the period 1984 to 1993, to almost 2.6 billion during 1994 to 2004 (Guha-Sapir et. al. 2004). In the most recent, relatively "quiet" year roughly 143 million people had their lives and livelihoods disrupted by exogenous shocks of various kinds (CRED 2007).

The economic costs (damage to assets, income foregone, and the cost of relief) have also escalated. It is estimated that the economic impact of disasters is today 15 times higher than in the 1950s (in constant dollars)—equivalent to $652 billion in material losses in the 1990s, compared with $38 billion (at 1998 values) between 1950 and 1959 (Freeman et. al. 2003). Economic losses in 2006 were estimated at more than US$ 34 billion (CRED 2007).

Humanitarian appeals through the United Nations' consolidated appeals process have grown in response to these challenges, rising from $1.5 billion in 1997 to $3.9 billion in 2007. Adding expenditure by non-governmental agencies and contributions of the general public and private sector, it has been estimated that total resources flowing to humanitarian responses have recently averaged around $5 billion per year of late--a level that continues to grow. However, most costs are borne by the country itself since external aid typically offsets less than 10% of a country's disaster losses (Linnerooth-Bayer and Amendola 2000). Although shocks can occur almost anywhere on the globe, losses in developing countries are generally higher than in industrialized countries as a share of gross national income or government revenue—mainly due of lack of disaster-proofing, lack of insurance systems, poor standards for urban development, large concentrations of poor people in urban slums, a lack of early warning, and an absence of functioning safety nets. For example, the Maldives' tsunami losses amounted to 66% of Gross Domestic Product (GDP), while Hurricane Mitch caused losses equal to 41% of GDP in Honduras (World Bank 2006). Similarly, while in 2006 the United States faced large absolute losses to disasters (an estimated US$5 billion), it was Guyana that suffered the largest losses relative to overall income—a devastating 21.5% of GDP (CRED 2007).

In cases like Guyana, losses are linked to the devastation of rural economies, including loss of assets (livestock perishing in droughts or irrigation infrastructure swept away by a tsunami), loss of revenue (such as when floods causing salinisation of paddy fields, or destroy stocks of seeds and fertilizer, which impairs post-crisis agricultural output), and/or loss of markets (where export production or processing are compromised).

There is a strong inverse relationship between the occurrences of shocks (be it a natural disaster or an armed conflict) and progress in tackling undernourishment or reducing poverty in poor countries (Webb and Rogers 2003). Droughts, floods, conflicts, and political or economic instability compound the daily risks facing food insecure communities. While investing in agricultural productivity is important to achieving longer-term development in many locations, the very sustainability of progress in agriculture is threatened where developmental gains do not reduce people's vulnerability to shocks. Hence, as Sparrow (2001) puts it, "catastrophe is no longer a brief dip on the curve of development but a danger to the process itself."

There are four main types of disaster: a) sudden natural shocks, such as Hurricane Mitch or the Orissa Super-Cyclone, require urgent action to save lives, which implies a need for rapid delivery of bulk commodities, especially where infrastructure has been destroyed. Pest (locusts) and disease outbreaks (avian flu) that impact human livelihoods can also be classified as sudden onset. Chronic emergencies (b) are characterized by pockets of people who normally survive long

periods of chronic food insecurity, but whose needs become acute when shocks destabilize their (already eroded) capacity to cope. Complex emergencies (c) remain a dangerous challenge, being associated with armed conflict in the context of failed or failing states, such as recent crises in Afghanistan, Somalia and Lebanon. Finally, slow-onset emergencies (d) are typically linked to droughts or certain types of recurrent flooding. While these can be anticipated, the impact is not always predictable--the scale of the 2002/03 crisis in southern and eastern Africa being a case in point. In areas lacking resources and services, creeping disasters manifest more slowly and their determinants are less clear, which makes defining the appropriate response a challenge. In 2006, floods accounted for 55% of all forms of natural disaster occurrences (CRED 2007).

These kinds of shocks are not all random occurrences, but tend to concentrate in certain locations that become inherently risky to human activity—seismic zones, drought prone (ecologically semi-arid) regions, coastal and riverine locations subject to frequent flooding or windstorms, and steep (often eroded) hillsides. The huge numbers of individuals killed or affected by disasters tend to inhabit such difficult environments (some of which face more than one kinds of shocks). Public and private investments tend to avoid these locations, but poor and vulnerable communities cannot. Without investment, productivity levels remain low (hence chronic poverty and malnutrition in these places), and the need for systems of disaster insurance or protection (safety nets) rises—a need that is rarely adequately met in already poor developing countries. As a result, beneficiaries of disaster relief tend to be inhabitants of marginalized agricultural systems, receiving limited public protection from shocks, who are thus caught in a vicious cycle of seeking to minimize risks, but never being able to optimize outputs.

It has been estimated that around 40% of the world's productive lands lie in arid, semi-arid and dry sub-humid zones, with almost 1 billion people relying for their livelihoods on the natural resources found in these locations (HTF 2005). Another 11% of the world's population live in mountainous areas, of whom 40% are food insecure. In other words, roughly 50% of the world's chronically undernourished people are small farmers inhabiting 'marginal' lands. The implications are huge. First, without serious and sustained investment in such environments many countries will not come close to attaining internationally-agreed goals for poverty and hunger reduction. Investments are needed both for enhancing productivity (through soil fertility enhancement, improved water management, pest and disease control, and reduced marketing costs), and for better managing risks (with drought-resistant crops, diversified crop and livelihood portfolios, crop insurance, etc). At the same time, the human vulnerability of such large numbers of people has to be minimized through effective safety nets and human capital enhancement (Freeman et al 2003). This requires improved and extended national and local early warning systems, strengthened national capacity to respond to emergencies, and more predictable funding of such preparedness at international levels, and effective (well financed and managed) productive safety nets based on availability

of work, conditional cash transfers, and targeted (life-supporting) assistance where appropriate (Hunger Task Force, 2005).

The international community is beginning to realize that a longer-term approach is needed to help people adapt to weather effects and strengthen their resilience to natural disasters. Developed countries have all introduced systems that transfer resources from the better off to the poorer, especially when the poor person involved is suffering from short-term deprivation or the effects of circumstances beyond the person's control. In general, the transfers are in the form of cash, such as the well-recognized unemployment benefits paid to people without jobs around the world. Similar "social safety net" systems have not been used to any great extent in developing countries, partly because poor country governments are unable to mobilize the cash necessary and also because donors have been unwilling to fund cash payments. Instead, they have preferred to provide food aid, sometimes through "food for work" schemes and short-term responses to disasters.

There have been a number of recent experiments in cash-based social safety nets, particularly in Latin America. Mexico's *Progresa* programme provides cash to mothers to provide the basic services needed by their children. For example, cash payments depend upon the child attending school and seeking health services. Brazil's programme to eliminate hunger provides $US20 per month to mothers for food, and at the same time supports agricultural production and establishes food reserves in the most food-insecure parts of Brazil. There has been much less success in introducing cash payment systems into the least developed countries, principally in Africa, but recently the idea of cash-based social safety nets has begun to take off. A major cash transfer programme has been launched in Kenya with the support of UNICEF and similar cash transfers programmes are being introduced elsewhere in Africa (Lesotho, Malawi, Mozambique, Zambia, Zimbabwe). Cash relief grants to food-insecure are helping households (Ethiopia), child support grants are being distributed (Ethiopia, Namibia, South Africa), child care grants focusing on orphans and other vulnerable children have been introduced (Lesotho, Malawi, South Africa, Tanzania), disability grants are being introduced (Lesotho, Namibia, South Africa), and non- contributory 'social pensions' (Botswana, Lesotho, Namibia, South Africa) are replacing worker-funded schemes.

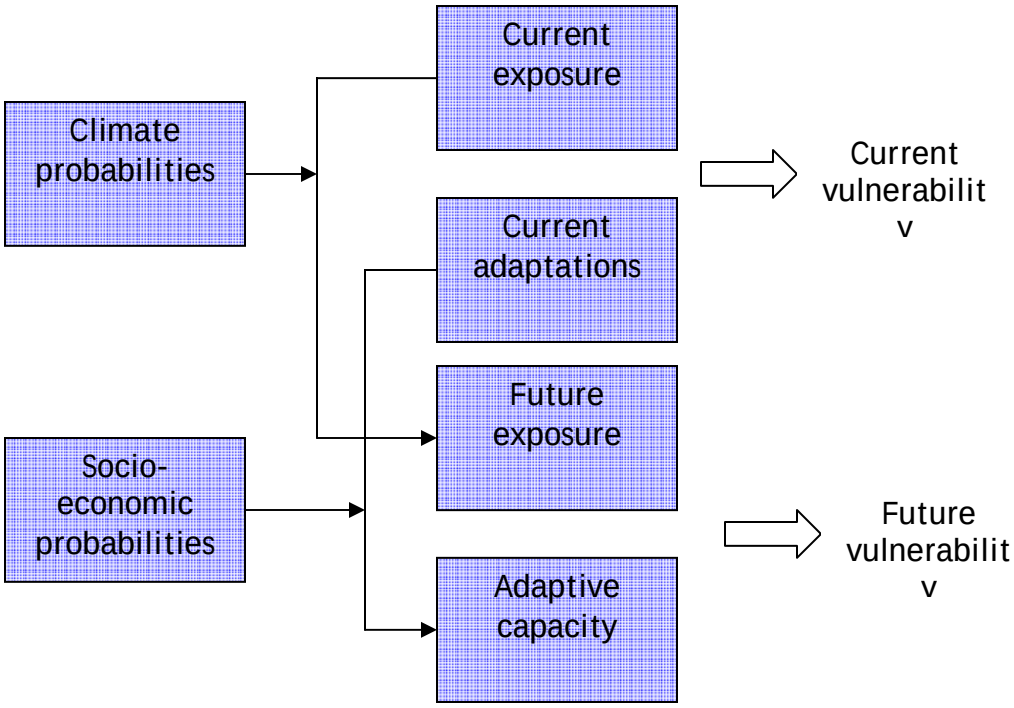
The current trend in shifting social safety net support from short-term relief to longer-term social insurance is clear, but all of the schemes currently in operation are dealing with current levels of deprivation and may not be aligned with future needs caused by increasing vulnerability to the effects of climate change. What will be needed is improved access to insurance schemes that meet the needs of poor people while limiting the risk of the insurance provider, whether government or the private sector. When operating at its best food aid provides a solid foundation of insurance that protects people during poor years from selling off their assets and failing to invest in future production. The evidence for the success

of food aid as insurance is best demonstrated by the many examples of high crop yields following years of famine. The transition of poor economies to social security based on insurance has been very slow. A number of innovative schemes have begun to demonstrate value of commercial insurance to help poor people to deal with the variability of weather and other impacts on their livelihoods. An Indian non-governmental organization called BASIX has joined with ICICI Bank, India's largest private sector bank and Lombard, one of the oldest property and casualty insurance companies in Canada to provide insurance to small-scale farmers. BASIX and ICICI Lombard along with the Commodity Risk Management Group, World Bank, have piloted rainfall insurance in India since 2003. In 2005, insurance schemes have been rolled out in six Indian states. Among the insurance services offered is rainfall insurance, under which poor farmers are able to protect themselves against the effects of drought. The world Food Programme has taken the principle of weather insurance to a national level. AXA Re, a reinsurance company working with WFP, has underwritten $7 million of weather-related protection for small farmers in Ethiopia.

The development community is moving from its old approaches based on welfare following crises to a more proactive approach based on an understanding of how to reduce the risks associated with exposure to natural hazards. These approaches will be increasingly needed as the effects of climate change affect more people as climate change exacerbates the effects that poor people are already experiencing fro the effects of current variability in weather patterns.

Policy implications

A sound understanding of current capacities to adapt to weather variability can help mould policy for the future. Huq and Reid (2004) Provide a simple flow chart to indicate that the processes needed to adapt to future climate change will frequently be built on the adaptive processes already developed to cope with current weather variability (Figure 3).



Promoting pastoralim to adapt to climate change

It is estimated that there are between 100 and 200 million mobile pastoralists in the world today (depending upon the definition of "mobility"). Some places will get wetter, and the options for the pastoralists there will be easiest to anticipate. Unfortunately, the IPCC predicts that many arid and semi arid parts of the developing world will get dryer, and the frequency of droughts will increase. The pastoralists there will be severely challenged, but if developing countries are to adapt their economies to the effects of climate change, the pastoralists must be part of the solution. A number of policy decisions will be important.

1. Recognize the rights of pastoral groups in national policy, including the validity of their mobile lifestyles and their needs.

2. Protect the rights of pastoralists to land and water.

3. Provide pastoralists with social services, especially health and education, to begin preparing a generation of people ready to adapt to change.

4. Provide pastoral services, including road access to rangeland areas, slaughterhouses, cold stores, water points and veterinary support.

5. recognise that pastoralism is not a meat production business – it is usually either a milk of fibre business, from which meat is a by-product (the relative importance of the commodities may shift according to market forces and policy incentives, which is part of the problem of an overt emphasis on meat markets)

6. Instigate animal health control that allows livestock to enter the international meat market.

7. Introduce financial services into pastoral areas.

8. Engage pastoralists in planning for a future affected by climate change. Recognize the need to provide education, training and social support to allow people to leave pastoralism and seek employment elsewhere. Plan for a pastoral future which is more intensive and employs fewer people to produce more and better animals. Encourage pastoralists to enter the cash economy and begin to save money rather than depend on livestock.

9. Work with neighbouring countries to develop regional livestock industries, with reciprocal rights of movement across borders and combined markets.

Adapt agricultural policy to build the resilience of smallholder farmers

Smallholder farmers will be affected by climate change in many ways. Some farming areas may be favoured by increased overall levels of rain. However, farmers in such areas will still need considerable support and access to new technology and opportunities to benefit. Their crop varieties, ways of farming and animal breeds will all be poorly adapted to the new, wetter conditions. Other smallholder farmers will have to deal with a dryer climate. They could be pushed out of farming if conditions become too dry, but most places will remain viable for well-adapted agriculture. The need for policy change is urgent, but most of the urgently-needed measures will have immediate benefits as well as long-term reduction of risk.

1. Strengthen (in many countries, restore) agricultural extension services and train them to understand farmers' current adaptive skills and equip them to advise agricultural communities on future adaptation.

2. Support capacity development efforts for farmers' associations and women's groups. Encourage farmer-led adaptation and organize exchanges to permit farmers to learn from other's adaptive knowledge.

3. Instigate a system of continually predicting expected future climatic conditions and analyse the likely most important local changes that will occur, and factor those changes into national policy on an on-going basis.

4. Immediately invest in national agricultural research systems and task them to adapt crop varieties and animal breeds to current and future conditions. Establish seed multiplication and animal breeding facilities in advance of future need. These can be based on NGOs and community out-growing schemes. Place emphasis on high-value crops that can be adapted to the expected conditions (for example, oilseeds for dry areas).

5. Strengthen marketing systems, taking into account predicted climate changes, with an emphasis on providing continuing incentives for agricultural production as conditions change.

6. Review irrigation policy, recognizing that increasing production in the future will often require the increased use of irrigation, but that much large-scale irrigation could be threatened by climate change. Build technical capacities to advise on the development of small-scale intensive irrigation.

7. Immediately increase investment in education and social services for smallholder agricultural communities to prepare a future generation of education and healthy people who will be able to move out of farming and pursue other livelihoods.

8. Decentralize financial management and decision-making. Provide technical support for locally-led small-scale water management promotion.

Design social safety nets to cater for forced changes

However good a set of adaptation policies might be, it is inevitable that climate change will bring about considerable social disruption. Unless these changes are anticipated and adequate social safety nets put in place, the consequences in terms of social unrest, conflict over resources, displacement of people, strain on urban centres and international migration will be huge. Wherever possible, social support should support efforts to adapt and provide the means by which people can build on their current adaptive capacities to cope with greater change. In more extreme cases, social measures will be needed to help people move into totally different livelihoods.

1. Build financial systems that can be used by poor people. This might include small-scale credit schemes and financial services that reach to poor.

2. Gradually move from a system that responds to crises through humanitarian relief to one that builds resilience. Encourage insurance schemes that help even out incomes and expenditures over years.

3. Replace food aid, where possible, with systems of cash payment, especially systems that encourage household investment in health and education.

4. Reform land tenure systems to permit communities and individuals to transfer the use of, or sell, their land rights to facilitate movement of people and consolidation of land-holding in a fair, equitable and gender-sensitive fashion. (This does not necessarily imply privatization, which would often threaten communally-held land, but should build on current land-holding norms).

5. Scale-up investment in job-creating development, including industrial development and adding value to agricultural goods. Review urban development, housing and social services policies to anticipate movement of people caused by climate change.

Box 4
Climate Change, Adaptation and Pastoralism[1]

Climate change will be felt differently depending on where you are and what you do, and opinions over what the future holds for the world's pastoralists are polarised. Some experts believe that pastoralists will be the first to feel the effects of climate change, whilst others consider pastoralism to be an adaptation to climate change and therefore amongst the best equipped to deal with it.

Pastoralism is a complex form of natural resource management, which requires maintaining an ecological balance between pastures, livestock and people, and it is an adaptive strategy to a stressful environment. This adaptation faces a myriad of challenges, of which climatic change is but one. Indeed, the challenge of climate change seems insignificant to many pastoralists who are faced with extreme political, social and economic marginalisation: relax these constraints and pastoral adaptive strategies might enable pastoralists to manage climate change better than many other rural inhabitants. The vulnerability that is associated with climate change in some pastoral environments has its roots in the restriction of tried and tested pastoral coping strategies, including the ability to move through different territories, to access critical livelihood resources, to trade across borders, to benefit from appropriate investments, and to participate in relevant policy decision-making.

Current concern for climate change seems to start from the assumption that climate patterns normally do not change, yet in reality the climate has always been changing. More than once pastoralism has provided a means through which fairly sedentary populations could increase their mobility in order to survive in the face of deteriorating climatic conditions. However, although the phenomenon is not a new one, three main factors justify the current growing concern on this critical challenge: the rate and the scale of its occurrence and the magnitude of its social impact.

A crucial adaptive response, whether to climate change, to global economic forces of to some other challenge, is to diversify livelihoods and embrace new opportunities. This adaptation is increasingly apparent in the blurring of the distinction between pastoralists and cultivators: a growing number of pastoralists now cultivate the land and increasing

numbers of crop farmers now have stock vested in pastoral systems. Despite the violent Despite the violent conflict that is associated with a small minority of the worlds pastoral regions, such collaborative and cooperative arrangements are the norm in pastoral areas.

Pastoralism is changing and must innovate accordingly, and it needs support in policy, in markets and at a scientific level. The leap forward requires overcoming the traditional/modern, sedentary/mobile, public/private, local/central dichotomies which have so far contributed to patterns of un-sustainability.

Paradoxically, although pastoralists have long been blamed for environmental degradation, they are amongst those most exposed to climate change phenomena, for which they are recognizably the least responsible. Nevertheless, where climatic conditions become more variable without leading to the collapse of rangelands, pastoral livelihoods have the potential to sustain populations in the face of climate change. Pastoralism may in fact provide food resources and secure a viable livelihood alternative where climate change and other pressures on ecosystems result in enhanced unreliability of marginal farming and the transformation of forest into savannah.

In the debate over whether there is a difference between development and adaptation, it is worth recognising that the capacity to adapt is something intrinsically pastoral, and its loss has been associated with 'development'. Sustainable pastoral development must be founded on the understanding that adaptive capacity is what makes pastoralism work and restoring, or enhancing, such capacities must be central to development plans. Adaptive capacity of pastoralists needs to be seen not as something different to, but as a primary indicator of, pastoral development.

[1] From "Change of Wind or Wind of Change? Climate change, adaptation and pastoralism" by Nori and Davies, The World Initiative for Sustainable Pastoralism, UNDP-GEF. 2007.