4 Possible system changes by 2050—opportunities and risks for poor households

We carried out a global analysis showing possible scenarios for system changes in an attempt to move beyond the static picture given by the poverty maps in the previous sections. These changes represent both opportunities and risks for poor households. They can represent an opportunity if the system changes lead to a growing and more diversified economy, increased market integration and more off-farm income, for example. This requires, however, that policies and interventions are designed to target some or most of the benefits to the poorer segments of society. These can exacerbate inequality and poverty if the benefits of system changes are captured mostly by the richer households, and if these changes destroy the livelihood systems of the poor (World Bank, 2001). It is reasonable to hypothesise that in countries and geographic areas that already have large gaps between rich and poor in terms of access to land or natural resources, it will be much more difficult to make these system changes beneficial to the poor.

The scenarios focus on two types of change: predicted changes in population density (and corresponding land use) to 2050 for all developing countries and possible impacts from climate change to 2050 for Africa. These plausible futures are intended to highlight the importance of including a time dimension in poverty analysis. They certainly fall short of more comprehensive scenarios, that could include other important factors affecting livestock production systems and human well-being such as urbanisation and migration rates, changes in market integration and trade relationships and changes in the capacity of ecosystems to continue to provide goods and services.

4.1 Production system changes—the demand side

Map 15a *Livestock only, rangeland-based and mixed rainfed production systems, 2000*

Map 15b *Livestock only, rangeland-based and mixed rainfed production systems, 2050*

Map 15c *Change in fallow land in mixed rainfed production systems, 2000 to 2050*

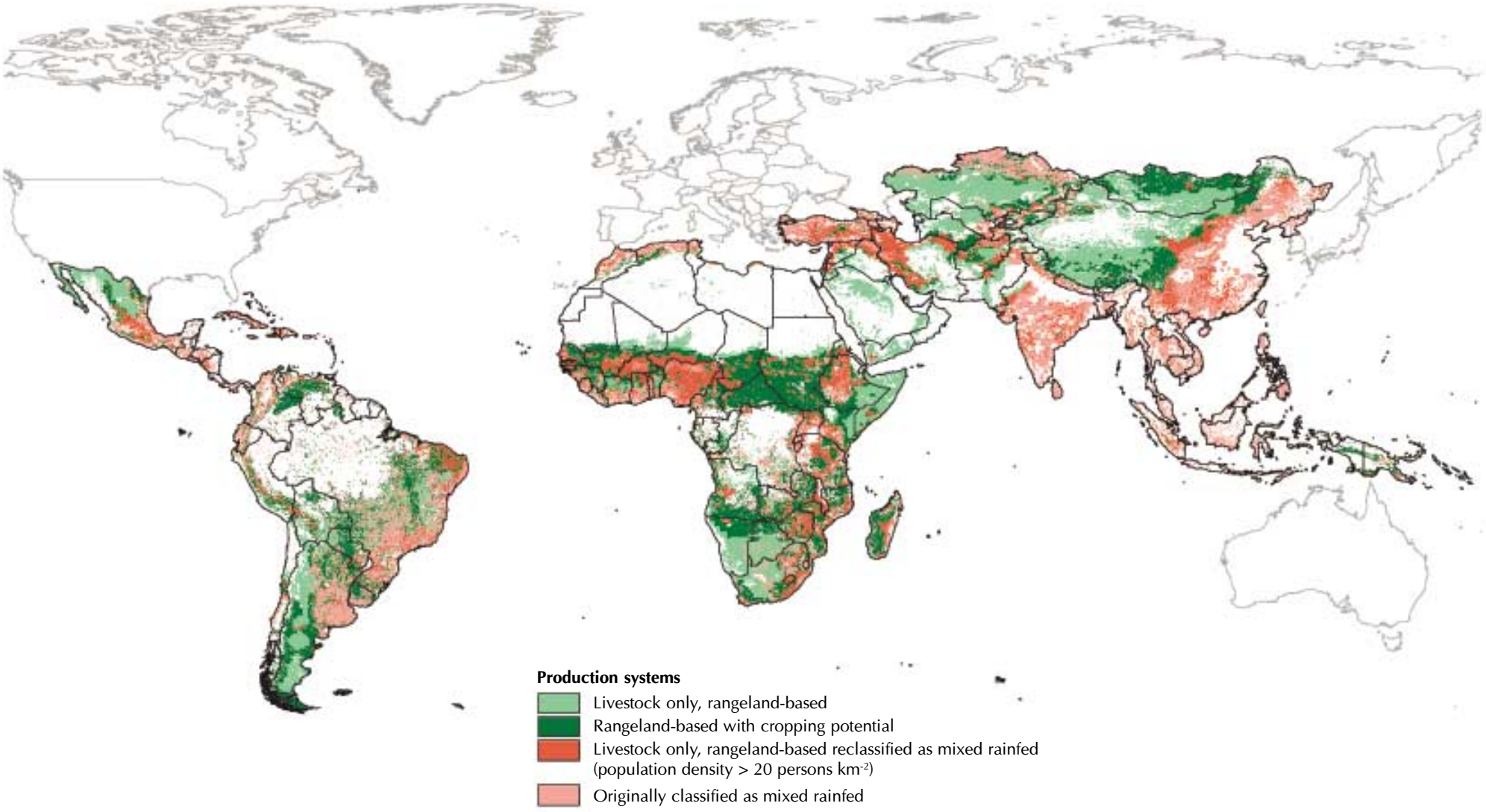
Table 8 *System changes based on threshold population densities of 20 and 85 persons km^{-2} and a length of growing period (LGP) boundary of 60 days: examples of opportunities and risks for poor households*

To identify potential changes in the boundaries of production systems by 2050, we applied two thresholds linked to population density—20 persons km^{-2}, and 85 persons km^{-2}—and projected them to 2050. The 20-persons km^{-2} threshold combined with LGP was discussed in more detail in Section 2.2 and was used to delineate additional cropped areas to those originally classified as grassland/rangelands in the global land-cover characteristics database. In the global livestock production maps, this threshold represents the boundary between the livestock/rangeland-based category and the mixed category (or between pastoral and agro-pastoral systems). The 85-persons km^{-2} threshold is a boundary within mixed production systems and represents the transition zone from areas with little fallow to areas with no fallow. It is based on earlier work that investigated the distribution of tsetse in Africa (Reid et al., 2000; and see Footnote 2, page 10). The transition to production systems with no fallow can have significant impacts on livestock keeping by, for example, reducing the range area (if fallow is used for forage) and changing the nature and degree of crop–livestock linkages (nutrient and energy flows).

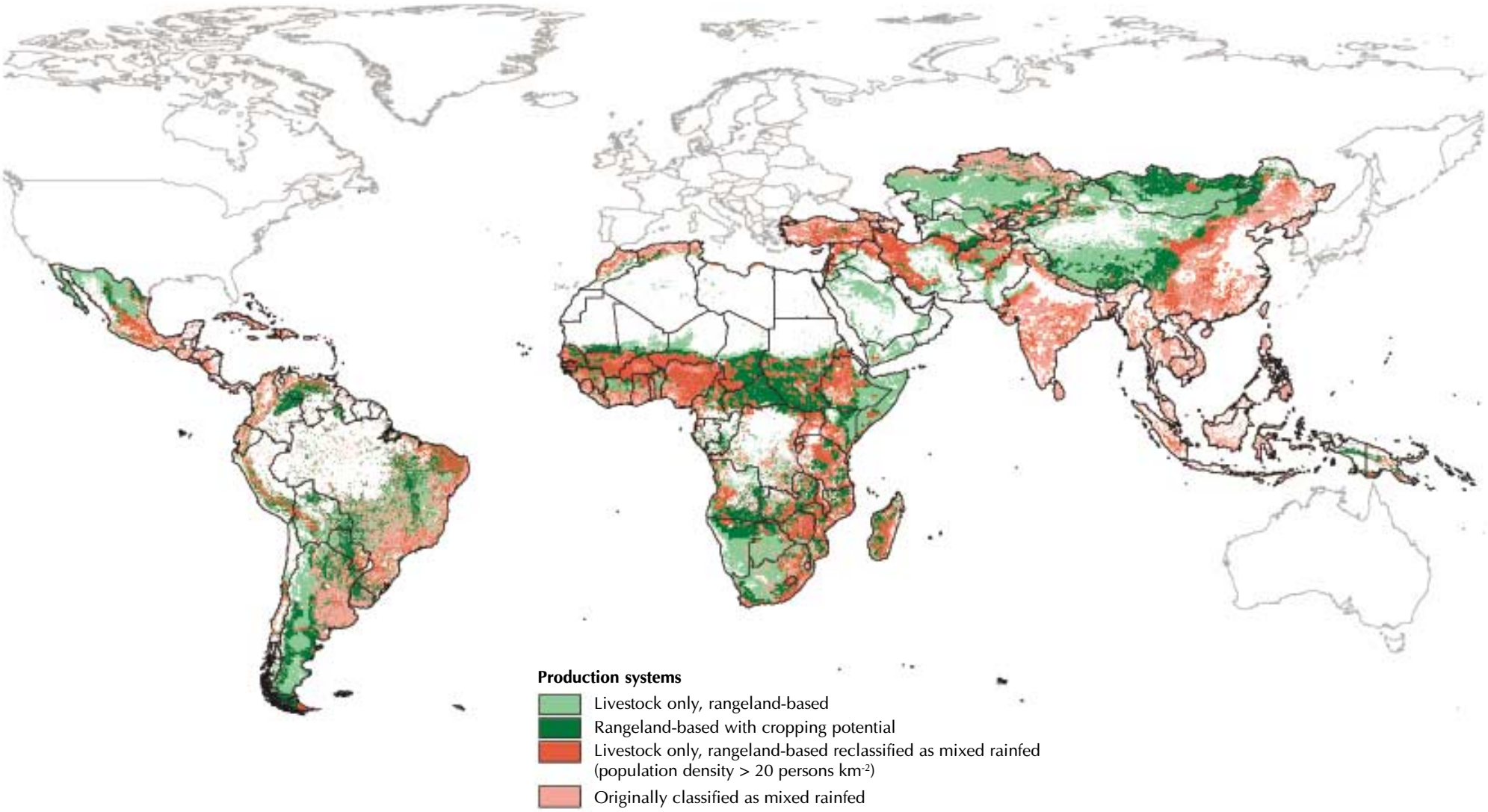
Maps 15a and 15b show changes in rangeland and mixed systems between 2000 and 2050; the largest contiguous areas remaining in the livestock only, rangeland-based production system category by 2050 are located in the Central African Republic, southern Chad and the Sudan, northern Namibia/southern Angola, western China, northern Mongolia, and areas in Venezuela, Colombia and Argentina. Over the next half-century, SSA will undergo substantial transition from pastoral to agro-pastoral systems. Map 15c identifies SSA as the region with the largest potential for reduction in fallow land by 2050.

Table 8 lists various examples of how these system changes could be beneficial or detrimental to poor households.

Map 15a. Livestock only, rangeland-based and mixed rainfed production systems, 2000



Map 15b. Livestock only, rangeland-based and mixed rainfed production systems, 2050



Map 15c. Change in fallow land in mixed rainfed production systems, 2000 to 2050

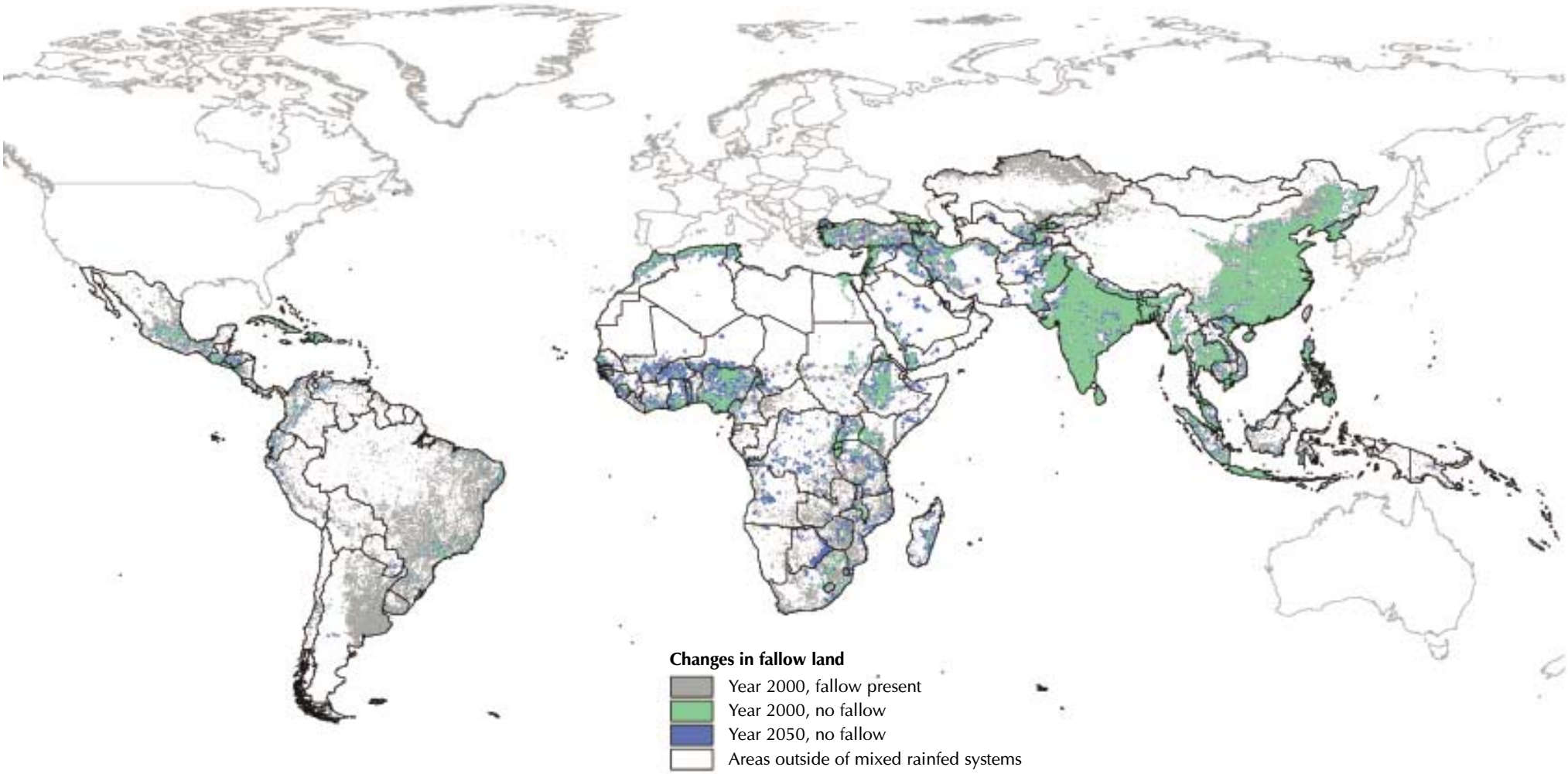


Table 8. System changes based on threshold population densities of 20 and 85 persons km^{-2} and a length of growing period (LGP) boundary of 60 days: examples of opportunities and risks for poor households

System changes	Opportunities for poor households	Risks for poor households
Areas that remain within the livestock, rangeland-based production system category in 2050 with no cropping potential in 2000—*Maps 15a and 15b*	• Improved production technology could provide limited additional opportunities (such as managed C sequestration) • Improved road infrastructure and access to markets could provide additional opportunities • With intact social and pastoral systems, poor households can buffer risks related to rainfall variability • In areas with wildlife, development of better opportunities to benefit from eco-tourism markets	• Overgrazing and rangeland degradation • High food insecurity, drought • Limited local demand and markets, limited access to other markets
Areas that remain within the livestock, rangeland-based production system category in 2050 with cropping potential in 2000—*Maps 15a and 15b*	• Improved production technology could provide additional opportunities, particularly in the more humid areas (e.g. managed C sequestration, BNF, energy and non-traditional crops, water harvesting) • Improved road infrastructure and access to markets could provide additional opportunities • With intact social and pastoral systems, poor households can buffer risks related to rainfall variability	• Overstocking, rangeland degradation • High food insecurity, drought • Limited local demand and markets, limited access to other markets • Frequent crop failure
Areas that could move from livestock, rangeland-based to mixed systems in 2050—*Map 15b*	• Increased degree of crop–livestock intensification • Increased market integration • Increased income diversification opportunities • Greater opportunities for off-farm income • Use of appropriate technology options (e.g. biological nitrogen fixation (BNF), energy and non-traditional crops)	• Reduction in (or loss of) common property resources with subsequent degradation of range resources • Poor livestock keepers may loose out in transition to more cropping, could become sendentarized, landless • Increased conflict between pastoral and agro-pastoral people • Restriction of livestock movement • Cropland that is degraded or returned to fallow provides only suboptimal pasture ('good rangeland to marginal cropland and then marginal cropland to marginal rangeland…')
Mixed systems: areas that could move from little fallow to no fallow area—*Map 15c*	• Increased degree of crop–livestock intensification • Increased market integration • Increased income diversification opportunities • Greater opportunities for off-farm income • Use of appropriate technology options (e.g. BNF, integrated pest management (IPM), non-traditional crops)	• Reduction in range area, increased feed resource limitations • Farming systems may become degraded because of continued human population pressure, decreasing farm size, and disinvestment, making it difficult to maintain cattle
Areas that could move from mixed systems to landless systems by 2050—not shown in a map, but could include all areas with mixed systems that are in close proximity to the landless systems identified in *Map 3e*	• Increased degree of crop–livestock intensification through spatial integration • Increased market integration • Increased income diversification opportunities • Greater opportunities for off-farm income	• Feed resource limitations • Relatively high levels of investment needed (e.g. zero-grazing systems) • Increased animal disease and human health risks

4.2 Climate change impacts on production systems

Map 16a. Change in length of growing period (LGP), 2000 to 2050
Map 16b. Movement of cropping boundary, 2000 to 2050
Map 16c. Movement of maize-growing boundary, 2000 to 2050
Map 16d. Expected changes in production systems, 2000 (left) to 2050 (right)
Table 9. Expected climate change impacts on production systems: examples of opportunities and risks for poor households

Recent reports from the Intergovernmental Panel on Climate Change (IPCC, 2001a; 2001b) indicate that global average temperatures may rise by 1.4–5.8° C in the present century.

Rainfall and temperature changes may have substantial impacts on (among other things) agriculture and human health in Africa, and Africa is the continent most vulnerable to the impacts of projected changes because existing widespread poverty limits adaptation capabilities. In a preliminary attempt to assess the possible impacts of these climate changes on production systems, we carried out some analyses for Africa related to changes in the length of the growing period that might be anticipated over the next 5 decades.

The LGP defines a period when crop production is possible based on temperature and moisture limitations—roughly when the precipitation exceeds half the potential evapotranspiration (FAO, 1978). Previously, McDermott et al. (2001) had estimated a current LGP surface for SSA based on long-term monthly climate normals (rainfall, daily temperature and daily temperature diurnal range) from over 7000 stations (Jones, 1987). A 10 minutes-of-arc surface was fitted, based on the NOAA data set TGOP006 (NOAA, 1984) using inverse square distance weights for spatial interpolation, and a correction for elevation effects. For each grid cell, a simple daily water balance model was run, interpolating the monthly climate normals to daily values using a fast Fourier transform (Jones, 1987). To derive a predicted LGP surface for 2050, mean values of maximum and minimum temperature and precipitation for 2041–2070 were obtained from the IPCC Data Distribution Centre on the worldwide web (http://ipcc-ddc.cru.uea.ac.uk/). These predictions are based on a greenhouse-gas-only experiment conducted at the Hadley Centre using the Unified Model (Cullen, 1993) at a resolution of 2.5 by 3.75 degrees of latitude and longitude. These data were then interpolated to a 10-minute pixel size (Jones and Thornton, 2000) and the water-balance model rerun to produce the 2050 LGP surface.

Map 16a shows the difference between the 2000 and 2050 LGP surfaces. Major reductions in LGP are predicted for areas of West Africa, southern Sudan, Uganda and some areas of Ethiopia, and increases are indicated in southeastern Kenya, northeastern Tanzania, southern Cameroon and other areas of Ethiopia.

To see how this might bring shifts in the cropping boundary, Map 16b shows changes in areas related to a 60-day LGP, which we assume to be the point at which transition can occur between pastoral systems (< 60 days LGP) and agro-pastoral systems (> 60 days LGP). Because of the general predicted decline in LGP for Africa, the total area that will experience a drop in LGP below 60 days is greater than the areas that will see a gain in LGP above 60 days. Areas that would be more suitable for pastoral systems in 2050 are predicted to stretch in a band across the Sahel and Sudan, the transition zones to lower elevations in Ethiopia, and a band cutting across southern Angola and central Zimbabwe. Areas that could move from pastoral to mixed systems are predicted to be located primarily in Kenya, Tanzania and Ethiopia.

To highlight potential changes within mixed systems, we have mapped the movement of the boundary for growing maize, which we defined at 120 days LGP. Map 16c shows a similar pattern in movement to that observed for the pastoral/agro-pastoral transition zones. Most of the potential reduction in areas suited for growing maize is predicted to occur in the Sahel and Sudan. Kenya is predicted to see some modest gain in area that is suitable for growing maize. Interestingly, some of the expansion here is expected to occur in districts in which poor households rely significantly on the sale of maize for their income from crops.

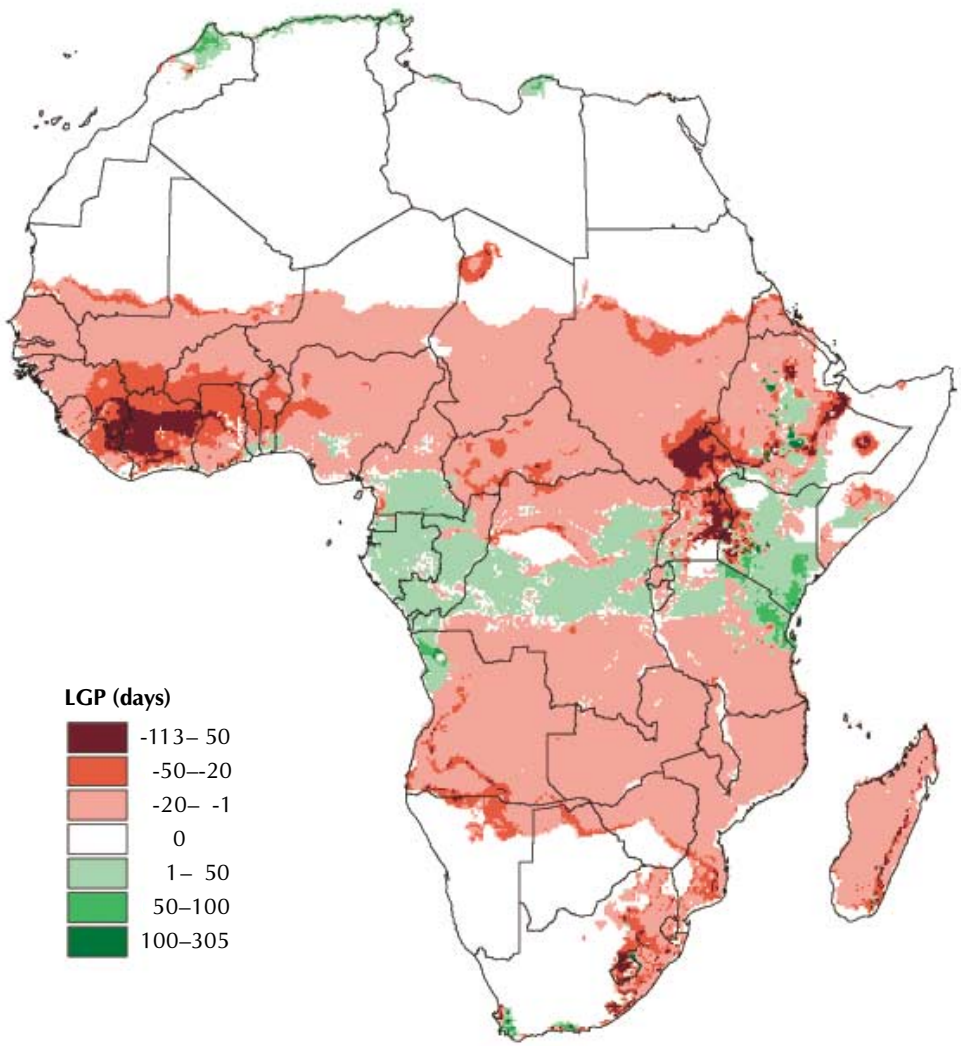
Data from the 1994 Kenya Welfare Monitoring Survey (Kenya Government, 1998; 2000) show that the districts where poor households had the highest share of monthly crop income from the sale of maize are located either in areas we classified as mixed systems or rangeland/ livestock-based systems. For the mixed systems, most of these districts include the transition zones to low suitability for growing maize. For example, the proportion of maize sales in mean monthly crop income for poor households is as follows: West Pokot 99%, Uasin-Gishu 97%, Kericho 91%, Trans-Nzoia 93%, Narok 90%, Nandi 73%, Elgeyo-Marakwet 64%, Laikipia 63%, Baringo 50% and Bomet 46%.

4
Possible system changes

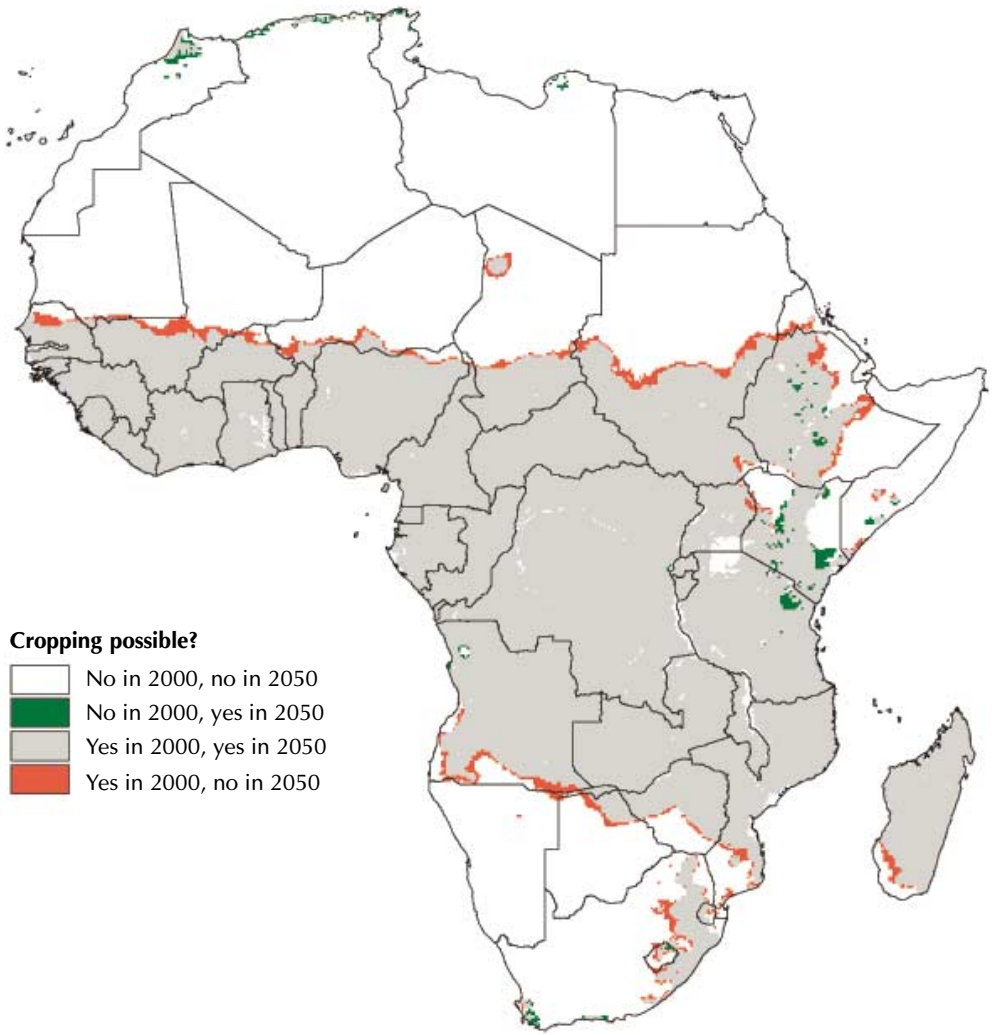
Three districts in the rangeland only, livestock-based systems also have a high proportion of crop income from maize sales for poor households (Wajir 96%, Mandera 80% and Marsabit 72%). The dependence of poor households on maize, often in more marginal production environments, parallels the general shift in Kenya away from traditional, drought-resistant crops, expansion into areas with higher rainfall variability, and a strategy by farmers to produce a significant marketable surplus during a favourable growing season at high risk, relying on food aid as a type of crop insurance (see, for example, FEWS In-Depth Report—June 27, 1996, Kenya in Depth, at: http://www.fews/org/fb960627/fewsidl.html).

Expected changes in production systems to 2050 in Africa are shown in Map 16d; particularly noteworthy are the predicted shifts in West Africa from rangeland-based systems to mixed, and in East and Southern Africa, the disappearance of mixed highland systems.

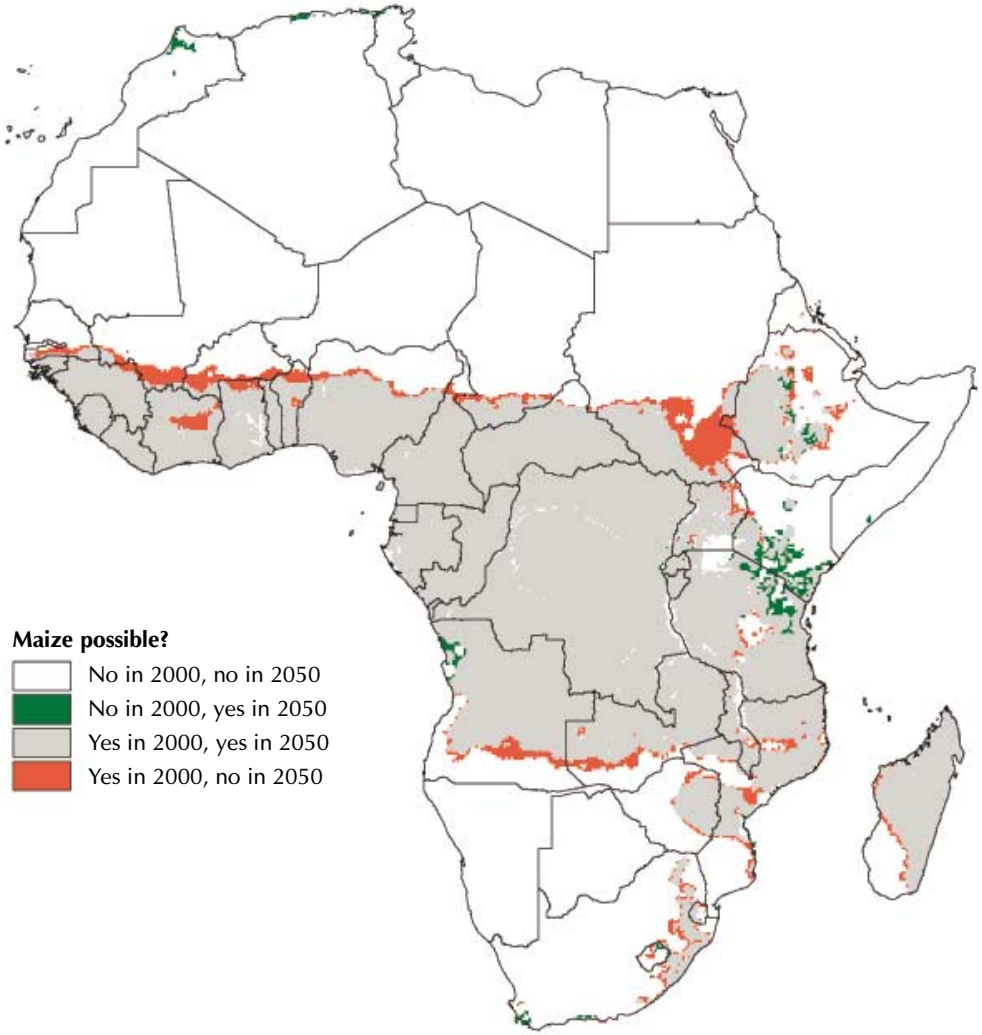
Map 16a. Change in length of growing period (LGP), 2000 to 2050



Map16b. Movement of cropping boundary, 2000 to 2050



Map 16c. Movement of maize-growing boundary, 2000 to 2050



Map 16d. Expected changes in production systems, 2000 (left) to 2050 (right)

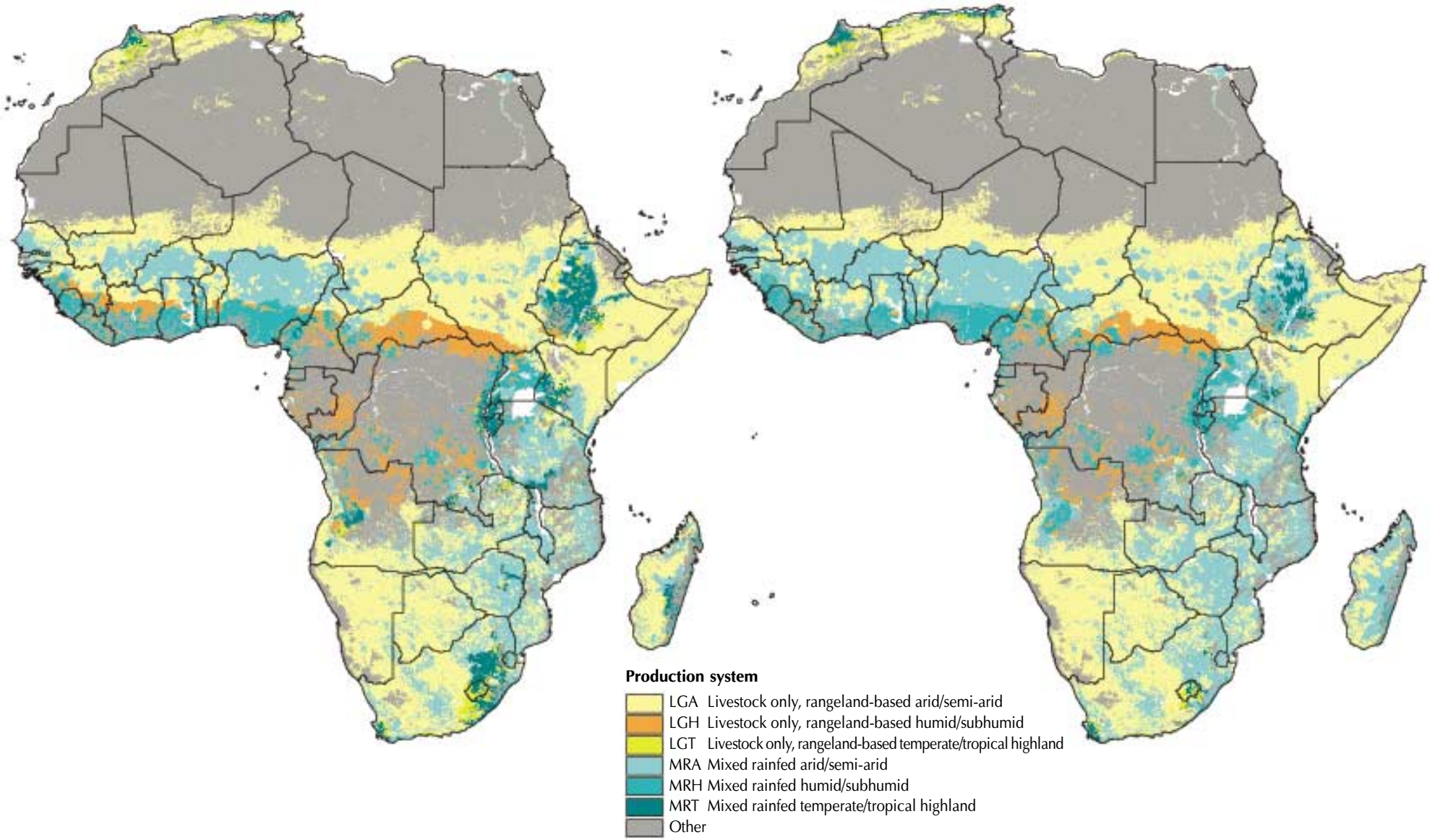


Table 9. Expected climate change impacts on production systems: examples of opportunities and risks for poor households

System changes	Opportunities for poor households	Risks for poor householdss
Livestock only, rangeland-based production system: movement of cropping boundary, **areas coming into production**—*Map 16b*	• Increased degree of crop–livestock intensification • Increased market integration • Increased income diversification opportunities • Greater opportunities for off-farm income	• Possible loss of or reduction in common property resources with subsequent degradation of range resources • Poor livestock keepers may loose out in transition to more cropping, could become sendentarised, landless • Increased conflict between pastoral and agro-pastoral people • Restrictions on movement • Cropland that is degraded or returned to fallow provides only suboptimal pasture
Livestock only, rangeland-based production system: movement of cropping boundary, **areas dropping out of production**—*Map 16b*		• High food insecurity, increased frequency of drought • More conflict • Migration
Mixed systems: movement of boundary for growing maize, **areas coming into maize production**—*Map 16c*	• Assuming increase in LGP is paralleled by a reduction in rainfall variability, this could decrease risk for poor households that depend on maize for crop income	
Mixed systems: movement of boundary for growing maize, **areas dropping out of maize production**—*Map 16c*		• High food insecurity, increased frequency of drought • Feed resources become increasingly limited • More conflict • Migration