THE EFFECTS OF CLIMATE AND LAND USE CHANGE ON CLIMATE AND AGRICULTURAL SYSTEMS IN TANZANIA

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Introduction

Climate change is one of the most significant challenges facing human society in the 21st century. Industrialisation has led to the release of greenhouse gases (GHGs) 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 GHGs 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 Tanzanian economy. The project builds on previous land use and climate change research conducted in Tanzania and elsewhere.[1]

Recent trends in climate in Tanzania

Temperatures in Tanzania have been increasing at least since the 1960's in a trend that is similar to the global average. Based on meteorological station data compiled by the Tanzanian Meteorological Agency, has compiled, mean temperatures across the coastal zones and the islands have increased at relatively rapid rates. For example, the average annual temperature in Zanzibar, has risen 1.9 degrees C between 1961 and 2005. Highland zones have also experienced rapid rises if not as dramatic. The temperature in Arusha for example has risen by 1.1 degree C. Elsewhere, temperatures have generally risen between 0.5 and 1 degree C.

Changes in average annual rainfall since the 1960s, on the other hand, are not as dramatic. Several lowland stations such as Morogoro have experienced a small decline in rainfall, and highland stations such as Arusha and Iringa have experienced somewhat larger declines.

The rises in temperature combined with either little change or declines in rainfall appear to have already had an impact on the amount of vegetation as indicated in analyses of satellite imagery (NDVI, AVHRR/GIMMS data). The amount vegetation of Tanzania has generally declined or remained the same, except for some coastal areas where vegetation has increased somewhat. This general decline does not reflect the increase in extreme rainfall events such as storms, flooding and droughts.

Because of recurrent climate variability especially in semi-arid areas, communities have developed drought coping strategies. These mechanisms for short term extremes may not be sufficient for successful adaptation to long term changes and the expected increase in extreme events.

Future Climate Simulation Results

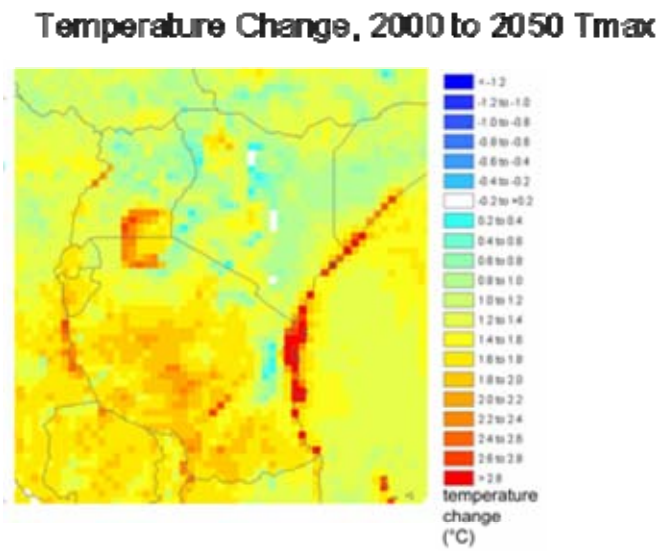
The CLIP regional climate model was calibrated for East Africa using available local and global datasets. The advantage of this model is that it operates with higher spatial resolution (more detailed) and better reflects East Africa's landscape and climate. The model is informed by the general circulation model CCSM v4 with the A2 SRES GHG emissions scenario. The research was designed to examine the effects of GHGs and LUC on East Africa's local and regional climate through a series of experimental scenarios (the effects of GHGs alone, LUC alone, both combined). Although we cannot be certain that these scenarios accurately reflect Tanzania'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 in general is the only tropical region in the world where the majority of GCM's project a generally wetter climate by the end of the 21st century (IPPC 2007). Future climate in Tanzania may be more complex according to the CLIP regional model.

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 and less in the highlands.
- The June-August season may experience more warming than during the low sun period of December-February.
- Average annual rainfall is not expected to change significantly for the country as a whole. However, this varies by zone. The ocean and Lake Victoria coasts may

experience substantial increases in rainfall due to LUC. Southern Tanzania is expected to become drier due to GHGs.

- 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, 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 GHGs. [1]



The impacts on crop yields are generally a result of the warmer temperatures and little change in rainfall. Results of crop-climate modeling using the results of the CLIP climate model indicate that maize yields will decline in most areas of Tanzania. The only exception is along the coast, where yields increase due to a rise in rainfall, and 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.

Rangelands will be generally become drier and less productive, and the plant species composition may change towards less palatable species for livestock and wildlife. 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 the rapid warming, coral reefs due to the warming 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 Tanzania who are already struggling to survive. Climate change impacts will affect development projects both directly where they concern climate-dependent activities (such as agriculture, forest management, infrastructure) and indirectly with regards to social-development strategies (such as health, education, and conflict).

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

People already face severe income and other constraints to their livelihood strategies. The threat of increasing vulnerability is serious when the prospect of increasing environmental stress is acknowledged.

[1] Olson, J., Alagarswamy, G., Andresen, J. Campbell, D., Ge, J., Huebner, M., Lofgren, B., Lusch, D., Moore, N., Pijanowski, B., Qi, J., Torbick, N., Wang, J. 2008. Integrating diverse methods to understand climate-land interactions at multiple spatial and temporal scales. GeoForum (2008) 898–911.

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