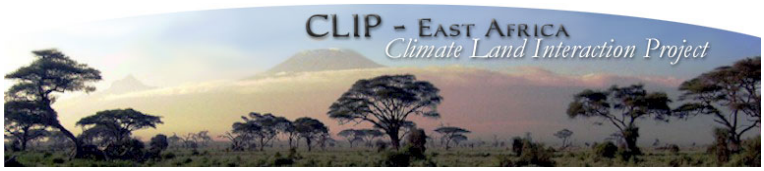

The Effects of Climate and Land Use Changes on Climate and Agricultural Systems in Kenya

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Climate change has over the past two decades taken centre stage in the world economy. It is expected to have significant negative impacts on poor nations and thus has made it necessary for developing countries to take keen interest in climate change and what they can do to adapt to the changes. This research is aimed at examining how climate change is impacting Kenyans and other East Africans.

Industrialization has led to the release of greenhouse gases (GHG) into the atmosphere, with subsequent changes in the Earth's temperature and weather systems. Land use change (LUC), such as deforestation and clearance of bush for crops, leads to alterations of the land surface such as albedo, soil moisture and surface roughness that also significantly affect climate on local to global scales. The Climate-Land International Project (CLIP) has simulated the effects of GHG and LUC on the future local and regional climate of East Africa in a regional climate model coupled to an LUC model, and examined the impact of the altered climate on crop productivity and other sectors of the Kenyan economy. The project builds on other land use and climate change research conducted in Kenya and elsewhere.[2]

Recent trends in climate in Kenya

According to 4th assessment report of the IPCC (2007), climate change is happening and is caused in a large measure by human activities. Temperatures in Kenya have been increasing since the 1950s in a trend that is similar to the global average. Kenya is also experiencing increasing weather extremes and the disappearance of the glaciers on Mts. Kenya and Kilimanjaro. The country relies on water supplies from Mt. Kilimanjaro for irrigation and other uses, while much of the country's hydropower depends on the water system fed by glacial melts from Mt. Kenya. The implications these phenomena on Kenya's future have yet to be appreciated.

Trends in changes in average annual rainfall since the 1960s, on the other hand, are not as clear as that for temperature. Some areas in the northeast, for example, have been experiencing somewhat higher amounts of rainfall whereas there is no general trend for most of the country. There is a significant increase in the amount of vegetation in the northeast, as reflected in satellite imagery (NDVI, AVHRR/GIMMS).

Other impacts of climate change in Kenya include sea level rise; increased incidences of extreme weather events; substantial reduction in surface water resources, especially in semi-arid areas (80% of Kenya's land mass is arid to semi arid); and threats to human health (e.g. highland malaria) and biodiversity.

According to the Ministry of Environment, the overall projected impacts of unmitigated climate change in Kenya is likely to have significant impacts on human livelihoods, health, water resources, agricultural production and food security as well as nature-based tourism. All these would undermine the country's economic prospects (Massawa 2007).

Future climate simulation results

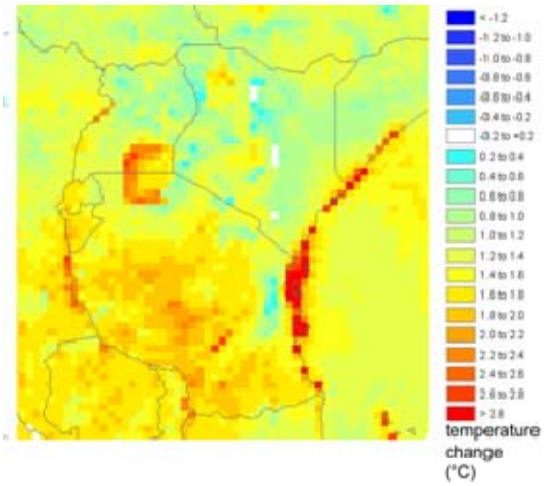
The CLIP regional climate model was calibrated for East Africa using available local and global datasets. The advantage of this model is that it operates with higher spatial resolution (more detail) and better reflects East Africa's landscape and climate. The model is informed by the general circulation model CCSM v4 with the A2 SRES GHG emissions scenario. The research was designed to examine the effects of GHG and LUC on East Africa's local and regional climate through a series of experimental scenarios (the effects of GHG alone, LUC alone, both combined). Although we cannot be certain that these scenarios accurately reflect Kenya's future climate, they do provide evidence of the complex connection between regional changes in climate and land cover. In general, the historical trends described above are expected to continue into the next fifty years. East Africa is the only tropical region in the world where the majority of global climate models project a generally wetter climate by the end of the 21st century (IPPC 2007). The CLIP regional model, however, suggests that Kenya's future climate may be more complex.

CLIP modeling results suggest:

- Temperatures may increase substantially, between 1.5 and 3 degrees C. The increase will be higher along the Indian Ocean Coast.
- The June–August season may experience more warming than the low sun period of December–February.

- Average annual rainfall, although not expected to change significantly for the country as a whole, varies by zone. The ocean and Lake Victoria coasts may experience substantial increases in rainfall due to LUC. Northern Kenya is expected to also receive more rainfall.
- Near large bodies of water, rainfall changes due to LUC are of similar importance to that from GHG. Farther from water, gains in rainfall from GHG may be offset by rainfall decreases due to LUC.
- Because of warmer temperatures and little change in rainfall in central and southern Kenya, there will be relatively more stress on the vegetation of Tanzania.
- All areas will see more variability of rainfall—intense storms, droughts and floods—due to the effects of GHG. [1]

Temperature Change, 2000 to 2050 Tmax



The impacts on crop yields are generally a result of the warmer temperatures accompanied by little or no increases in rainfall.

Results of crop-climate modeling using the results of the CLIP climate model indicate that maize yields may increase somewhat in areas expected to experience more rainfall (along the coast and in some areas in northern Kenya) but decline elsewhere of Kenya. The main exception is in the highlands, where warmer temperatures will enhance production in areas previously too cool for maize cultivation.

Other impacts of the changing climate will be a decline in availability of surface water due to more rapid evaporation. This will affect irrigation, water for livestock and wildlife, and water for household uses. Except in the northeast, rangelands will generally become drier and less productive, and the plant species composition may change towards less palatable species for livestock and wildlife. In the northeast, the increase in rainfall may lead to an increase in bushiness. Throughout the country, droughts will impact people and animals more quickly and more severely because of the higher temperatures and more rapid evaporation, and the frequency and intensity of droughts are expected to increase. Challenges due to droughts are often aggravated during El Nino events.

Other ecosystems expected to be particularly vulnerable include wetlands due to reduction in water and increase in use, the highlands due to rapid warming, coral reefs due to warmer surface water, and coastal zones due to more intense storms and salt water intrusion.

Conclusion

Climate change is a real and current threat to households and communities in Kenya already struggling to survive. Climate change will impact development projects both directly, by affecting climate-dependent activities such as agriculture, forest management and infrastructure, and indirectly, by affecting social development in the health and education sectors and in some conflict-prone areas.

While global climate model results indicate that the East Africa region will experience wetter and warmer conditions and decreases in agricultural productivity, the results of the CLIP regional model calibrated for East Africa show a high degree of variability within the region. Sub-regional factors such as topography and LUC need to be taken into account.

Many millions of Kenyans already face severe poverty and constraints in pursuing a livelihood. Their vulnerability threatens to become more serious with these projected increasing environmental stresses.

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