11.4 CLIP: CLIMATE-LAND INTERACTION PROJECT—INVESTIGATING HUMAN-CLIMATE INTERACTIONS IN EAST AFRICA

Brent M. Lofgren*
Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan
Nathan J. Moore, Jeffrey A. Andresen, Jennifer J. Olson, and David J. Campbell
Michigan State University, East Lansing, Michigan
Bryan C. Pijanowski
Purdue University, West Lafayette, Indiana

1. INTRODUCTION*

East Africa is a region with an economy that is rapidly developing in a variety of sectors, an expanding population, and a distinct climatic challenge. Conflict sometimes occurs both between and within tribal groups over conversion of land from pastoral to agrarian use, but the trend is toward the cultivation of crops, both for subsistence and for cash (Campbell et al. 2000). Much marginal land that previously supported a pastoral economy has been irrigated for crops.

Large-scale land use change has been shown to have significant effects on climate in other parts of Africa, leading to feedback between vegetation and climate (e.g. Xue 1997). However, land use change in East Africa may be more fragmented and less drastic (typical transformation from savanna to cropland rather than from grassland to desert), and crops will introduce a seasonal character with sharp anthropogenic discontinuities corresponding to tillage and harvest.

The Climate-Land Interaction Project (CLIP) was conceived to investigate the interactions and feedback between climate and land use in East Africa. It will specifically consider land use transformations that are mediated by humans, in addition to the more commonly investigated land use/land cover changes that occur in response to climate perturbations through natural processes. A schematic diagram of the project as a whole is presented in Fig. 1.

2. OVERALL GOALS OF CLIP

CLIP is designed to investigate how climate and land use/human systems are influenced by one another within East Africa, and by external factors. Influences are categorized into the following types, and framed around questions related to each type:

* *Corresponding author address*: Brent M. Lofgren, NOAA/GLERL, 2205 Commonwealth Blvd., Ann Arbor, MI 48105-2945; e-mail: Brent.Lofgren@noaa.gov.

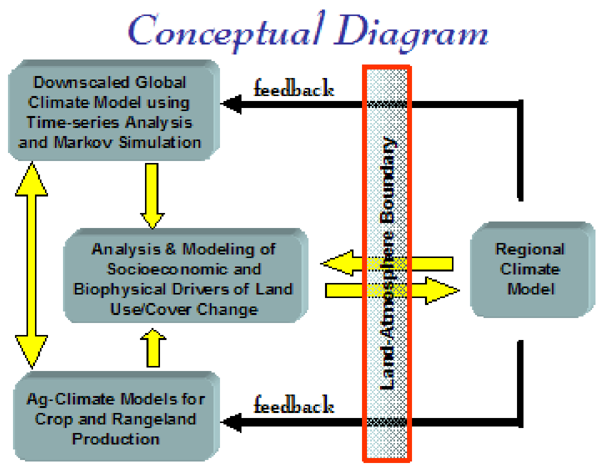

Figure 1. Schematic of the overall design of the CLIP project.

- *Global to regional links:* Is global climate change discernibly affecting regional climate, and if so, how? What are the current and near-term climate variability trends, such as the frequency and intensity of droughts, floods and El Niño Southern Oscillation (ENSO) events, and how are they influenced by large-scale climate phenomena?
- *Regional climate to productivity:* Does the composition and distribution of natural and agro-ecosystems change with past and future climate change? How might the spatial and temporal dynamics of natural and agro-ecosystems affect net primary productivity (NPP)?
- *Productivity to use:* How will changes in natural and agricultural productivity affect land use practices and patterns? What aspects of climate change are most likely to affect individual and community decisions regarding their land use? How will different livelihood systems respond?
- *Use to cover:* What intensity of land use change significantly affects land cover?
- *Cover to climate*: How sensitive is regional climate to alterations of land cover? What degree of conversion of land cover, such as from bush to crops or forest to crops, is required to alter bio-

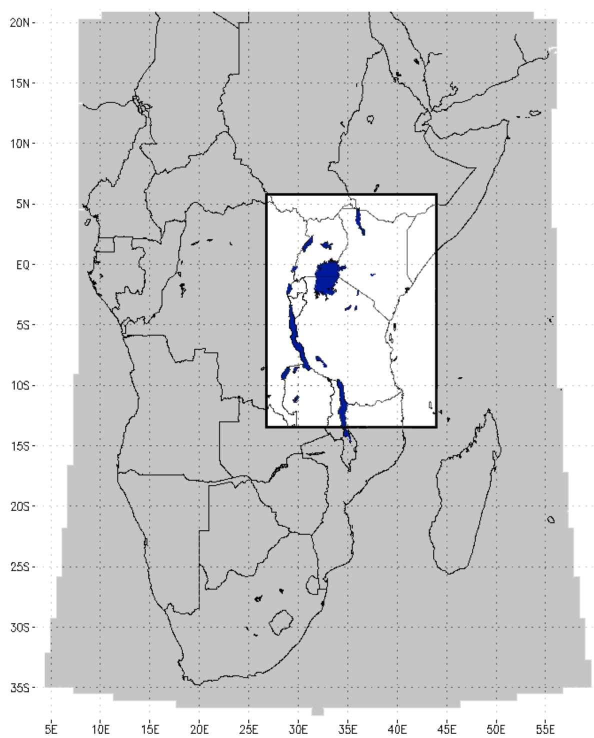

Figure 2. Map of the outer domain (gray) and inner domain (white) used in RAMS simulations for the CLIP project.

physical parameters that link to regional climate? What spatial extent of land cover change is required before the climate is significantly affected, at local and regional scales?

3. MAJOR COMPONENTS OF CLIP

3.1 *Climate modeling*

Climate modeling is being done using the Regional Atmospheric Modeling System (RAMS, Pielke et al. 1992). The planned inner and outer domain model grids are shown in Fig. 2. Development of a proper configuration is ongoing and is described in the companion paper (Moore et al., 2005, this conference). For validation of the models and independent analysis, available observed climatological data are being gathered from stations within East Africa and nearby areas.

3.2 *Land cover from remote sensing*

Data from remote sensing sources (primarily MODIS) are being used to characterize the land cover in terms of surface albedo, leaf area index, fractional photosynthetically active radiation, and fractional vegetation cover, as in Foley et al. (2000). These raw numbers will then be cross-referenced with the land cover types defined by different datasets, including OGE, Africover, and Global Land Cover. From this cross-referencing will be derived seasonal characteristics of land use types within the region.

3.3 Agricultural productivity

The response of agricultural productivity to climate will be simulated using CERES-Maize (Tsuji et al. 1994), RANGEMOD (Berry and Hanson 1991), and BIOME3 (Haxeltine and Prentice 1996). These models will evaluate how much agricultural productivity will occur under various climatic changes induced both by greenhouse gases and land use transformations.

3.4 Land use/cover change predictions

In order to create a complete system with feedback between climate and land use, land use prediction schemes will be used. Chief among these will be the Land Transformation Model (LTM, Pijanowski et al. 2002) and the Multi-Agent Based Economic Landscape (MABEL, Sallach and Machal 2001). These use climate along with population and infrastructure to predict a sequence of transformations in land use based on neural net (LTM) and agent-based (MABEL) algorithms.

4 SUMMARY

The four areas of research enumerated in the previous section will be brought together in one research project focused on East Africa. Through the combination of these disciplines and the ability to look at multiple spatial scales, we hope to run simulations that point to new phenomena. These will include interactions and feedbacks between greenhouse warming, local human activities, and land cover characteristics. Our scientific team hail from the disciplines of meteorology, climatology, geography, statistics, remote sensing, computer science, entomology, forestry, and agronomy.

5 ACKNOWLEDGMENTS

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