## SUMMARY

<table>
<thead>
<tr>
<th>Situation analysis</th>
<th>Policy responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drylands population growth rates have been high whilst poverty is widespread</td>
<td>Advance regional cooperation to help scale up successful initiatives in drylands</td>
</tr>
<tr>
<td>Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia adding challenges to livelihoods</td>
<td>Support to developing country governments in dryland regions to engage effectively with the Climate Change negotiation process, ensuring they shape the post-2012 agreement</td>
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<tr>
<td>Ecological indicators e.g. soil formation processes, nutrient pollution and water resources distribution are already showing declines and will be further challenged by climate change</td>
<td>Focus on water resources and river basin management at regional, national and local levels to reduce flooding risks and capture rainfall for agricultural and ecosystem use</td>
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<tr>
<td>Climate change will bring increased likelihood of disasters, caused by storms, floods and droughts, displacing large numbers of people who must find new homes</td>
<td>Mainstream climate adaptation into plans and strategies at national and local/district level and at sectoral levels, such water resources management, agriculture and livestock development, etc</td>
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<tr>
<td>Both the differentiated effects of climate change impacts and the inequitable distribution of climate adaptive capacity are poorly understood</td>
<td>Action-research is required to investigate and counteract socio-economic processes of differentiation. Successful community-based initiatives for enhancing climate by the poorest need scaled out.</td>
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<tr>
<td>Poor climate observation data makes climate forecasting through statistical downscaling from GCMs is very problematic</td>
<td>Ensure effective public information campaigns to help people understand and respond to the climate change challenges faced in different regions and districts</td>
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<tr>
<td>Models that produce estimates of changes to yearly or seasonal averages are a blunt way to assess effects in marginal rainfall and high temperature areas</td>
<td>Improve the utility of models by facilitating better dialogue between dryland dwellers and development people and modelers</td>
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<tr>
<td>Non-climate stressors already affecting agrarian populations in the dryland regions will have strong interactions with climate change effects</td>
<td>Scale up pilot community-based adaptation with poor and vulnerable communities in urban and rural areas in drylands, to ensure the documentation and rapid replication of these activities at a community level</td>
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<td>Combinations of large scale migration, impoverishment, and people seeking new land has potential for significant conflict and security issues, especially where guns are widespread, young men are without jobs, and government capacity to deal with emergencies is limited.</td>
<td>Regional and national initiatives to improve governance need to take into account likely climate change effects and to factor in ways of addressing these through formal and informal institutions</td>
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<td>Pastoral groups that manage significant proportions of national livestock herds are particularly vulnerable to climate change. Existing land tenure arrangements and services will come under increased strain, exacerbating relations between communities and fuelling conflict</td>
<td>Policies to enable herd mobility while securing rights to critical resources (dry-season pastures and water). Robust conflict management institutions Effective drought mitigation systems incl. early warning, insurance and safety nets to protect livelihood assets. Strengthening pastoral groups to engage with policy issues directly affecting their lives</td>
</tr>
</tbody>
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1 These papers have been commissioned by the World Bank Group for the “Social Dimensions of Climate Change” workshop and are not meant for citation. Views represented are those of the authors, and do not represent an official position of the World Bank Group or those of the Executive Directors of the World Bank or the governments they represent. The World Bank does not guarantee the accuracy of data presented in these papers.

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1. INTRODUCTION

There has been critical concern expressed about the future of populations in dryland systems given their current ecological and socio-economic status, and the likelihood that climate change will exacerbate a worsening situation. Climate change will affect the poor drylands dwellers disproportionately. Therefore the challenge is to understand not only the bio-physical aspects of climate change impacts, but also analyse the socio-economic aspects of climate vulnerability and the socio-political aspects of climate adaptation.

This paper examines the current status of drylands and their inhabitants, identifies the likely climate change impacts on drylands, then asks what are the main socio-economic components of climate vulnerability, and what is and can be done to mitigate and to prepare.

2. LOCATION, EXTENT AND ECOLOGICAL STATUS OF DRYLANDS

Drylands cover 41 per cent of Earth’s land surface. With only 8 per cent of the world’s renewable water supply per capita water availability is two thirds of the level required for minimum levels of human well-being. Figure 1 shows the geographic locations of drylands – hyper-arid, arid, semi-arid and dry subhumid – according to the Millennium Ecosystem Assessment.

The FAO’s typology of agro-ecological zones is based on agroclimatic zones defined according to the length of growing period. Note that there are differences in the way the MA and the FAO categorise zones. See Figure 2.

Within the developing countries, several major dryland regions can be distinguished on the basis of environmental, economic, political and cultural characteristics – a list of these areas are given in Annex 1.

Drylands are by definition areas with limited water resources. Rainfall is scarce, unreliable and concentrated during a short rainy season with the remaining period tending to be dry. High temperatures during the rainy season cause much of the rainfall to be lost in evaporation, and the intensity of tropical storms ensures that much of it runs off in floods. Water supply is not only meagre in absolute terms but also of very limited availability for human and natural uses. The other dominant characteristic of dryland climates is substantial and unpredictable differences between years in total precipitation and intra-seasonal distribution of precipitation, and there may be substantial differences in precipitation between areas in any one year.

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4 Several definitions and sub-classifications of drylands have been developed. Drylands are defined by the Millennium Ecosystem Assessment (MA), as including “all terrestrial regions where the production of crops, forage, wood and other ecosystem services are limited by water”. In operational terms, they comprise dry subhumid, semiarid, arid and hyper-arid regions, as defined by the Aridity Index (AI), that is the long-term mean of the ration of an area’s mean annual precipitation to its mean annual evapotranspiration. The United Nations Convention to Combat Desertification defines the arid, semi-arid and dry subhumid regions of its mandate as having AIs between 0.05 and 0.65. The MEA, and this review, also includes the hyper-arid areas with an AI of less than 0.05.

5 Where arid is less than 75 days/year, semi-arid is less than 120 days/year, and dry sub-humid is less than 80 days/year.
Figure 1. Drylands areas as defined by the MA

Drylands include all terrestrial regions where the production of crops, forage, wood, and other ecosystem services are limited by water. Formally, the definition encompasses all lands where the climate is classified as dry subhumid, semiarid, and/or hyper-arid. This classification is based on Aridity Index values.

Figure 2. Drylands areas as defined by FAO

Drylands are home to 44.3% of the global population in 2000.

Source: Millennium Ecosystem Assessment

Notes: The map is based on data from the UNEP GRID Data Portal (http://unep.grid-dp.net/) and Global area based on Digital Chart of the World data (147,573,136,6 square km). Data presented in the graph are from the MIRTA database for the year 2000.
The Millennium Ecosystem Assessment (MA) characterised drylands as drylands and dryland peoples as a “continuum of ecosystems and human inhabitants arranged along a global aridity gradient in which life and livelihoods are constrained by water.” The scale of the water constraint “determines the make-up of the suite of services provided by the ecosystems and, accordingly, the land uses by people and their respective livelihoods” (Safriel and Adeel 2005: pp. 623-663).

Annex 2 sets out the MA’s main conclusions on drylands systems. Key issues relevant to this paper are:

- Existing water shortages in drylands are projected to increase over time due to population increase, land cover change, and global climate change,
- Transformation of rangelands and other silvipastoral systems to cultivated croplands is leading to significant, persistent decrease in overall dryland plant productivity,
- Some 10–20% of the world’s drylands suffer from one or more forms of land degradation,
- Traditional and other current management practices contribute to the sustainable use of ecosystem services, and
- Depending on the level of aridity, dryland biodiversity is relatively rich, still relatively secure, and is critical for the provision of dryland services.

It is upon this bio-physical and socio-economic base that climate change impacts will unfold. This paper will refer to the MA’s conclusions in subsequent sections.

3. HUMAN POPULATIONS AND WELL-BEING IN THE DRYLANDS

Drylands are home to over 2 billion people or 35% of the world’s population. 54% of dryland inhabitants live in rural areas (the same figure dryland Africa is 56.5% and 65.3% in Asia). More than 90% of dryland inhabitants are found in developing countries. Approximately half of all people living in poverty are in drylands. Drylands populations had the highest population growth rates in the 1990s – see Figure 3. Table 1 below shows population figures for drylands across rural and urban areas, population densities and land areas. A high proportion of major urban centres are in drylands particularly in Asia. See Figure 4.

Population growth projections for drylands can be confounded by the impact of socio-economic and health problems, like HIV/AIDS. For example, in the case of Botswana (mostly semiarid) where one in three adults are reported to be infected, a 20% decline in population is predicted between 2000 and 2050. This situation could also apply to other dryland countries in Africa.

Many dryland dwellers have the lowest levels of human well-being, lowest per capita GDP and highest infant mortality rates recorded anywhere. Figure 5 shows how GNP per capita and infant mortality in drylands compare to other ecosystems.

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6 This statement from the MA is made cautiously. An understanding of the dynamism of human responses to degradation in general and desertification in particular helps explain why degradation estimates based on carrying capacity concepts of the desertification paradigm can be somewhat misleading. The desertification paradigm is grounded in simplistic, mechanistic thinking about human responses to the dryland environment and the processes of desertification.

7 Data in this section is taken from the MA.
Table 1. Population estimates for drylands and other ecosystems

<table>
<thead>
<tr>
<th>System</th>
<th>Total</th>
<th>Urban (million)</th>
<th>Rural</th>
<th>Share Urban (percent)</th>
<th>Total</th>
<th>Urban (persons per sq. km.)</th>
<th>Rural</th>
<th>Share Urban (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal zone</td>
<td>1,147</td>
<td>744</td>
<td>403</td>
<td>64.9</td>
<td>175</td>
<td>1,119</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Cultivated</td>
<td>4,233</td>
<td>1,914</td>
<td>2,309</td>
<td>45.3</td>
<td>119</td>
<td>793</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Dryland</td>
<td>2,149</td>
<td>963</td>
<td>1,185</td>
<td>44.8</td>
<td>36</td>
<td>749</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>1,128</td>
<td>401</td>
<td>725</td>
<td>35.6</td>
<td>27</td>
<td>478</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Inland Water</td>
<td>1,505</td>
<td>780</td>
<td>725</td>
<td>51.8</td>
<td>51</td>
<td>826</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>1,154</td>
<td>349</td>
<td>805</td>
<td>30.3</td>
<td>36</td>
<td>636</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>6,052</td>
<td>2,828</td>
<td>3,224</td>
<td>46.7</td>
<td>46</td>
<td>770</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Note: Population numbers for each ecosystem will not add to total as systems are not mutually exclusive. Island systems are excluded.

Source: MA 2000

Figure 3. Population growth in drylands and other ecosystems 1990-2000

Sources: Millennium Ecosystem Assessment
Figure 4. Main urban settlements in dryland areas

Figure 5. Per capita GNP and infant mortality across different ecosystems

Source MA 2005
There are direct and indirect effects of the drylands ecosystem on the well-being of the inhabitant human population. Table 2 below describes the main effects. From the evidence of Table 2 it is not difficult to assert that poorer drylands inhabitants are very likely to be disproportionately affected by any downturn in the provision of goods and services provided by the drylands ecosystem, for instance due to increasingly erratic rainfall and increased temperatures caused by climate change.

Table 2. Main dryland ecosystem effects on human well-being (adapted from Safriel and Adeel, 2005)

| Basic materials for a good life | Low biological production constrained by water limits the provision of basic materials for a good standard of living. This also limits the livelihood opportunities in drylands and often leads to practices, such as intensified cultivation, that cannot be serviced due to low and further impaired nutrient cycling and water regulation and provision, requiring adjustments in management practices or the import of nutrients and water provided by services of other ecosystems. |
| Health | Poor health in drylands are due to malnutrition and limited access to clean drinking water. In Asia 36% of children under five face hunger in drylands compared with 15% in the forest and woodland system. Poor health is exacerbated by poor health-related infrastructures. |
| Good social relations | Environmental refugees leave their homes due to environmental degradation and lack of viable livelihoods. The sale of stock, wage labour, borrowing of cash for food, and the sale of valuables all precede their migration. Other categories include people displaced for political reasons that may affect the availability of services in drylands to which they have been relocated. Thus demography and sociopolitical drivers, more than the direct condition of ecosystem services, contribute to the quality of social relations. |
| Security | Food security is an essential element of human wellbeing in drylands and is related to socioeconomic marginalization, lack of proper infrastructure and social amenities, and often the lack of societal resilience. Climatic events like prolonged droughts and excessive floods also drive insecurity in drylands. But sociopolitical drivers like land tenure practices that relate to sharing and conservation of natural resources or that generate land cover change that may limit traditional pastoral livelihood opportunities can greatly affect food security. |
| Freedom and choice | With the exception of OECD countries, dryland peoples are mostly politically marginalized; that is, their role in political decision-making processes is perceived as being insignificant. Consequently, market factors that determine dryland farmers’ decision-making and the effects on their well-being are often critical. |

4. NON-CLIMATE STRESSORS THAT INCREASE DRYLANDS CLIMATE VULNERABILITY

As this paper is primarily concerned with the ways that climate change will impact upon the poor living in drylands, the phrase ‘non-climate stressors’ is used to identify other factors that are negatively affecting drylands and drylands dwellers.

Non-climatic stressors can increase vulnerability to climate change by reducing resilience (IPCC 2007) e.g. human-induced degradation of ecosystems may increase vulnerability to climate extremes. The MA demonstrated how drylands are challenged by the major drivers of ecosystem services change – habitat change,
invasive species, over-exploitation, nutrient pollution and importantly climate change (see Figure 6 below and Annex 2 for the MA’s main findings on drylands).

**Figure 6. Drivers of ecosystem change**

<table>
<thead>
<tr>
<th>Environment</th>
<th>Habitat change</th>
<th>Climate change</th>
<th>Invasive species</th>
<th>Over-exploitation</th>
<th>Pollution (nitrogen, phosphorus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boreal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperate grassland</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mediterranean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical grassland and savanna</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Island</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polar</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Process**s in drylands that increase climate vulnerability include:

- Transformation of rangelands and other silvipastoral systems to cultivated croplands is leading to significant, persistent decrease in overall dryland plant productivity;
- Desertification causes adverse impacts on dryland and non-dryland ecosystems

However, the MA also found that traditional and other current management practices are contributing to the sustainable use of ecosystem services. Some alternative livelihoods e.g. have a lower impact on dryland ecosystem services – these include dryland aquaculture for production of high-value food and industrial compounds, controlled-environment agriculture (such as greenhouses) that requires relatively little
land, and tourism related activities. Depending on the level of aridity, dryland biodiversity is relatively rich, is still relatively secure, and is critical for the provision of dryland services.

Morton (2007) lists a series of non-climate stressors affecting agrarian populations, particularly smallholder and subsistence farmers and pastoralists. Some of these are listed in Table 3 below alongside examples of interactions between climate change effects and non-climate stressors relevant to dryland areas.

**Table 3. Interactions of non-climate stressors with climate change effects**

<table>
<thead>
<tr>
<th>Non-climate stressors</th>
<th>Examples of interactions of non-climate stressors with climate change effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population increase driving fragmentation of landholding (Sadik, 1991)</td>
<td>Reduced agricultural productivity due to rainfall and temperature changes exacerbates fragmentation effects by reducing per area yields and carrying capacities.</td>
</tr>
<tr>
<td>Environmental degradation caused by population, poverty and ill-defined and insecure property rights (Vosti and Reardon (eds) (1997), including widespread soil degradation (Lal, 2000)</td>
<td>Migration as a climate adaptation strategy increases population pressure, balance of poor and non-poor and destabilizes property rights systems.</td>
</tr>
<tr>
<td>Regionalised and globalised markets, and regulatory regimes, increasingly concerned with issues of food quality and food safety (Reardon et al., 2003)</td>
<td>Concern over carbon emissions and food miles increases downward pressure on food imports affecting agricultural dependent economies.</td>
</tr>
<tr>
<td>HIV/AIDS pandemic, reducing household labour supply, eroding household assets, disrupting knowledge transmission and agricultural services (Barnett and Whiteside, 2002)</td>
<td>Distribution and spread of climate sensitive diseases alters with precipitation and temperature changes leading to new disease burdens in high HIV/AIDS regions.</td>
</tr>
<tr>
<td>Threats of panzootics (e.g. avian influenza) attacking livelihoods and constraining trade (ILRI, 2005)</td>
<td>Increased frequency of extreme weather events increases probability of disease outbreaks e.g. flooding in northern Nigeria where a focus of avian influenza due close proximity of intensive and low input poultry systems</td>
</tr>
<tr>
<td>State fragility and armed conflict in some regions (FAO, 2005)</td>
<td>Climate change effects of both fast and slow onset represent increased hazards that fragile states are ill-equipped to deal with and are likely to fuel conflicts. Both types of effects can cause decreasing resource availability or equity of access.</td>
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</tbody>
</table>

All of the non-climate stressors listed on the left-hand side of the table above have greater likelihood to affect poorer individuals and households more than those better-off. In addition, the interactions with climate change effects are likely to be felt more keenly by the poor hence a form of double exposure is apparent leading to differentiated vulnerability.

Rapid demographic changes in response to climate signals - increases or decreases - make planning resource management more problematic. Migrating populations can...
be a source of additional pressure on dryland environments and resource management within them when livestock temporarily concentrate at key resources such as water points. Under these circumstances conflicts over water often arise between nomads and farmers (e.g. in dry subhumid part of Tanzania). A transition between migration as a temporary livelihood strategy to permanent migration creates additional pressure on drylands.

5. OBSERVED CLIMATE TRENDS AND IMPACTS

The IPCC Working Group 1 notes, among the long-term changes in climate that have already been observed and are highlighted in its Summary for Policy Makers (IPCC 2007:6):

- “Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions....Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.”
- “More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics.” These are linked to higher temperatures, decreased precipitation, changes in sea surface temperatures, wind patterns, and decreased snow cover.

The IPCC reports that most land areas of the world have faced warming, fewer cold days and more hot days, increased frequency of heat waves, increased frequency of heavy precipitation events, increased cyclone activity, increased incidence of extreme high sea-level. More relevant to dryland regions is that areas affected by drought have and will continue to increase (IPPC 2007:7). In particular, Working Group 1 reports downward trends in precipitation, either over the period 1900-2005 or some more recent sub-period within it, in northwest Mexico, southern Africa, northwest India and especially the Sahel (Trenberth et al. 2007:255-256).

IPCC Working Group 2 says little about observed impacts on crops and livestock in drylands or other developing country regions (Rosenzweig et al. 2007:105-6). It does note findings that, in the Sahel, warming plus reduced rainfall has reduced the length of the vegetative period “no longer allowing present varieties [of millet] to complete their cycle”. Sahelian farmers usually cultivate both long and short cycle millets with the aim of spreading risk.

If the inclusion of an increased occurrence of droughts is accepted as an observed climate change trend, as IPCC Working Group 1 does, then some of the well-known and catastrophic impacts of drought across major developing country dryland regions have to be added to the observed impacts of climate change. The countries of the Sahel experience multidecadal periods of drought. One such is being experienced now (see Figure 6). There have been several since the last glaciation. Whether the current period is such a natural episode or is a product of global warming is not known. It is more likely that that the current drought is a product of a combination of factors including the effects of climate change, land degradation, water pollution and biomass burning. Nevertheless, whatever the cause, global warming will exacerbate such droughts and other natural extremes (Conway, pers comm).

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8 The more detailed text of AR4 chapter 3 refers to long-term drying over northwest Mexico. Within southern Asia, northwest India is specifically referred to.
There is already evidence that Africa is warming faster than the global average and this is likely to continue. Some African dryland areas are seeing greater warming than elsewhere. Southern and western Africa have seen an increase in the number of warm spells and a decrease in the number of extremely cold days, but in eastern Africa temperatures have fallen close to the coasts and major inland lakes.

6. FUTURE PROJECTIONS

Arid regions are expected to undergo significant changes under a scenario of global warming, but there is considerable variability and uncertainty in these estimates between different scenarios. The complexities of precipitation changes, vegetation–climate feedbacks and direct physiological effects of CO2 on vegetation present particular challenges for climate change modelling of arid regions. Great uncertainties exist in the prediction of arid ecosystem responses to elevated CO2 and global warming. Learning from the historic record of drylands has been assessed as a guide to what is likely to happen in the future. However, although palaeodata provide valuable information about possible past changes in the vegetation–climate system, it is unlikely that the history of the world’s deserts offers a guide to their future because climate changes are likely to be uncharacteristic of the distant past and there are far great human pressures.

Recent Hadley Centre work on convergence of climate projections from global circulation models (GCMs) across geographic zones identifies those areas of the world where the climate impacts projected are not consistent. Discrepancies exist for a number of regions in terms of whether projected changes in rainfall will increase or decrease. The theory-based biophysical models disagree where the complexity of weather systems is greatest – some dryland areas of Africa and some monsoon affected areas fall into this category. In addition there are areas where due to a lack
of climate observation data makes it very difficult to downscale from GCMs. Many of the dryland areas in developing countries fall into this category. A further difficulty is that predicting rainfall and temperature changes using models that produce estimates of changes to yearly or seasonal averages is a rather blunt way to assess effects in marginal rainfall and high temperature areas.

The IPCC 4AR assesses various future trends based on climate projections using different emissions related scenarios. They report that it is likely and in some cases virtually certain that there will be fewer cold days and nights over most land areas, there will be warmer and more frequent hot days and nights over most land areas. In addition, the frequency of warm spells/heat waves will increase, as will the frequency of heavy precipitation events. Also likely is an increase in areas affected by drought increases, the intensity of tropical cyclone activity and the incidence of extreme high sea-levels.

Regional projections of climate change are made in Chapter 11 of the Report of IPCC Working Group 1. In particular, the report presents a synthesis of projections for different regions for the period 2080-2099 from 21 global models using the SRES A1B scenario (Christensen et al. 2007:854). A summary of projections is presented here (see Table 4 below) for some of the regions used in the analysis which contain significant developing country dryland regions, and for which drylands account for a significant proportion of total area. Admittedly, the timescale of 2080-2099 used by the IPCC is of limited relevance to some development debates. However, the comprehensive nature of the IPCC table, plus the fact that in some cases the implied trends can be assumed to be roughly linear makes it an important starting point.

Besides a global pattern of warming (which is important for evapotranspiration from soil and crops and effects on human and animal health), what this table shows, at a highly aggregate geographical level and mainly aggregating across seasons, is that Southern Africa, the Sahara, North Africa and Central Asia (which are also the regions used by the IPCC that most closely coincide with drylands) are projected to receive smaller average rainfall, and more seasons and years that would be considered extremely dry relative to 1980-1999. East Africa and South Asia (each of which include significant non-dryland areas) are projected to receive higher rainfall and more seasons and years that would be considered extremely wet relative to 1980-1999. West Africa is one of the regions of the world that presents most uncertainty, and disagreement among models, as regards future trends in precipitation. An average of the major models suggests a modest increase in rainfall for the Sahel with little change on the Guinean coast, although there are models which project either strong drying or strong moistening.

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10 The scenario based on global integration with an economic, rather than environmental emphasis, but with a balance of fossil fuels and other energy sources

11 At best the regions used in the analysis contain significant areas that are not drylands and this should be noted. The three analytical regions of Central and South America are clearly in the majority non-dryland, and are not included here. There is a considerable amount of technical detail on, and qualifications to, the original table in the IPCC report, to which reference should be made.
Table 4. IPCC reported climate change projections in drylands regions comparing current climate with projection for 2080-2099

<table>
<thead>
<tr>
<th>Region</th>
<th>Median projected temperature increase (°C)</th>
<th>Median projected precipitation increase (%)</th>
<th>Agreement on precipitation among models</th>
<th>Projected frequency of extreme warm years (%)</th>
<th>Projected frequency of extreme wet years (%)</th>
<th>Projected frequency of extreme dry years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Africa</td>
<td>3.3</td>
<td>+2</td>
<td>Not strong</td>
<td>100</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>East Africa</td>
<td>3.2</td>
<td>+7</td>
<td>Strong for increase in DJF, MAM, SON</td>
<td>100</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Southern Africa</td>
<td>3.4</td>
<td>-4</td>
<td>Strong for decrease in JJA, SON</td>
<td>100</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Sahara</td>
<td>3.6</td>
<td>-6</td>
<td>Strong for decrease in DJF, MAM</td>
<td>100</td>
<td>See footnote</td>
<td></td>
</tr>
<tr>
<td>Southern Europe and Mediterranean</td>
<td>3.5</td>
<td>-12</td>
<td>Strong for decrease in all seasons</td>
<td>100</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Central Asia</td>
<td>3.7</td>
<td>-3</td>
<td>Strong for decrease in MAM and JJA</td>
<td>100</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Southern Asia</td>
<td>3.3</td>
<td>+11</td>
<td>Strong for increase in JJA, SON</td>
<td>100</td>
<td>39</td>
<td>3</td>
</tr>
</tbody>
</table>

Few studies so far have attempted to map out the implications of climate change projections for livelihoods. The work of Thornton et al (2006) shows impacts of rainfall and temperature changes on across Africa including dryland areas. GCM outputs for changes to rainfall and temperature are used in crop and forage models to identify climate effects on farming systems (as a proxy for rural livelihoods) across Africa. The implications of climate change for farming systems were over-laid on socio-economic vulnerability information to identify climate and poverty hot spots. Many of the hot spots identified are in dryland areas. Figures 8, 9 and 10 show changes in predicted rainy season failure, predicted changes in length of crop and forage growing period, and climate and poverty hotspots respectively.

In future, it may be fruitful to combine such approaches with techniques developed for geographically mapping subjective perceptions of risk (Smith et al., 2000).

Apart from the uncertainty with regard to the precision of climate projections there are a number complicating factors that require taken into account in assessing the impacts of climate change on livelihoods. The work of Thornton et al (2006) shows the way that climate changes in marginal areas – such as drylands – are likely to be non-linear. For example, in east Africa the favourable aspects of increased rains

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12 The original disaggregates median response by the four quarters of the year; the figure given here is the annual average as given in the original.
13 As for temperature.
14 Agreement is “strong” (current authors’ terminology), when the 25th percentile and the 75th percentile of the distribution of models were of the same sign; this is shown in the original by brown shading for agreement on decrease, and blue shading for agreement on increase.
15 Essentially, years warmer than the warmest between 1980 and 1999; similar definitions apply for wet and dry years. The original further presents projections of warm/wet/dry seasons.
16 No aggregate figure for years, but significant frequency of dry DJF and MAM seasons.
(duration and absolute precipitation levels) in the short to medium term may well be cancelled out in terms of increased length of growing period by increased temperatures leading to increased evapo-transpiration. Eriksen et al (2005) and Mworia and Kinyamario (2008) have drawn attention to the problems that increased rainfall can cause in terms of the movement of crop farmers into previously pastoral areas.

**Figure 8.** Increased incidence of rainy season failure across Africa.

*Percentage of failed seasons: left-hand panel current conditions, right-hand panel in 2050 lighter colours depict greater likelihood of failed seasons* (using the HadCM3 model, scenario A1)

Figure 9.

7. A CONCEPTUAL FRAMEWORK FOR UNDERSTANDING DRYLAND AGRARIAN SOCIETIES

A sketch of a conceptual framework for understanding dryland agrarian societies, and the context for the impacts of climate change upon them, is presented in Figure 11. It derives from various sources: the livelihoods framework (Scoones 1998, Carney 1998); writing on coping and adaptation (Davies 1996), writing on economic institutions (e.g. Wiggins and Davis 2006), to name the most important.

The essence of the framework is that the physical geography of the drylands imposes some basic constraints on drylands livelihoods. Some generalisations can also be made, though less securely, about the political and economic constraints on drylands livelihoods. Within this dual context, specific livelihood strategies, which can to some extent be generalised, take shape under two broad themes: flexibility of institutions, and constant coping and adaptation.

7.1 Geographical characteristics and livelihood strategies

Definitionally, drylands are areas of low rainfall. This immediately influences the productive bases of dryland societies. Food production is dominated by maize, sorghum and millet, with wheat in the WANA countries and Central Asia and various legumes and rootcrops. Cashcropping opportunities are limited; the most notable cashcrops (other than cereals) are cotton, groundnuts and in some areas soybean. In most dryland regions livestock are extremely important for livelihoods – the more arid end of the dryland continuum is characterised by pastoralism, defined as dependency on livestock, and often involved mobility (nomadism or transhumance).
Elsewhere in the drylands mixed-crop livestock systems prevail – in some areas involving relatively little interaction between the two production elements, elsewhere and (as a generalisation\(^{17}\)) increasingly involving use of animal manure as a fertiliser, use of crop-residues or cultivated forages as animal feed, and use of animals for draught power (see Devendra et al. 2005 for more on the classification of relevant livestock systems).

Drylands in developing countries are also generally regions of high variability of rainfall. Rainfall variability is greater in the tropics: this fact is at the core of the re-appraisal, under the heading of the “New Range Ecology”, of the ecology of African rangelands and the traditional pastoral production systems which make use of them (Scoones 1995 and many other references). Although, as Ellis (1995) demonstrates, the New Range Ecology is only strongly applicable in regions of less than 600mm average annual precipitation, a small subset of the regions defined as drylands, the fact of rainfall variability also marks livestock-based and mixed crop-livestock systems throughout the whole continuum of the drylands. Rainfall variability is the most important, but by no means the only, form of risk, which is a dominant motif in drylands agricultural production (Scoones et al. 1996).

Risks and other production constraints influence dryland livelihoods towards the use of multiple strategies, both within agriculture (multiple crops and livestock species)

\(^{17}\) see Scoones and Wolmer 2005 for an unpicking of this generalisation
and complementary to it – migration elsewhere with remittances. Although the term was not coined specifically for drylands, “complex, diverse and risk prone” sums up much of the flavour of these livelihoods.

Where developing countries include both dryland and higher-potential areas, capital cities and centres of economic power are generally outside, often at some distance from dryland areas (e.g. Brazil, Kenya, Ethiopia, the coastal states of West Africa, China), leading to economic and political marginalisation. In some cases, dryland areas within states lie close to national frontiers. Added to this is the fact that dryland population densities are generally low, leading to high per capita costs of providing infrastructure and services.

7.2 Coping, vulnerability and adaptation

Two main interpretations of vulnerability exist in the climate change literature. O’Brien et al (2007) interpret these as manifestations of different discourses and framings of the climate change problem. The two differing interpretations are ‘outcome vulnerability’ and ‘contextual vulnerability’. They are linked respectively to a scientific framing and a human-security framing of climate vulnerability. Each framing prioritizes the production of different types of knowledge, and emphasizes different types of policy responses to climate change. This paper tries to use both interpretations in assessing how and why people individually and collectively adapt to climate change impacts in the drylands context.

Climate change impacts on the poor and marginalised can be assessed by looking at:

- Added risks due to climate change to current ways of securing well-being,
- The particular strategies or adaptive capacity of poor people in the face of climate stresses,
- The causes of vulnerability, or specific factors and conditions that make poor people vulnerable to climate stress.

As an initial step in assessing the differentiated effects of climate change impacts on the poor in drylands the framework developed by Eriksen et al (2007) is useful. The framework is presented in Table 5 below.

Dryland societies are characterised by an orientation to adaptation, the readiness to adopt flexible strategies that reduce ex ante vulnerability to climate shock and other forms of environmental risk. Adaptation as thus used in dryland development literature is therefore closely allied to the use of the term in climate change literature: “adjustments, or changes in decision environments, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate” (Adger et al. 2007). Adaptation in both senses is closely linked to adaptive capacity: “the ability or potential of a system to respond successfully to climate variability and change” (Adger et al. 2007).

The fact that dryland societies are already adapted to climate variability clearly also increases the likelihood they can adapt to climate change (either further increases in that variability, or shifts in mean climate parameters, or both). However this does not mean that the capacity to adapt to climate variability will remain constant, or that there will not be limits on capacity to adapt to climate change.
Table 5. The influence of climate variability and change on the way that people secure or fail to secure four types of basic needs: some examples [from Eriksen et al., 2007]

<table>
<thead>
<tr>
<th>Dimensions of poverty</th>
<th>Climate risk to ways of securing needs</th>
<th>Coping and adaptation strategies to climate stress</th>
<th>Factors and processes causing vulnerability among poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income and material needs</td>
<td>• Increased variability, heat stress, flooding and drought inhibiting livestock and cultivation</td>
<td>• Increased multiactivity, multifocality and migration</td>
<td>• Increasing marginality of off-farm livelihoods as well as natural resource based activities</td>
</tr>
<tr>
<td></td>
<td>• Damage to productive assets and infrastructure</td>
<td>• Shifts in cultivation and herding practices</td>
<td>• Increasing inequality</td>
</tr>
<tr>
<td></td>
<td>• Urban disasters</td>
<td>• Destitution and inability to adjust long term and inability to access adaptation initiatives</td>
<td>• Environmental degradation undermining livelihoods</td>
</tr>
<tr>
<td></td>
<td>• Enhanced agricultural potential in some areas</td>
<td>• Reinforced need for access to common pool resources</td>
<td>• Economic liberalization related changes</td>
</tr>
<tr>
<td></td>
<td>• Terms of trade deteriorate during crisis</td>
<td>• Increased dependence and need for local/informal economic opportunities/remittances</td>
<td>• Interaction with stressors such as HIV/AIDS and conflict</td>
</tr>
<tr>
<td></td>
<td>• Cut off from markets by floods</td>
<td></td>
<td>• Barriers to formal markets and employment opportunities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Dependence on conventional energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Economic specialisation increases vulnerability</td>
</tr>
<tr>
<td>Health and basic education</td>
<td>• Droughts and floods cut people off/increases remoteness from facilities</td>
<td>• Increased dependence on school feeding programmes</td>
<td>• Poor education and generation of knowledge inhibits responses and access to climate information</td>
</tr>
<tr>
<td></td>
<td>• Poor water supply and sanitation, heat stress and pollution</td>
<td>• Increased cash need for hospital bills and demand for indigenous medicinal plants</td>
<td>• Poor nutrition and health services compound disease outbreak and loss of productive labour during droughts and floods</td>
</tr>
<tr>
<td></td>
<td>• Dropping out of school due to non-payment of fees, hunger or coping strategies</td>
<td>• Increased reliance on social networks to cover costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Loss of breadwinner to disease and labour time spent caring for ill</td>
<td></td>
</tr>
<tr>
<td>Rights and empowerment</td>
<td>• Loss of democratic rights through dependence on aid</td>
<td>• Dependence on kinship ties and social networks</td>
<td>• Local democratization strengthens access to developments such as water</td>
</tr>
<tr>
<td></td>
<td>• Redirecting of attention from poverty to climatic change and ‘external’ factors</td>
<td>• Gazettelement and privatisation of land undermine resource rights and coping strategies of the poor</td>
<td>• Powerless/excluded groups vulnerable</td>
</tr>
<tr>
<td></td>
<td>• Shifts in power relations</td>
<td></td>
<td>• Informal rights precarious</td>
</tr>
<tr>
<td></td>
<td>• Social mobilization</td>
<td></td>
<td>• Loss of international formal migration rights increases vulnerability</td>
</tr>
<tr>
<td></td>
<td>• Informal adjustments to tenure and access rights</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Monetisation of critical drought resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social and cultural affiliation and security</td>
<td>• Crises justifying social exclusion</td>
<td>• Increased reliance on social networks</td>
<td>• Inability to access networks of non-poor reinforced</td>
</tr>
<tr>
<td></td>
<td>• Climatic events increase isolation</td>
<td>• Increased reliance on local knowledge to cope and adapt to climatic changes</td>
<td>• Existing social networks and customary institutions exhausted?</td>
</tr>
<tr>
<td></td>
<td>• Relocation and remoteness from social and cultural ties</td>
<td></td>
<td>• Loss or irrelevance of local knowledge to new geographic areas, livelihood options and networks</td>
</tr>
<tr>
<td></td>
<td>• Breaking up of families and networks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adaptations to climate variability centrally include livelihood diversification, practised at individual, household or community level, seasonally, in response to bad years or sequentially: between cropping, various forms of mobile and sedentary livestock production, use of wild resources, off-farm employment and out-migration. Within dryland cropping systems adaptation strategies include: use of multiple crops, livestock species, breeds and varieties; and preparedness to intensify use of labour at critical times of year (Mortimore and Adams 2001); also on-farm storage of food and feed (Swearingen and Bencherifa 2000), and close management of soil and water resources. For pastoralism, pastoral mobility itself, the rangeland tenure systems that make it possible, and the orientation to accumulating large herds as insurance against drought are themselves the most important adaptation strategies.

One way to classify adaptation practices has been developed by Aggarwal (2007) based on Halstead and O’Shea (1998):

- Mobility pools risks across space
- Storage pools risk across time
- Diversification pools risk across assets
- Communal pooling pools risk across households, and
- Exchange can substitute, in the right institutional conditions, for any of the above.

Allied to adaptation is the possession of repertoires of what are called “coping strategies“, which manage the impacts of climate shocks ex-post. Coping strategies include out-migration and recourse to wage labour, use of wild resources, exceptional pastoral migrations to drought refuges or rarely-used rangelands, intra-community sharing of food and livestock, and even begging.

As the above lists suggest, there is overlap between adaptation and coping strategies, and the distinction is indeed a problematic one (Davies 1996): coping strategies may become adaptive strategies when households or whole communities are forced to use them over a run of bad years, and across seasons rather than just at the worst time of year. The concept of coping strategies also extends to strategies that are erosive of household assets and thus risk sinking households into permanent destitution, and/or degrading to the environment, thus raising questions about the utility and ethics of using it (Davies 1993). In this way, coping and adaptation can be seen as linked by feedback loops: the way households cope with crises may either enhance or constrain their future coping and their future long-term adaptation.

Out migration by individuals of a household or entire households is increasingly being used to avoid climate related stressors – especially in cases where social upheaval is prevalent. This strategy can contribute to the household’s adaptive capacity. It can also decrease the demographic pressure on land and provide remittances.

Eriksen et al. (2005) assessed how smallholder farmers in Kenya and Tanzania cope with drought and how different factors shape coping strategies in differentiated ways between households and over time. They found that households where an individual was able to specialize in one favoured activity (e.g. employment or charcoal burning) were often less vulnerable than households where members are engaged in many activities at low intensity. Lack of access to favoured coping options was compounded by social relations that led to exclusion of certain groups, especially women, from carrying out favoured activities with sufficient intensity. Such households carried out a multitude of less favoured and frequently complementary coping strategies.

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18 Which is not to say that all coping strategies are erosive.
activities instead (e.g. collecting indigenous fruit) and these strategies often yielded marginal returns due to marginalization of local niche products and the commercialization of forest resources exemplify processes leading to differential vulnerability.

What this brings out is that adaptation to and coping with climate variability, and adaptation to climate change, are all enabled by assets, and by the institutions which regulate access to assets: and that adaptive capacity is bound up with those assets and institutions.

7.3 Institutional flexibility

“Institutions” is a word used in a variety of senses, but increasingly very broad definitions, drawn from the “New Institutional Economics” that refer to much more than formal and visible organisations, are used in development research, for example: “Institutions are durable systems of established and embedded social rules and conventions that structure social interactions” (Hodgson 2001: 295 cited by Wiggins and Davis 2006). By this view institutions can be formal, recognised by law, or informal, recognised by “tradition” or simply by mutual agreement. Cross-cutting this, institutions can be “political”, for governance and for representation, or “economic” institutions – more precisely, “institutions with an economic function”, as some informal institutions that fulfil such functions may not exist primarily for economic reasons or appear to be “economic” in form. The latter can be broken down by their functions:

- establishing and protecting property rights;
- facilitating transactions;
- permitting economic co-operation and organisation (Wiggins and Davis 2006).

Alternatively, they can be seen as regulating access (a broader formulation than establishing property rights) to the various factors of production: land, labour, capital, and information (Scoones and Wolmer 2005).

Because of the importance of variability and risk in drylands, dominant institutions need to be flexible, allowing for variable and complex use of resources. Dryland societies are characterised by markets for produce and consumer goods, but even markets may function flexibly, through institutions like shopkeeper credit, and long-distance trade networks linked by specific ethnic groups, within which trust and information can flow. Markets function alongside informal and “traditional” (but in fact constantly evolving) institutions for allocating resources, which largely display such flexibility. The classic example of this is rangeland tenure: rangeland tenure in pastoral areas is often referred to as “common property”, occasionally as “open-access”, but neither term does justice to the complexity and flexibility of rights in different resources (grazing en passage, prolonged grazing, browse) asserted, extended and negotiated by different communities and collectivities at different scales. There are other examples: traditional patterns of loaning livestock and sharing their produce, rights to use wells of different kinds, seasonal use of fallows and crop residues, collective labour parties, families as institutions for regulating migration, networks for information.

Institutions such as these are fundamental in enabling adaptation and coping strategies, by determining access of different sorts for different categories of people to different types of assets. It is important to note that flexibility does not necessarily imply equity – institutions may structure assets differentially for men and women, for
groups defined by their landholder or outside status, for castes and occupational groups. Markets may be embedded in local social relations, in some cases allowing flexible credit or other services, but market relations clearly favour the adaptation and the coping of those with saleable assets, produce, savings or labour.

While for the present authors, “institutions” can and should be used in a general sense that includes informal institutions, institutions that are not organizations, and markets, the term is in practice used, however, by Aggarwal (2007), writing on linkages between institutions and adaptation, in a way that privileges organizations. Rural institutions here comprise: bureaucratic agencies; elected local governments; membership organizations; cooperatives; service organizations; private businesses. These also are important in structuring adaptation; through provision of information, technology, financial capital, and leadership. But they also function in institutional matrices formed by the indigenous and informal institutions.

7.4 The economic and political context

Developing country dryland dwellers, like the inhabitants of developing countries in general, have suffered from an inheritance of poor and unrepresentative political institutions, policy bias against rural people, a lack of government capacity to provide core public goods and services, and a lack of power and information for dealing with world markets. But remoteness and low population density (see above) can exacerbate these generic problems, increasing political and economic marginalisation. It has already been noted that in many major countries containing drylands, those drylands are far from the seats of power. But even where countries are in the majority (of their area or their population) dryland, there can be marginalisation of particular categories of dryland dwellers, notably pastoralists. Pastoralists tend to suffer from multiple marginalisation (Lesorogol 1998, Markakis 2006), environmental in terms of being found in the lowest-potential areas, economic in terms of market access and shares of public expenditure, socio-cultural in terms of misunderstandings of and prejudices against their livelihoods, and political as a consequence of all of those. As pastoralists are frequently located close to international borders, there is in addition scope for them to be stigmatised as people with ambiguous national identities and weak rights to participate in national politics.

It is important to see this context as dynamic. The non-climate trends outlined in Section 1 above, and other global trends, notable market failures following the withdrawal of government involvement in services and markets, are changing this context, and in many cases in the direction of provoking higher vulnerability to climate risk.

Participation in markets can be costlier and less predictable, or in some cases more monopsonistic: examples of this can be seen in the dependence of Sahel countries on the world cotton market, the immiseration of some cotton-farmers, and the complex debates about the merits of privatisation of cotton para-statals which have previously integrated marketing, input supply and some social service functions. The livestock sectors of dryland countries are vulnerable to international veterinary regulations, and international “veterinary politics”: in southern Africa to the high costs of maintaining access to EU meat markets, in the Horn of Africa to the threat of less than transparent import bans by the Gulf States. Poor provision of human services leads to low indicators of human development in many dryland regions. Services to agriculture are also poor in many regions (unless bound up with produce markets as in the Sahel cotton zones). Privatisation or liberalisation in the provision of these services will be a long and convoluted path: the way forward in animal health...
services in the Horn of Africa, through community-based provision, has only been identified by painstaking work by NGOs and donor-funded bodies. Governments distant from and ignorant of the flexibility necessary for dryland institutions can fail to support, undermine or disrupt valuable informal/traditional institutions that govern dryland livelihoods. The lack of recognition of traditional land tenure and collective resource management, particularly among pastoralists, by so many governments is a classic case.

This dynamic, and in many ways worsening, economic and political context has implications for institutions, both formal and informal, and through those institutions for dryland dwellers’ capacity to cope with and adapt to climate risk. These issues will be further discussed in Section 8.

8 IMPACTS OF CLIMATE CHANGE

Box 1 provides an illustration of the complex issues that pertain to the way marginalised dryland dwellers are affected by climate related events and trends. Many of the issues presented in this paper are shown in the stark reality of pastoralists in Ethiopia.

Box 1. Ethiopia’s pastoralists at a turning-point

(adapted from the World Disasters Report 2007: focus on discrimination. International Federation of the Red Cross and Red Crescent Societies.)

Louren Nakali Loyelei passes his hand across his eyes as he talks – as if he still cannot believe what he saw in August 2006 when severe floods devastated his home region in south-west Ethiopia. In one month, the flood killed 364 people and swept away around 3,200 cattle. “The whole land was covered with water” he says. “There was nowhere to pass and we rowed for an hour. We usually cross two rivers on this journey and during this flood we crossed four.”

Louren, 28, is a pastoralist. He grew up herding cows across the borders of Kenya, southern Sudan and Ethiopia. Even though he is accustomed to the hardships of the nomad’s life, the events of 2006 were exceptionally severe. Louren says: “The government and NGOs provided supplies and mosquito nets. They did helicopter drops where the people were displaced. After three weeks, the government sent trucks with maize and wheat, but they have not yet replaced animals.” Months later, people in Louren’s home area are still recovering from the devastation. But he predicts it will not be long before the next disaster strikes. “Before this flood, there was a long drought, and people suffered. When drought comes again, they will suffer again.”

Already, the long-term effects of prolonged and more frequent droughts – widely attributed to climate change – are being felt. Haji Mussa Gara, a pastoralist elder from the Oromiya region, is a veteran of many harsh seasons. “I have a herd of 30 cattle. It is less than before,” he says. “The lowland only grows grass – not cereal. We cannot grow crops. We have only our cows… Our lives are in our livestock.”
Dwindling natural resources have already led to an upsurge of fighting among the pastoralist peoples in the border lands of Ethiopia, Somalia, Kenya and Uganda. The situation in southern Ethiopia is further complicated by the overspill from the war in neighbouring Somalia – and the ready availability of small arms in the region. This insecurity has had an impact on the provision of emergency relief. A spokesman for an international non-governmental organization says: “Local government officials are afraid for their security. International aid agencies have also pulled out of certain regions. It is hard to provide assistance in insecure areas and, thus, certain groups suffer.” But the violence has also had the effect of reinforcing discriminatory stereotypes of pastoralist peoples. Widely seen as backward by mainstream African societies, the intertribal fighting is written off as typical of ‘primitive’ tribes. But an Ethiopian NGO activist has a different interpretation: “People think pastoralist areas are breeding centres for conflict. But it is not true. Pastoralists live in conflicting situations.”

Official efforts to introduce disaster prevention measures have been hampered by ignorance of the pastoralists’ culture. Their lifestyle and the intricate civil systems they have developed to survive in Ethiopia’s lowlands – one of the world’s harshest environments – have been little understood by successive governments.

The current Ethiopian government is dominated by Tigrayans, from the highland area of northern Ethiopia. Dr Zerihun Mabaye, of the Ethiopian Pastoralist Research and Development Association (EPaRDA), an Ethiopian NGO, says: “Do not expect high-level people in important positions to understand the discrimination and neglect. They are highlanders, they think like highlanders and their solutions are not the right solutions for pastoralists.”

He went on to describe watering holes that were provided for cattle with no other services around them, clinics being built where barefoot doctor schemes would be more appropriate, and schools that were hard to reach, with lesson times that coincide exactly with the time that men and boys tend to the herds and women and girls cannot leave the home. In a similar vein, Haji Mussa Gara says the government tried to build stock ponds to counter the effect of drought, but added that: “This can cause us to settle. We do not want to settle with the cattle: it is inappropriate for cattle to stay in one place. They need to move.” When it comes to food aid, his assessment was that: “There is support, but it is on and off. It is here today and gone tomorrow.” In any case, he reckoned it was not good for pastoralist communities to become dependent on food aid. Despite the difficulties, there have been some improvements in recent years. An early warning system for lowland pastoralist areas has been established, while the infrastructure has been improved. There is now a new road to Jinka – a drought-affected area in the southwest – which has cut the time it takes to reach the capital, Addis Ababa, from six days to one. In 2002, a department for pastoralist development was established as part of the Ministry of Federal Affairs.

Three years ago, the government also officially recognized Pastoralist Day – an event that NGOs had been marking for six years – as a national event. On this day, Ethiopian society as a whole has a chance to familiarize itself with the issues pastoralists are facing. It also gets a chance to understand
the pastoralists' rich traditions and the positive contribution they make to Ethiopian life.

Sisay Tadesse, spokesman for the Ethiopian government’s Disaster Prevention Preparedness Agency (DPPA), says: “Awareness creation is very important; we have to break traditional thinking.” He adds: “I highlight pastoralist issues at various forums and I have seen encouraging changes in the last five years – even in the last two.”

Dr Mabaye recognizes this change in attitude, saying: “The government is now thinking about water development in pastoralist areas. If we have enough wells, we could solve 50 per cent of the problems.” But he stresses that aid agencies and governments must draw on the expertise to be found at the grass-roots level. He says: “Officials must sit down and discuss genuinely and critically with the communities where such wells should go.” For Dr Mabaye, the genuine participation of local people is the key to long-term sustainable development. Pastoralist communities themselves are also taking the initiative. In a project supported by Minority Rights Group International and Pastoralist Forum Ethiopia (an umbrella forum that connects 27 INGOs and NGOs), a pastoralist elders’ council made up of men and women from Uganda, Ethiopia, Tanzania and Kenya has been established. The council will work with local government and will lobby at national level to raise the profile of pastoralist issues. It will also have a peacemaking role by attempting to mediate in the conflicts that are tearing apart pastoralist communities.

There are no guarantees that any of these measures will work. But there is no doubt about the urgency. Emergency relief is only ever a short-term solution. If the pastoralists’ lands in Ethiopia are always in a state of emergency, their unique way of life may be lost forever.

8.1 Direct impacts

Projection of and reflection on climate change impacts has been characterised by gaps between research communities based on disciplines, sectors and timescales of interest. For example, work on agricultural impacts has largely focussed on the biological responses of crops to climate change, including water demand. This has dealt with increasing crop water demand and changing water supply in the form of direct precipitation: it has engaged little with hydrometeorological work which has projected decreased water availability in major irrigation systems (Barnett et al. 2005). Social scientific research and much advocacy work engaged little with either body of work, focussing largely on currently observed patterns of, and medium-term projections of increases in, dramatic extreme events, such as droughts and floods. Morton (2007) suggested a conceptual framework to integrate these different sorts of impact. Modifying this schema further, it is possible to classify the direct impacts of climate change on dryland production systems, livelihoods and societies along two broad axes.

One axis takes up the distinction between extreme events and changing climate means. Although “extreme events” can be defined in some contexts very precisely by a quantified probability or degree of departure from the mean, it is used here in its everyday sense of weather events such as droughts and floods perceived as extreme by those suffering them. The importance of such events, especially droughts, in present-day drylands is unquestioned, and an increase in such events
dominates discussion of climate change impacts in the drylands over the next twenty years or so. The impacts of changing means, of precipitation, temperature and atmospheric CO₂, will be felt over a longer timescale. However, we have felt the need to introduce a middle term, increased variability, to cover short-term climate variability that does not obviously constitute extreme events, but can have serious production and livelihood impacts: for example, unusually hot or cold spells of the order of days in length than can effect plant development at crucial stages, and a generalised uncertainty about weather that can effect investment in agricultural production (Porter and Semenov 2006).

The other axis consists of two different scales on which climate change impacts can be felt upon agriculture and natural resources, plus two other “domains” of impacts. The axis therefore includes:

- Field or organism-level effects on crop and livestock productivity
- Landscape- or watershed level impacts, such as impacts on water supply or soils
- Impacts on human health, animal health and zoonoses
- Impacts on infrastructure, but also on non-agricultural livelihoods, such as industry, trade and tourism (given the importance of livelihood diversification to dryland agrarian societies).

Using this schema, some important future direct climate change impacts on drylands, both generic, and more location-specific, are set out in Table 5.

The most obvious impacts, and the most important in the medium-term, are those in the top left hand cell, especially increased risk of droughts and floods. Even with certain caveats on the relation of current climate variability to long-term climate change, and certain caveats on disaggregating severity of meteorological drought and increasing societal vulnerability to drought, it is increasingly likely that there have been real trends in the last few decades towards more frequent and more severe drought in many dryland regions, and that these are associated with global processes of climate change. The more complex case of the Sahel apart, this has been most marked in the Horn of Africa, but unprecedented multi-year droughts have also struck North Africa and West Asia.

Floods have also become more likely in some dryland regions, including the Horn of Africa and Mozambique, largely due to intense rainfall in upstream areas. Changes in water-holding ability of soils, both climate- and land-use-related, are probably also a factor.

For the future, the IPCC projections of increased extreme wet and extreme dry years in most of the dryland regions should be noted (Table 1), as should the findings of Burke et al. (2006) that the proportion of the world’s land surface in extreme drought is predicted to increase markedly over this century. More specific risks of extreme events projected for the future include increased outbreaks of Rift Valley Fever associated with extreme high rainfall in the Horn of Africa (Bayliss and Githeko 2006)¹⁹, and increased risks of a variety of extreme cold or snow events known in Mongolia as dzud.

¹⁹ RVF is dangerous to both livestock and humans, but has become important in the Horn of Africa in recent years as the cause of economically devastating livestock trade bans by the Gulf States (the scientific basis for which having been questioned by international agencies and authorities in the exporting countries)
The impact of extreme events will also be felt at the other scales and in the other
domains set out in Table 5, through, for example, increased soil erosion, increased
waterborne disease and destruction of infrastructure due to floods.

Porter and Semenov (2006) have documented the importance of increased climate
variability for plant growth, specifically high-temperature events at levels and of
durations that would not be considered “heatwaves” in ordinary language, but which
coincide with and are extremely limiting of, key stages of plant growth. They also
document the possible impacts of climate variability, below the levels normally
considered “extreme events”, on grain quality and specifically protein content. This
sort of variability may also be key to the spread of certain crop pests and diseases.
The IPCC (Kundzewicz et al. 2007) note the projected greater erosivity of rainfall and
its effects on soils. Its potential impacts on rural roads, and thus on transport costs,
have not to our knowledge been noted.

Impacts of changing means of climate parameters are likely to be felt over longer
timescales. The principle impacts on crops in drylands will be compounds of higher
water demands linked to rising temperatures, decreased precipitation in most dryland
regions. These will be balanced by the positive impact of CO$_2$ fertilization, but recent
research has tended to play down this factor (Easterling et al. 2007).

A synthesis of recent modelling studies for maize, wheat and rice has been carried
out by the IPCC (Easterling et al. 2007), plotting yields against degrees of average
local warming, with their associated changes in CO$_2$ and precipitation. For all three
crops, moderate warming in temperate regions is associated with modest increases
in yields, especially if assumptions about agronomic adaptations are factored into
models. In tropical regions, trends are much more clearly downward, with any
degree of warming and even with adaptation$^{21}$ factored in. For maize, the most
important of the three in dryland regions, the downward trend in yields is clearest.
Also highly relevant is the work of Jones and Thornton (2003) that aggregate yields
of maize in Africa and Latin America (largely but by no means exclusively in dryland
regions) are likely to show a decrease of around 10% by 2055, but that these results
hide enormous variability and give cause for concern, especially in some areas of
subsistence agriculture.

There is likely to be some direct impact on the productivity of livestock through heat
stress, though available studies (King et al 2005) concern exotic cattle in tropical
dryland settings, and the mainly zebu breeds indigenous to dryland areas are known
to be more tolerant of heat.

There are various potential impacts of changing mean climate parameters at
landscape or environmental level. Major irrigation systems, such as those of the
Indo-Gangetic plain are usually considered apart from the drylands, even if defined
as semi-arid by precipitation levels, but the dramatic projections of Barnett et al.
(2005) of reduced usable water in such systems as a result of snowpack melt, should
be noted. Basic knowledge of climate change impacts is greater for temperate and
Mediterranean rangelands than for those in the tropics, but findings of the IPCC
report (Easterling et al. 2007:285-289) should be noted: effects on plant community
structure and changes in forage quality. The increased encroachment of woody
species on rangeland as a result of higher CO$_2$ levels has been projected for semi-
arid rangelands in North America (ref.). Shifts in the distribution of tsetse fly could be

$^{20}$ The references are to heat periods of eight days at 25°C at double ridge stage and 35°C at
anthesis in wheat.
$^{21}$ Including changes in planting, changes in cultivation and shifts to irrigation
considered both a landscape level impact on agriculture and an impact on human health, but will probably be minor, especially compared with the potential for control of tsetse fly both through exogenous insecticidal strategies and spontaneous bush clearance (ref.). Finally there are impacts on non-agricultural livelihoods such as a projected decline in tropical tourism (Wilbanks et al. 2007), tourism being a major employer in some dryland regions.

8.2 Indirect Impacts

A schema such as that above only begins to set out the range and complexity of impacts. Additional dimensions are needed.

Impacts will not only be directly on production systems and livelihoods, but also on coping, adaptation and local institutions. Such “downstream” impacts will tend to be compounds of the specific direct impacts exemplified in Table 5, i.e. of impacts on different scales and livelihood domains, and along the extreme events/changing means continuum.

In addition, impacts will not only be those of climate change itself, but also of:
- adaptation to climate change elsewhere (by other communities in the drylands and outside the drylands),
- policies adopted, or ostensibly adopted, in the name of climate change adaptation, which may have unintended impacts
- policies adopted in the name of climate change mitigation, such as encouragement of biofuel cultivation. This could be experienced both through local changes in land-use and land tenure, and through national and global changes in food prices if there are large-scale switches from food to biofuel cultivation.

There will also be impacts of the non-climate-related shocks and trends, as detailed in Sections 1 and 6 above.

Clearly we are faced here with a very complex web of causation here. A simplified representation of this is shown in Figure 12. Both direct and indirect impacts set out above apply to the main livelihood strategies adopted in drylands, while the direct impacts also constrain adaptive capacity and the adaptive and coping strategies adopted, and the non-climate related trends and shocks influence and constrain local institutions, often but always in the direction of reduced flexibility. But, as already set out in Figure 12, the elements of livelihood strategies, coping/adaptation, and institutions, also interact with each other.
Figure 12. Causation web of direct, indirect and non climate effects on livelihoods

8.3 Aggregate Impacts

Within this complexity, we can nevertheless see some major outlines of aggregate impacts. Many dryland regions will become drier, and all will become more variable in rainfall. Drought will increase, with direct losses of crops and livestock leading to human suffering, but also loss of purchasing power and feedbacks into increased land degradation and conflict.

Both drought and an underlying level of risk that falls short of extreme events, will increase fluctuations in production of both crops and livestock. Likely impacts will be a lack of investment in production by farmers and livestock producers; investment of labour but also a decreased tendency to adopt new technologies, and underdevelopment of markets for livestock and crop commodities suffering unpredictable supply.

Risks to cropping may lead to an increase in extensive livestock production, and to an increase in livelihood diversification, but the policy environment necessary to make either shift sustainable will be critical. Without such a policy environment livestock production may not be sustainable, and livelihood diversification may tend towards low-skill, low-income employment.

As discussed above the capacity to cope with and adapt to climate change and variability is influenced both by coping and adaptive strategies previously adopted, but also by external socio-economic, demographic and environmental trends. Many
of the direct and indirect impacts of climate change, and the non-climate trends, will tend to reduce adaptive capacity.

Dryland dwellers do have a repertoire of adaptive strategies and some important examples of spontaneous or largely spontaneous adaptation have been recorded (see Box 2). But many coping strategies, especially those available to the poorer and those made more vulnerable by external trends (such as those whose land tenure has been made less secure), will be erosive of both households assets and environmental sustainability. This is discussed in Section 9 below.

The impacts on institutions themselves are, not surprisingly, the most difficult to gauge. The institutional flexibility of dryland societies is important for adaptation, both to climate variability and climate change. Climate change per se is unlikely to weaken that flexibility, but over the last few decades policy trends have weakened it. It remains to be seen whether newer policy trends for increased local self-governance, such as decentralisation and increased recognition for community resource management, can counteract this. On top of that, there are fears that governments may use policy concerns around climate change and other forms of environmental change to increase bureaucratic and political control over dryland resources.

**Box 2. Cases of climate adaptation in drylands**

[adapted from an article by Chris Reij in Haramata no 52, December 2007] see [http://www.iied.org/pubs/pdfs/12544IIED.pdf](http://www.iied.org/pubs/pdfs/12544IIED.pdf)

In some regions of Niger farmers began protecting and managing on-farm trees in the middle of the 1980s. Remote sensing images and field visits show that this farmer-managed re-greening in Niger now concerns at least 5 million ha. This means an average increase in on-farm protection of trees of 250,000 ha/year over a period of 20 years. This has never been achieved by any tree planting project in Africa.

Five million hectares at an average 40 trees/ha means 200 million new trees. If each tree produces an average annual value of 1 Euro/ tree (firewood, fodder, fruits, medicinal products, etc.) this means an annual production value of 200 million Euro. This does not yet include the value of the standing tree stock (asset building).

In some places projects have played a key role in stimulating farmers to protect and manage on-farm trees, but it subsequently spread spontaneously

**What has triggered farmers to protect and manage on-farm natural regeneration in Niger?**

- The environmental crisis of the 1970s and 1980s (the need to fight dust and sand storms, land degradation, declining crop yields, etc.)

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22 The impacts mentioned are based on an exploratory study by Larwanou, M., M.Abdoulaye and C.Reij (2006), Etude de la Régénération Naturelle Assistée dans la Région de Zinder (Niger): une première exploration d’un phénomène spectaculaire. This report as well as other information about the re-greening can be downloaded from: [www.frameweb.org/nigerregeneration](http://www.frameweb.org/nigerregeneration)
• The perceived shift in rights to trees from State-owned to private ownership.
• The need to intensify production systems in reaction to strong demographic growth.

Which are some of the measured or perceived impacts of this farmer-managed re-greening?

• Higher crop yields and improved household food security. Before the farmers had to sow 2 – 4 times before the crops succeeded as the strong winds covered the crops with sand or wind-blown sand razed the young plants. Now they only sow once, which increases the length of the growing season.

• The local climate has changed as wind and sun do not scorch the soil. Rainfall studies have shown that large-scale re-greening also leads to locally higher rainfall (+ about 30%).

• The farming systems become more complex, more productive, which leads to a reduction in rural poverty and increases in household food security. Trees produce fodder, which allows farmers to keep more livestock. More livestock means more manure, which is no longer used as a source of household energy, but is all used to fertilize the fields and subsequently increase productivity.

• The time women spent on the collection of firewood has gone down from about 2.5 hours/day to 0.5 hours/day.

• The re-greening has reduced vulnerability to drought. During the 2005 famine, child mortality in villages which had protected natural regeneration was much lower than in villages without.

• In some regions farmer-managed natural regeneration is dominated by *Acacia albida*, but elsewhere tree biodiversity is increasing.

• The economic benefits to farmers of investing in the protection and management of on-farm natural regeneration are high. A study by economists, which is based on a review of some of the benefits, shows an internal rate of return of 31%.

Conclusion
Promoting farmer-managed natural regeneration in the Sahel is complex, but it contributes to realizing some of the MDGs as well as the international environmental conventions on climate change, desertification and biodiversity. It also offers a cheap, rapid and sustainable means of fulfilling the African Heads of state desire to combat desertification through the Green Wall initiative, without repeating the mistakes and failings of previous similar movements.
9. TRENDS IN DRYLANDS RELEVANT TO CLIMATE CHANGE IMPACTS

Several of the major external trends that have had impacts on the drylands in recent decades have been trends in policy, designed and implemented by national governments, often with the encouragement of international donors. Most of these policies have been national in scope, others have been specifically designed for drylands development. All have had impacts, positive, negative or complex, on the vulnerability of dryland dwellers to climate variability and climate change.

There has, of course, been a general trend for state withdrawal from markets and services across Africa in the 80s and 90s, driven by new views among international donors on the appropriate role for the state, as well as by a recognition that heavy state involvement in the economy in Africa was inefficient, unsustainable and associated with inequity, particularly urban bias. However, the pattern of this withdrawal as it relates to dryland regions has been more complex, for reasons discussed below. In Central Asia and Mongolia, there was a rapid decollectivisation associated with the collapse of communism. Other dryland regions, such as the WANA countries and India, had less state involvement in the rural economy to begin with, and withdrawal from what there was has been less marked.

In dryland Africa (setting aside states in collapse such as Somalia and Zimbabwe), the pattern of withdrawal has been modified by the importance of cotton and the particular politics of cotton in Sahelian countries, where parastatals part-owned by both national governments and the French government have long governed a system of monopsonistic purchase interlocked with credit, input and information supply. These systems have been more resistant up till now for pressure to liberalise, and different countries in the zone are now adopting different tactics in the privatisation debate. Elsewhere in Africa, a more classic case has been the ending in Kenya in the early 80s of the system whereby government acted as a buyer of last resort for livestock, through the Livestock Marketing Division and the Kenya Meat Commission. Whatever the arguments about the unsustainability of government purchase, this shift is still regretted by Kenyan pastoralists. In Ethiopia by contrast, the liberalisation of both meat and livestock export in the early 1990s, has been broadly positive, even though much remains to be done in facilitating private sector activity.

Withdrawal from services, both input provision and extension, has been more universal. The slow steps to provide alternatives in veterinary services have been mentioned above, and there has been a similar pattern in crop extension – the most thorough-going initiative in this respect, the Ugandan NAADS, being in a comparatively early stage.

Parallel with economic liberalisation, governments particularly in Africa, but also in Northeast Brazil, have pursued policies of decentralisation. While in principle decentralisation of governance encourages local decision making, and potentially local adaptation and the building of local adaptive capacity, there is also the potential for decentralisation initiatives in dryland areas:

- To be captured by local elites
- To favour sedentarised populations clearly associated with territories at the expense of pastoralists and other mobile people
- To under perform due to high transport and transaction costs in territories with large areas and low populations.

More comparative research needs to be done on how decentralisation initiatives are played out in dryland, including pastoral, areas.
Policy responses more specific to dryland areas include: initiatives on land tenure, strengthening of local resource management, and various initiatives in drought management, “safety-net” provision, and donor-funded “community-driven development”.

Land tenure policies have taken many forms across dryland regions, starting from many different points. Overlapping with land tenure policies have been local resource management policies, such as gestion de terroir in the Sahel.

Drought is a recurrent risk in the drylands. Some national governments responsible for dryland regions have long taken a role in “managing drought” through food relief, public works programmes to create temporary employment, and subsidised feed distribution for livestock. Such strategies were available to middle-income countries, for example in the WANA countries, or to very large poorer countries such as India. Governments of poorer developing countries needed to rely on emergency assistance from international donors, often delivered late after protracted assessment, negotiation, and logistics.

The African droughts of the mid-1980s brought about new forms of drought management with linked emphases on:

• Early warning systems
• Contingency planning
• Mitigation measures to support livelihoods

New technologies, particularly remote sensing of vegetation conditions, have been deployed to give early warning of drought for actions by national governments and donors, including prompter delivery of food relief.

At the same time, a powerful model of district-level contingency planning has also developed, following early experiences in Turkana District, Kenya (Swift 2000). Regular on-the-ground data collection is designed and implemented, such that results could be codified into “warning stages” such as normal/alert/alarm/emergency/recovery. At the same time, contingency plans are made at district or similar level for relief, mitigation and rehabilitation actions that can be triggered at specific warning stages.

The special case of pastoralists facing climate change is developed in Box 3.

**Box 3. The case of Pastoralists facing climate change**

Climate change is affecting drylands and pastoral livelihoods particularly, but not only, in Africa. The delicate balance on which pastoral systems depend is being undermined. The quality, quantity and spatial distribution of natural pastures are mainly shaped by rainfall. The predicted changes in rainfall patterns will result in increasingly scarce, scattered and unpredictable pastures. The number, distribution and productivity of permanent pastures and water points, which are so critical for livestock survival during the dry season, are bound to decline. Scarcer resources, coupled with current levels of demographic growth, are likely to lead to stronger competition between pastoral communities and between these and other groups - possibly resulting in conflict and even violent clashes. As a result, access to pastures becomes more difficult, leading to loss of livestock and of livelihoods. In north-west
Kenya, for instance, several years of low rainfall have recently resulted in the death of many livestock, and in a major food crisis among the Turkana pastoralists.

In the longer term, pastoralists are likely to further diversify their livelihoods, both within the pastoral system (i.e. increasing reliance on more drought-resistant species such as camels) and out of livestock production. However, efforts to diversify out of livestock production are likely to be constrained by the difficult environment characterizing pastoral areas in Africa. Over time, pastoral groups will shift out of drier areas that are no longer viable, to zones that are more humid and have more predictable rainfall patterns. Existing land tenure arrangements and services in these areas will come under increased strain, exacerbating relations between communities and fuelling conflict.

Within this context, mitigation measures gained increased importance. Provision of employment opportunities, through large-scale public works programmes has probably been economically one of the most important mitigation activities. In pastoral and livestock-based livelihood systems a number of innovative mitigation strategies have been piloted to maintain livestock numbers, and/or improve livestock-keeper purchasing power during drought. They include (LEGs Website, 2008):

- Commercial off-take of livestock
- Destocking, emergency slaughter and meat distribution
- Supplementary feeding for livestock
- Water provision for livestock
- Veterinary care
- Shelter for livestock

Also negotiating special access to protected areas, and through peace-building, to pastures normally closed off because of endemic conflict (Morton 2007).

Mitigation measures can be viewed as: supporting productive livelihoods rather than simply feeding people; as taking place early in the drought cycle as enabled by early warning, and requiring less subsidy relative to eventual economic benefits than does relief. In practice the distinction between mitigation and relief activities is hazy, for example with large-scale highly subsidised feed distribution (Morton 2002).

Such approaches to drought management are becoming increasingly mainstreamed in work funded by international donors. While it is difficult to produce quantitative evidence, it appears that drought response both at a national level is becoming prompter, more cost-effective, more efficacious, and is learning more from indigenous drought coping strategies. In addition, even newer approaches are now being discussed, such as the use of index-based insurance, whereby farmers or livestock-keepers can be insured against area-based indices (of rainfall, vegetation quality, or livestock mortality) passing certain thresholds, thus avoiding the moral hazard and adverse selection problems associated with agricultural insurance in

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23 At an operational level in the Kenya Arid Lands Resource Management Project and the Ethiopia Pastoral Community Development Project, both funded by the World Bank; at the level of developing policies, through the ALive initiative (Morton 2007) and the Livestock Emergency Guidelines and Standards project
developing countries. Box 4 describes cases where livestock insurance is being developed and tested.

However, as many writers on the topic point out, drought management cannot be divorced from a whole range of long-term policies, most notably on land-tenure, resource management and access to markets, which can strengthen (or weaken) resilience to drought. In the context of climate change, such linkages are even more important.

**Box 4. Index-based insurance and climate risks**

[first adapted from an article in Haramata 52: December 2007- Harriet Matsaert and Andrew Mude “Getting paid when drought strikes: Index-based insurance could be a viable risk-management tool for the drylands” see - http://www.iied.org/pubs/pdfs/12544IIED.pdf]

Last year the Ethiopian government, in partnership with the World Food Program, insured its farmers against rainfall failure. This meant that in return for a premium of US$930,000, the insurance company would have paid out anything up to $7.1 million in the case of severe drought. To arrive at a ratio of premium-to-sum-insured acceptable to all parties, this innovative scheme assessed the weather risks in terms of expected loss of income by affected people in the rural areas.

As it turned out, there was no severe drought and therefore no payout on the policy last year. If there had been, the money would have gone to the government of Ethiopia, on condition that it would be used for emergency relief and recovery. For the World Food Program, it means that when an emergency occurs they can rely on the insurance money to pay for their relief work, rather than having to depend on donations, which can entail long delays. And with the assurance of those funds arriving on time, people badly affected may be able to avoid destructive, last-resort measures such as selling their assets, cutting the use of crop nutrients, becoming refugees or turning to crime.

Equally importantly, reducing risk exposure can give producers in dryland areas the confidence to invest in inputs and strategies that will potentially give them higher returns in other years.

Two different examples of index-based insurance come from Mongolia and Malawi. In Mongolia, herders can now buy private insurance to cover livestock losses up to a certain level. In Malawi, weather insurance for crops is making groundnut production less risky. For the first time in these and other countries, people who had no access to insurance in the past are being able to use this type of policy – called index-based insurance – to cover some of their risks. All these examples involve a relatively novel and innovative risk management tool: ‘index-based insurance’.

Traditional insurance products are based on an individual’s circumstances and losses. In dryland areas where infrastructure is not good, however, these services are generally unavailable because of the high cost of administering them. In contrast, index-based insurance is based on a fixed trigger...
mechanism not directly related to any individual farm. This could be calculated on average crop yields, area average livestock mortality rates, cumulative rainfall or even data from satellite imagery.

Index-based insurance can be effectively delivered through a wide range of products. Government or international aid agencies can purchase famine insurance based on a weather index tied to the likelihood of droughts. Individual producers can purchase insurance privately from insurance providers, local banks, NGOs or some partnership of these. Insurance clauses can be folded into loan agreements whereby indexes triggered by adverse events relax the terms of the loan or pay it off.

The potential applications are numerous and many organizations are pioneering contract design. Experience has shown that these models can provide policies acceptable to both buyers and sellers. In arid and semi-arid lands, the major constraint has been the limited availability of reliable and objective data. Now, the new-found interest in index-based insurance arises in part from the wider availability of high-precision, high-frequency, satellite based climate data, an increasing number of weather stations and increased sophistication in the empirical tools for modelling and designing indexes.

10. POLITICAL PROCESSES AND ADAPTATION

Reference has been made throughout this paper to a variety of policies which have impacts on dryland livelihoods, institutions and adaptive capacity. Many of those policies, such as policies weakening local resource management, or limiting access to markets for dryland products, have had negative impacts on the adaptive capacity of dryland-dwellers. Others, such as policies on decentralisation, which might have been assumed to favour adaptive capacity, have been weakly or unevenly implemented, or been captured by local elites.

This section will therefore focus on:
• the processes by which policies are made and implemented;
• how dryland dwellers are, and can be better, represented in those processes, or in slightly different terminology, how they can participate, or find voice.

Directly connecting this discussion of better policy-making, better representation and better governance to building capacity to adapt to climate change is difficult, but there is a strong argument, as made above, that poor policy limits adaptive capacity. If dryland dweller participation in making and implementing policy can be increased, policies can be more responsive to local livelihoods, local institutions, and local patterns of adaptation/coping.

There is a considerable literature on policy processes. One relevant summary and development of this literature is found in the book by Keeley and Scoones on environmental policy processes in Africa. They start from the perceived longevity of dominant environmental policies and consistency across colonial and post-colonial regimes. In order to explain this tenacity, they seek to get away from a linear view of policy driven in a straightforward way by objective scientific expertise, in favour of a richer description of policy processes which draws on three broad and overlapping approaches to the analysis of policy and policy change found in the literature:
• Through the interaction, or competition, between different groups with different political interests, (where the state itself, or differing interests within the state, may themselves be seen as part of the competition)
• Through the activities and practices of actors, and their formation of networks, often crossing between obvious interest groups, and
• Through the establishment of dominant discourses, where the establishment of problems and the very terms used to speak and write about them determine policies.

All these approaches are relevant to the analysis of policy processes in the drylands: an interest-based (broadly speaking political economy or political ecology) perspective has clear relevance to many policy issues in drylands, such as encroachment on rangelands and customary-tenure croplands by commercial interests, or the state intervention in export markets that differentially favours large producers. For network approaches, Keeley and Scoones themselves discuss coalitions of actors, including key individual researchers around policies privileging soil fertility issues in Mali. The discourse approach subsumes previous discussions of the tenacity of dominant policy narratives in the drylands (Leach and Mearns 1996), especially that of desertification (Swift 1996). Dryland policy is characterised by the persistence among governments of policy narratives based on out-of-date, over-simplified or inappropriate research, with central concepts such as “carrying capacity”, “overgrazing”, and “the tragedy of the commons”.

The issue, however, is wider than simply policy-making: policies are implemented, with varying degrees of efficiency, faithfulness to their intentions, and unforeseen effects, which may include implications for gender and other aspects of equity. Keeley and Scoones (2003) refer to Lipsky’s (1979) concept of “street-level bureaucrats”, those who implement policy at the local level, to characterise their limited and complex, but real, agency of these people. But policy implementation in the drylands is often ineffective, inefficient, or partial. The combined failures of policy-making and policy implementation can be

The analysis of problems in both policy-making and policy-implementation, which can also be viewed in combination as serious problems of governance, require a focus on how dryland dwellers are represented in those processes. Lister (2004) begins her study of Ethiopian pastoralist representation, by carefully considering the different meanings of “representation” and “representative”, in everyday speech and in political science, and warns about the dangers of making either/or judgements about institutions or individuals being “representative”. She then analyses a number of “processes mediating between citizen interests and policy outcomes….”the functioning of the federal parliament, the functioning of regional and sub-regional systems of government, and the interaction between formal and ‘traditional’ or ‘customary’ institutions”.

Morton et al. (2007) examined the groups that have sprung up to represent pastoralists in the parliaments of Kenya, Uganda and Ethiopia. They demonstrate a certain potential for those groups to promote pro-poor development, and make concrete proposals for donors and NGOs to engage with them. At the same time, they conclude that this can only ever be one form of representation among many. Others strategies, may of which overlap, include:

• NGOs and CBOs: there has been a huge growth in the drylands in Community-Based Organisations and of Non-Governmental Organisations with varying
degrees of local participation. International NGOs are involved in building capacity, including the capacity to represent and advocate, of CBOS and local NGOs. Support for civil society and the self-organization of dryland-dwellers is important vital, but such support must build links to formal government and policy-making, and act above the community level. NGOs, both national and international, must also look to their own legitimacy and accountability.

- **Producer associations**: dryland dwellers can act politically through producer organisations around specific commodities or economic sectors, especially where these are federated at regional or national level; the national livestock-producer federations of the Sahelian countries are good examples. Such structures have potential risks for equity, of being dominated by larger producers and by men, but can potentially be very effective, especially on matters of marketing policy.

- **“Traditional” authorities**: no systems of authority or governance in post-colonial countries are truly traditional, all having been harnessed and changed by colonial and post-colonial governments, but some of these hybrid structures can be effective in representing dryland dwellers, and in some countries new experiments are being tried, for example the Council of Amakari (elders) in Somali Region Ethiopia.

- **Decentralised local government**: formal decentralisation as the subject of policy, as well as a mode of making and implementing policy, has been mentioned elsewhere in this review. Some additional relevant points are that there has to be an active initiative to equip dryland dwellers, particularly the poorer, the more vulnerable, and women, to participate in decentralised government, and that the tendency for decentralisation to assume a territorial model may discriminate against the participation of mobile peoples such as pastoralists.

- **Bureaucratic structures**: A number of countries organise the governance of particular vulnerable groups through appointed bureaucratic bodies, such as state-level welfare boards variously for particular castes, tribal peoples and nomads in India. In certain circumstances, particularly if the client groups are numerically very small or face particular difficulties in representing themselves, reforming and working with such bodies may remain an option.

- **The media and communication technology**: there are arguments for improving the way mass media deal with the problems faced by dryland dwellers, and also for promoting new uses of communication technology (internet, video, mobile phones, FM radio) to overcome the constraints of distance and information that limit participation in policy and political processes.

- **Participation in research**: given the importance of knowledge production in changing and maintaining policy, it is important that dryland dwellers participate fully in research and throughout the research cycle, including the initial framing of research questions: there is a growing literature on this topic.
11. RECOMMENDATIONS FOR POLICY-MAKERS

From this brief analysis of the ways that climate change will impact upon dryland areas in developing countries the following set of policy recommendations is advocated:

1. Support to developing country governments in dryland regions to engage effectively with the Climate Change negotiation process, to ensure they can shape the post-2012 agreement in ways that are responsive to their priorities
2. Mainstream climate adaptation into plans and strategies at national and local/district level and at sectoral levels, such water resources management, agriculture and livestock development, etc.
3. Continue long-term, decentralised development in the drylands that builds on local institutions – there is huge overlap between such development and the facilitation of adaptation to climate change.
4. Support better participation of dryland populations in governance, and better implementation of policy in dryland areas – both require multiple strategies of support
5. Safeguard dryland populations against unintended effects of climate change mitigation, e.g. encroachment on grazing lands by biofuel cultivation or human immiseration by investing in adaptive institutions that may exacerbate existing vulnerability traps with little scope for virtuous circles of asset accumulation
6. Rethink issues of sustainability, market principles and subsidy – it may be more sustainable (as well as being an ethical obligation) to subsidise certain sorts of adaptation, e.g. provision of agricultural technology, than to suffer the human costs and the opportunity costs of dryland agriculture becoming unsustainable
7. Provide a focus on water management at regional, national and local levels to reduce risks from flooding, and capture rainfall for agricultural, livestock and eco-system use through a mix of micro- and larger scale investments
8. Scale up pilot community-based adaptation projects with poor and vulnerable communities in urban and rural areas in selected dryland countries, to ensure the documentation and rapid replication of these activities at a community level
9. Advance regional cooperation to help scale up successful initiatives in drylands
10. Ensure effective public information campaigns to help people understand and respond to the climate change challenges faced in different regions and districts

With regard to Pastoralists
11. Policies to enable herd mobility, both seasonal and as a response to drought, while securing rights to critical resources (dry-season pastures and water)
12. Support to pastoral livelihoods through better water access and tailored service provision, and supporting livelihood diversification, for instance in the areas of tourism and conservation
13. Build robust conflict management institutions and effective drought mitigation systems, including early warning, insurance and safety nets
14. Strengthening the capacity of pastoral groups to engage with debates on policy issues directly affecting their lives
12. IDENTIFICATION OF A FUTURE RESEARCH AGENDA

During the process of preparing this paper and the review of literature required gaps in knowledge with regard to drylands and climate change have been revealed. The most obvious gap from ‘developmentalist’ perspective is the testing and ground-truthing of climate adaptation theory, particularly with regard to equity, through application to actual cases of climate adaptation by the poor. It seems that we have very little evidence as how the costs and benefits of climate adaptation are distributed in reality and how greater equity can be brought into the distribution process.

Areas identified as under researched topics are listed below:

- Differentiated effects of climate change impacts on dryland dwellers
- Differentiation in climate adaptive capacity of dryland dwellers
- Interactions between short-term coping, long-term adaptation, local institutions and external policy environments
- Governance and representation of dryland dwellers in decision making for climate change adaptation
- Climate information needs of dryland dwellers and other stakeholders, including service providers and local government, and across different timescales: much existing work has had a narrow focus on needs of farmers/livestock-producers only and therefore tended to be pessimistic about usefulness of new information.
- Appropriate technological responses to climate change by private and public sectors
- Institutional responses, what are the bases to build upon in the different drylands
- How adaptation and mitigation can be linked to achieve synergies in drylands
- Social policy alternatives where adaptation fails
- Conflict management particularly between pastoralists and croppers etc
- Migration management and an analysis of the success and failures of sedentarisation policies
- Livestock and famine/food security early warning systems, insurance approaches, etc.
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Annexes

Annex 1. Major dryland regions in developing countries distinguished on the basis of environmental, economic, political and cultural characteristics

The Sahel countries of Senegal, Gambia, Mauritania, Mali, Burkina Faso, Niger and Chad, together with northerly, dry regions of the West African coastal states.

The Greater Horn of Africa, comprising Sudan, Ethiopia, Eritrea, Djibouti, Somalia, and parts of Kenya, Uganda and Tanzania

Southern Africa: Namibia and Botswana, large parts of Zimbabwe, South Africa and Mozambique and parts of neighbouring states

West Asia and North Africa (sometimes the WANA countries): a belt from Morocco to Iran, Yemen and Oman, which in ecological, political and cultural terms also includes the oil-exporting countries of the Gulf.

South Asia: nearly all of Pakistan and most of India fall within the definition. Much of the population lives and depends on major riverine irrigation systems, which face different environmental and climate-related challenges, but significant populations live in rainfed farming areas such as the Potohar Plateau and Andhra Pradesh, and in arid areas such as the Thar Desert on the border between the two countries

Central and Inner Asia: the Central Asian Countries of the former Soviet Union, Mongolia and parts of China have environmental similarities (challenges of cold winters as well as hot, dry summers) and a common heritage of emerging from command economies

Latin America includes several distinct dryland regions, including Northern Mexico, parts of the Andes (that face rather different challenges as dry highland regions), and especially the densely populated, poor and drought-prone areas of Northeastern Brazil.
## Annex 2. Key drylands findings of the Millennium Ecosystem Assessment

<table>
<thead>
<tr>
<th>Drylands cover about 41% of Earth’s land surface and are inhabited by more than 2 billion people</th>
<th>Drylands are limited by soil moisture, the result of low rainfall and high evaporation, and show a gradient of increasing primary productivity, ranging from hyper-arid, arid, and semiarid to dry subhumid areas. Deserts, grasslands, and woodlands are the natural expression of this gradient.</th>
</tr>
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<tbody>
<tr>
<td>Dryland populations on average lag far behind the rest of the world on human well-being and development indicators</td>
<td>The current socioeconomic condition of dryland peoples, about 90% of whom are in developing countries, lags significantly behind that of people in other areas.</td>
</tr>
<tr>
<td>Existing water shortages in drylands are projected to increase over time due to population increase, land cover change, and global climate change</td>
<td>From 1960 to 2000, global use of fresh water (drylands included) expanded at a mean rate of 25% per decade. The availability in drylands is projected to decline further from the current average of 1,300 cubic meters per person per year (in 2000), which is already below the threshold of 2,000 cubic meters required for minimum human well-being and sustainable development. This increased water stress will lead to reduced productivity of croplands and availability of fresh water, resulting in further adverse impacts on human wellbeing in drylands. There is a high degree of certainty that global climate change, land use developments, and land cover changes will lead to an accelerated decline in water availability and biological production in drylands.</td>
</tr>
<tr>
<td>Transformation of rangelands and other silvipastoral systems to cultivated croplands is leading to significant, persistent decrease in overall dryland plant productivity</td>
<td>Extreme reduction of rangeland vegetation cover through grazing of forage and collection of fuelwood exposes the soil to erosion. Transformation of rangelands to cultivated systems (approximately 15% of dryland grasslands, the most valuable dryland range, were converted between 1950 and 2000), in combination with inappropriate dryland irrigation and cultivation practices has led to soil salinization and erosion. These processes reduce the provision of water-related services, which affects the provision of many other significant dryland services and goods, culminating in persistent reduction of primary production.</td>
</tr>
<tr>
<td>Among dryland subtypes, ecosystems and populations of semiarid areas are the most vulnerable to loss of ecosystem services</td>
<td>Population density within drylands decreases with increasing aridity from 10 persons per square kilometer in the hyper-arid drylands to 71 persons in dry subhumid drylands. Conversely, the sensitivity of dryland ecosystems to human impacts that contribute to land degradation increases with increasing aridity. Therefore, the risk of land degradation is greatest in the median section of the aridity gradient (mostly the semiarid drylands), where both sensitivity to degradation and population pressure (expressed by population density) are of intermediate values.</td>
</tr>
<tr>
<td>It is thought that some 10–20% of the world’s drylands suffer from one or more forms of land degradation</td>
<td>Despite the global concern aroused by desertification, the available data on the extent of land degradation in drylands (also called desertification) are extremely limited. In the early 1990s, the Global Assessment of Soil Degradation, based on expert opinion, estimated that 20% of drylands (excluding hyper-arid areas) was affected by soil degradation. A recent MA commissioned desk study (Lepers 2003) based on regional data sets (including hyper-arid drylands) derived from literature reviews, erosion models, field assessments and...</td>
</tr>
</tbody>
</table>
found much lower levels of land degradation in drylands. Coverage was not complete, but the main areas of degradation were estimated to cover 10% of global drylands. Most likely the true level of degradation lies somewhere between the 10% and 20% figures. To identify precisely where the problems occur and the true extent of degradation will require a more in-depth follow-up to these exploratory studies.

**Desertification, which by definition occurs only in drylands, causes adverse impacts on non-dryland ecosystems**

Desertification has both direct and indirect impacts on non-dryland ecosystems and peoples. For example, dust storms resulting from wind soil erosion, driven by degradation of the dryland vegetation cover, may affect people and ecosystems elsewhere. Similarly, transport of sediments, pesticides, and nutrients from dryland agricultural activities affects coastal ecosystems. Droughts and loss of land productivity are considered predominant factors in the migration of people from drylands to other areas.

**Traditional and other current management practices contribute to the sustainable use of ecosystem services**

Many existing practices help prevent desertification. These include enhanced and traditional water harvesting techniques, water storage and conservation measures, reuse of safe and treated wastewater for irrigation, afforestation for arresting soil erosion and improving ground water recharge, conservation of agrobiodiversity through diversification of crop patterns, and intensification of agriculture using technologies that do not increase pressure on dryland services. Policies that involve local participation and community institutions, improve access to transport and market infrastructures, and enable land users to innovate are essential to the success of these practices.

**Alternative livelihoods have a lower impact on dryland ecosystem services**

These livelihoods still depend on the condition of drylands services but rely less on vulnerable services and make use of the competitive advantages drylands can offer over other systems. They can include dryland aquaculture for production of high-value food and industrial compounds, controlled-environment agriculture (such as greenhouses) that requires relatively little land, and tourism related activities.

**Depending on the level of aridity, dryland biodiversity is relatively rich, still relatively secure, and is critical for the provision of dryland services**

Of 25 global “biodiversity hotspots” identified by Conservation International, 8 are in drylands. The proportion of drylands designated as protected areas is close to the global average, but the proportion of dryland threatened species is lower than average. At least 30% of the world’s cultivated plants originated in drylands and have progenitors and relatives in these areas. A high species diversity of large mammals in semiarid drylands supports cultural services (mainly tourism); a high functional diversity of invertebrate decomposers in arid drylands supports nutrient cycling by processing most arid primary production; a high structural diversity of plant cover (including microphyte diversity of soil crusts in arid and semiarid areas) contributes to rainfall water regulation and soil conservation, hence to primary production and its generated diversity of the dryland wild and cultivated plants.