

# **EXPLORING POTENTIAL ECONOMIC AND LIVELIHOOD IMPACTS OF CLIMATE CHANGE AND POSSIBLE ADAPTATION MECHANISMS IN THE KENYAN RANGELANDS**

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By

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## **INTRODUCTION**

The rangelands of East Africa are facing an unprecedented period of change. In 2009 the interactive effects of climate uncertainty and land-use change have had devastating effects on biodiversity and livelihoods. Climate variability, and traditional adaptation strategies, have long been a part of pastoral production systems in the region, but the convergence of unprecedented levels of land-use change coupled with increasing climate uncertainty is eroding the resilience of ecological and social systems alike. In particular, the spatial scale and connectivity that underpins the inherent cultural and biological diversity of the region is increasingly fragmented and constrained by land-use and climate. Landscapes are becoming increasingly isolated with constraints on the movement of species and system flows threatening biodiversity and human livelihoods.

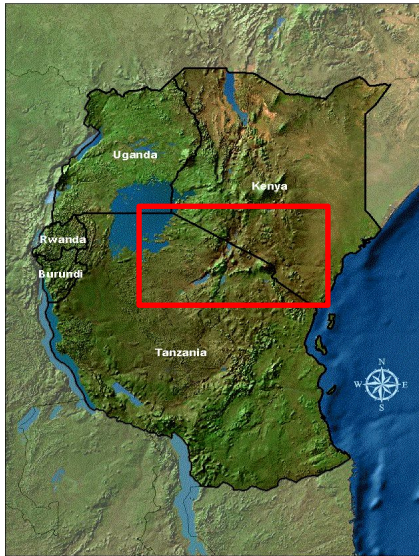
The potential effects of climate and land-use change are independently daunting for a region that has been hampered by poverty and lack of planning, but the interactive effects of land-use and climate are even more extreme. The emerging challenge, however, is not to consider each of these processes in isolation, but to evaluate the interactive effects of these transformations. In the Kenya-Tanzania borderlands of East Africa, the African Conservation Centre, working with international partners and local communities, is working to understand the extent of climate and land-use change, to assess the likely impacts of these changes, and explore potential adaptation mechanisms for communities and ecosystems.

## **KENYA-TANZANIA BORDERLANDS**

The 60,000 square kilometer region stretching across the Great Rift Valley from Serengeti-Masai Mara in the west to Tsavo and Mkomazi in the east hosts one of the richest mammal and bird assemblages on earth. The borderlands account for 80% of the large mammals, 50% of the vertebrates and 25% of the vascular plants found in Kenya and Tanzania. The region also has many regionally endemic species and threatened animals and plants. The diverse landscape spans 14 world-renowned parks, attracts over 1.5 million visitors a year and generates a half-billion dollars in revenues for the two African nations. The borderlands are also home to the Maasai and other indigenous peoples whose lifestyle and livestock help them live in areas of variable climate and co-exist with wildlife.

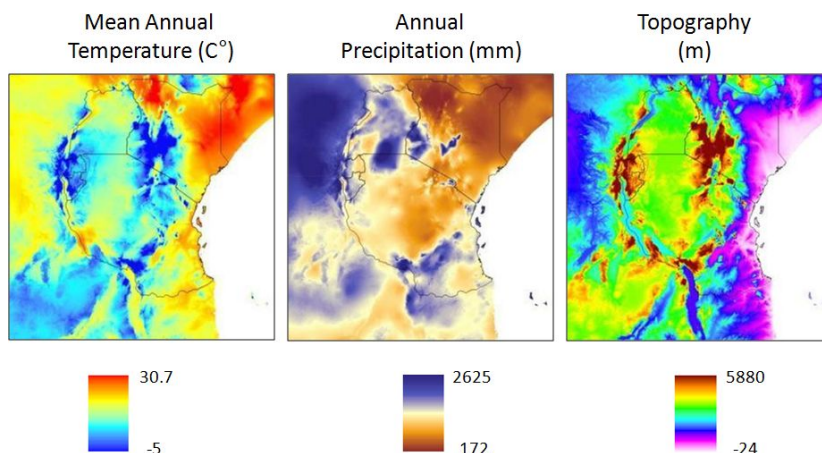
East Africa is a focal area of biological and cultural interaction as numerous distinct cultures and biomes come together in this diverse area. In Kenya, the trans-border region encompasses the two districts of Kajiado and Narok. Together these southern rangelands cover over 36,200 km<sup>2</sup> with a population of over 900,000 (PWC Strategic plans for Kajiado and Narok). The southern rangelands include extensive pastures, forest reserves, and agricultural areas under diverse land tenure arrangements ranging from National Parks (e.g. Amboseli), National Reserves (e.g. Masai Mara), forest reserves, private land holdings, collectively owned Group Ranches, and trust lands. While agricultural activities predominate

in many of the arable areas (approximately 18% of the total area) livestock production continues to represent the economic cornerstone of the region. On average, over 50% of the population depends on livestock for their livelihood (PWC reports). Agricultural production and off farm incomes are increasingly important to local livelihoods, but income diversification is not without its challenges as rapid urbanization, mining, sand harvesting, fuel wood harvesting, irrigation, rainfed agriculture, livestock production, and conservation all compete for limited land and increasingly degraded natural resources.



*Figure 1. The Kenya Tanzania trans-border area*

Underlying this extremely rich ecological heritage are high levels of topographic and environmental heterogeneity. Straddling the rift valley, the trans-border region is characterized by a complex topography incorporating numerous altitudinal gradients ranging from the dry lowlands on the rift floor (500m) to the top of Africa's tallest mountain – Mt. Kilimanjaro with two snow-capped peaks rising to 5,898.7 m. Rainfall is highly variable in space and time with a generally bimodal pattern. Annual rainfall averages range from approximately 300mm in the Amboseli Basin to over 2000mm in the highland areas. As with rainfall, temperature variation is highly altitude dependent (Fig. 2).



*Figure 2. Topographic and Climatic Gradients*

Water resources are extremely poor and the few permanent rivers flowing off the highland areas in Mau, Nairobi, Kilimanjaro are threatened by extensive abstraction and deforestation and degradation in the catchment areas. Ewaso Ng'iro's (Brown River) tributaries flow from the forests of the Mau escarpment which is at the edge of the rift far to the north and runs into L. Natron. This is one of the major rivers in Kenya.

The region is of great economic and cultural importance some of which are livestock production (subsistence, market – expanding and active), industrial (Magadi Soda), agricultural – wheat, horticulture, tourism (national parks and community conservation), ecological services (biodiversity, water, carbon sequestration)

### **Challenges**

In recent decades rapidly growing human populations, expanding settlement and land fragmentation have reduced wildlife and pastoral movements, exposing human and natural populations to range loss and vulnerability to drought. Additionally, the extent and speed of climate change, superimposed on restricted movements and range loss, pose a threat to wildlife, plants and rural livelihoods. Uncertainty is one of the biggest challenges for accurate climate change predictions in East Africa. While it is essential that policy makers understand the inherent difficulties in extrapolating global climate patterns to regional and local weather, it is clear that increasing climatic variability (whether wetter or drier) and the increasing probability of extreme climatic events (UNEP discussion paper 2009) will pose unique challenges to the resilience of communities and ecosystems.

Global climate change models suggest a variety of scenarios for East Africa. On average, the different scenarios suggest a general increase in rainfall for East Africa and the Kenya-Tanzania borderlands in particular. At first glance, this would appear to suggest that climate change will have a positive impact on ecosystems and human livelihoods as environmental productivity increases. While this may be true, changes in the spatial and temporal variability in rainfall, the timing of rainfall and a likely increase in extreme events, including both droughts and floods, may in fact exacerbate vulnerability in the region. Similarly, the combined effects of current levels of environmental degradation and predicted temperature increases may easily negate any potential productivity gains associated with increased rainfall. Indeed, the interaction of climate change and land-use change will bring an entirely new suite of challenges to the communities and ecosystems of the borderlands.

The real challenge for policy makers and local communities alike will be balancing the interactive effects of climate and land use change. Land-use change is a major threat to East African ecosystems. Increasing human populations, coupled with changing land tenure systems, are fragmenting once open and dynamic ecological systems. The interaction of climate change and land-use change presents new challenges to policy makers, managers and local communities pursuing sustainable natural resource management strategies for human welfare and conservation of biodiversity. Agricultural expansion into key resource areas such as swamps and the riverine strips eliminates important dry season grazing reserves. Wildlife and livestock vulnerability to drought due to the loss of these forage reserves is exacerbated by the loss of landscape scale connectivity associated with the expansion of agriculture into marginal areas. Agricultural expansion is facilitated by the development of water resources (boreholes, wells, pipelines) and changing attitudes towards land tenure and the individualization of natural resource access and management.

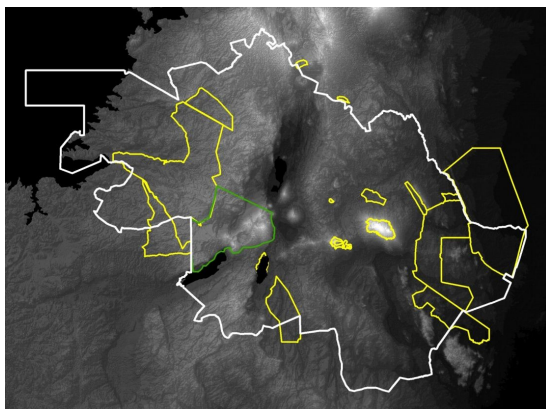
Much of Kenya's southern rangelands have been subdivided into individual parcels, including the high potential areas which are critical dry season grazing reserves for traditional livestock keepers. Areas which have not yet been officially subdivided have undergone a parallel

process of sedentarization. Sedentarization, or the shift from a dynamic semi-nomadic and highly mobile society to one that is increasingly focused on permanent settlement areas, alters settlement patterns in both space and time, resulting in decreased mobility, sustained grazing impacts, and a polarization or homogenization of vegetation resources. All of these impacts reduce the ability of pastoralists to respond to changes in the spatial and temporal distributions of rainfall predicted under different climate change scenarios.

### Impacts

One of the first steps in assessing the cost of adaptation to climate change is to evaluate the potential impacts of climate change. Researchers at the African Conservation Centre (ACC) in Nairobi, Kenya, in conjunction with both international and local partners, are working to highlight the potential impacts of climate and land use change on ecosystems and livelihoods in the borderlands region (Fig. 3). Currently in its initial stages, this project is bringing together a network of local and international researchers in partnership with communities to identify the potential impacts of climate change and options for adaptation. This programme integrates community based monitoring of natural resources, long term biodiversity information, land use, and regionalized climate models in an analytical framework for assessing the likelihood of shifts in key species of plants and vertebrates, changes in the structure of ecological communities, broad scale changes in eco-climatic zones, and the potential implications of uncertainty and change for conservation and livelihoods. The main focus areas for the project are:

- i) highlighting the vulnerability to climate change of biodiversity and community livelihoods and interactions with land use changes
- ii) assessing how communities and ecosystems respond to change
- iii) identifying options for creating and maintaining resilience through management and policy change
- iv) methods for preserving the inherent diversity/heterogeneity that has made this system so rich including an assessment of the connectivity of nationally, privately and communally protected areas as a spatial mechanism for cushioning the impact of climate change to biodiversity



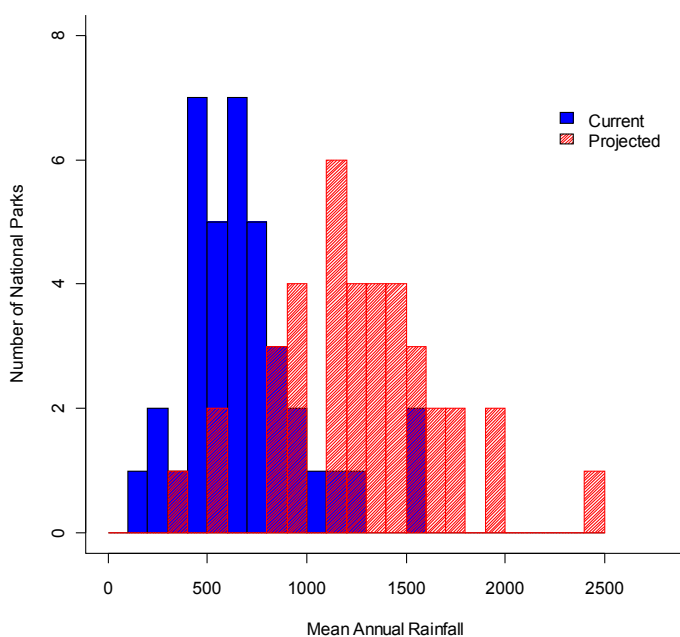
*Figure 3. Kenya-Tanzania borderlands study area with protected areas in yellow and green.*

Initial results suggest potentially significant shifts in species and habitats over time, with increasing conflicts between rapidly expanding agriculture into previously marginal areas, and pastoral communities and biodiversity as they struggle to adapt to an increasingly variable climate in less and less space. For biodiversity, these challenges will be most acute for narrow ranged species and those confined to highland areas. For people and their livelihoods, it is the dominant production system in the region that will be most affected – pastoralism. The expansion of small scale agriculture and the gradual loss of key grazing

reserves will continue to erode the resilience of pastoral systems. Combined with sedentarization and an increasingly individualistic production system this loss key resources will make livestock keepers even more vulnerable to climate change. The lack of flexibility associated with lack of mobility is highlighted by the case of national parks and reserves in Kenya in the face of projected changes in climate. A preliminary analysis of protected areas and rainfall (Fig. 4) indicates that the majority of the national parks and reserves in Kenya are in areas with mean annual rainfall ranging between 500 mm and 800 mm.

While this is the ideal rainfall range for protecting the large wildlife for which they were designed, projected changes in rainfall suggest that the areas protected in parks and reserves may soon be much wetter. Increasing rainfall in protected areas may be initially beneficial for wildlife populations, but in the absence of intensive management these areas may soon revert to larger less palatable vegetation. As a result, wildlife concentrations may move out of protected areas to slightly lower rainfall areas thus presenting new challenges to KWS and other policy makers. Similarly, increased rainfall around protected areas may exacerbate agricultural expansion and sedentarization and speed the process of fragmentation further reducing the ability of protected areas to buffer wildlife populations in the face of changing climatic conditions.

**Number of National Parks and Reserves by Mean Annual Rainfall**



*Figure 4. Number of National Parks in Kenya at different levels of mean annual rainfall for current (blue) and future (red) climate.*

In 2009, the increased vulnerability of pastoralists and rangeland ecosystems to climatic extremes has been far too evident. As pastoralists in the border lands region have become increasingly tied to individual points in space - either agricultural plots, permanent settlements, or individual parcels--they have begun to lose the inherent flexibility and dynamism associated with mobility that has proved to be such an important adaptive strategy in the past. This loss of resilience due to fragmentation, declines in the spatial scale of resource use, loss of key resource areas, and over utilization has led to massive displacement of people and livestock, extensive and severe livestock losses, disruption of education, and the near collapse of a production system. Confronting these challenges has been made all the more difficult as pastoralists in the region make the difficult transition from communal to

private production systems and traditional institutions collapse in the face of changing demands and poor governance.

### **Opportunities for Adaptation**

The combined effects of land use change and increased climatic uncertainty will have far reaching implications for people and ecosystems throughout the borderlands region. Adaptation strategies need to integrate local action with the development and establishment of appropriate policies, legal mechanisms and support systems to enhance economic, social and ecological sustainability of the rangelands and the pastoral livelihood system. Sustainable adaptation strategies must be built on a sound foundation of traditional and scientific knowledge. When assessing the potential of adaptation strategies, it is critical to consider not only the short and long term costs and benefits for any particular target variable (e.g. livelihoods, biodiversity, etc) but also the potential impact on fundamental processes and system potential. Almost by definition, adaptive strategies which favor flexibility and potential will be most effective in the face of increasing climatic uncertainty. Similarly, strategies which preserve the adaptive potential of the system will be most effective in the long run.

In the rangelands of the borderlands region, some possible strategies for reducing pastoral vulnerability and preserving adaptive potential would include the development of grass banks as integrated dry season forage reserves and conservation areas, and livestock breeding and marketing programs. ACC has piloted a livestock breed improvement program and has begun working with communities to set aside land for re-seeding and development into drought refuges. These drought refuges also act as wildlife concentration areas which in turn supports ecosystem services and tourism. Due to increasing human populations and land fragmentation, maintaining connectivity and other critical ecological processes and services is an essential component of enhanced resilience.

Institutions are an essential component of any successful adaptation strategy. Grass root institutions that enable and empower the landowners to be directly engaged in the management of the health of the land and natural resources therein are critical. One such institution is the South Rift Association of Landowners (SORALO), which brings together 14 group ranches spanning both Narok and Kajiado districts. Other institutions that ACC has supported are Maasai Mara Management Association (MMMA) and the Amboseli Ecosystem Trust. Similar institutions exist in the north – The Northern Rangelands Trust. Such institutions give opportunity to the landowners to participate in decision making and policy development. Such institutions will also require alliances and synergies with other, more formal institutional levels such as governments, civil society and the private sector. An understanding of the changing nature of institutions in pastoral societies and the critical role of local initiatives for the sustainable management of natural resources will be essential to any successful adaptation initiatives.

The generation and integration of both scientific and indigenous knowledge will be an essential tool for adapting and expanding traditional coping mechanisms with the incorporation of learned information through science and research. Hybrid knowledge systems should be generated not only by academic research but also through the engagement of local community resource assessors who facilitate the collection and exchange of information on the impacts of climate change and system vulnerabilities.

Increasingly, the provision and protection of key ecosystem services will be a key component of adaptation in the borderlands region. The preservation of open space for the benefit of rapidly increasing urban populations, the provision of clean air and water, carbon sequestra-

tion, and biodiversity conservation are all services which will continue to increase in value as land use change and climate uncertainty intensifies. The value of these services both in ecological and monetary terms is largely unexplored. In particular, the carbon potential of the rangelands represents a significant economic asset which is yet to be unexploited.