

Annual Report for Period:08/2007 - 07/2008

Submitted on: 12/08/2008

Principal Investigator: Olson, Jennifer M.

Award ID: 0709671

Organization: Michigan State University

Submitted By:

Olson, Jennifer - Principal Investigator

Title:

CNH: Dynamic Interactions Among People, Livestock, and Savanna Ecosystems Under Climate Change

Project Participants

Senior Personnel

Name: Olson, Jennifer

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Campbell, David

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Andresen, Jeffrery

Worked for more than 160 Hours: Yes

Contribution to Project:

Contributes to the climate and vegetation analyses

Name: Glew, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

Contributes to the educational activities

Name: Kim, Dong-Yun

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts statistical analyses of climate data

Name: Moore, Nathan

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts climate and other modeling

Name: Qi, Jiaguo

Worked for more than 160 Hours: Yes

Contribution to Project:

Lead analysis of remote sensing data, analysis of seasonal trends in vegetation

Name: Ogutu, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:

Leads activity in Kenya, and conducts statistical analysis of climate and vegetation

Name: Maitima, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts ecological research in Kenya

Name: Thornton, Philip

Worked for more than 160 Hours: Yes

Contribution to Project:

Contributes to impacts of climate change on crop production and households

Name: Yanda, Pius

Worked for more than 160 Hours: Yes

Contribution to Project:

Leads field activities in Tanzania

Name: Smucker, Thomas

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts socioeconomic field work in Kenya, does educational activities

Name: Wangui, Edna

Worked for more than 160 Hours: Yes

Contribution to Project:

Conducts socioeconomic field work in Kenya, does educational activities

Post-doc

Graduate Student

Name: Qin, Chuan

Worked for more than 160 Hours: Yes

Contribution to Project:

Models remote sensing data to identify trends in vegetation

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Ohio University

International Livestock Research Institute

University of Dar Es Salaam

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)**Findings:****Training and Development:**

The educational activities of the project thus far have involved:

1. Curricular development for high schools. Recruitment of a Michigan Master high school teacher has begun, and the teacher is expected to be chosen this month. This teacher will learn about the project's research activities in the U.S., and will travel to Tanzania in the summer of 2009 to work with a faculty member of the Dar es Salaam University College of Education (a teacher training college). They will visit the project's field site, and develop various curricular modules around the themes and results of the research.
2. Two PhD students from the MSU College of Communications will be engaged in developing innovative and effective communications approaches to communicate the project's results to the broader public and to policy makers in the U.S. and East Africa.
3. The project website will host the products of the above two activities to provide an interactive platform for students and others.
4. An African American undergraduate student has been identified who will be engaged in the project's activities. She will develop a research proposal and work with project scientists to conduct and write up her research.
5. PI's are using the results of the research, particularly the field work thus far, in the classes that they teach. One Masters and one PhD student are working with the project and both are planning to do their thesis / dissertation on a project related theme.

Outreach Activities:**Journal Publications****Books or Other One-time Publications****Web/Internet Site****Other Specific Products****Contributions**

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Activities and Findings: Any Findings

Activities and Findings: Any Outreach Activities

Any Journal

Any Book

Any Web/Internet Site

Any Product

Contributions: To Any within Discipline

Contributions: To Any Other Disciplines

Contributions: To Any Human Resource Development

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Dynamic Interactions among People, Livestock, and Savanna Ecosystems under Climate Change

ACTIVITIES AND FINDINGS

The main objective of the project is to attempt to separate out the impact of climate change from human impacts in an ecological system. The project is addressing the question: *What are the key characteristics of and dynamics between coupled human-biophysical systems in savannas under climate change?* This question is being examined in semi-arid savanna lands in East Africa, where the impacts of climate changes on vegetation and society are particularly acute. This project is examining the changing ecosystem functions and human land uses of the savannas that extend over large areas of Kenya and Tanzania. These areas are dominated by pastoralism and, in some areas, wildlife. Savannas are at the expanding edge of cropped agriculture and the location of the most rapid in-migration and land use change in the region over the past twenty years

The project is taking a comprehensive conceptual and methodological approach to modeling and statistical analysis of climate, land management, and ecosystem dynamics at two scales—the local scale where human decisions are made and ecosystem dynamics are most evident, and at the regional scale where the cumulative effect of human activity and ecosystem change may significantly impact climate. A regional climate model and some other models will be run at both scales, and remote sensing and other data analyzed at both scales. Interaction between scales and temporal dynamics including feedback effects will form the crux of the analysis of the coupled natural and human system.

Note that both research activities and initial findings are described in this file. The activities during first year of the project, known as Eaclipse (East Africa Climate People and Ecological Systems) were focused on local and regional data collection and initial analyses. The first project wide workshop was held in October 2007 in Nairobi, Kenya to discuss research questions, analytical approaches, additional data needs, and to prepare a work plan.

Local level field data collection.

The purpose of the field data collection is to estimate the effects of climate change on savanna structure and the ability of the changing savanna system to support pastoral peoples, their livestock and wildlife. The case studies will also provide calibration and validation data on the biophysical and human system processes whose consequences are discernable at the regional level. Ecological, land use and socioeconomic data is being collected at two sites currently, with a third site to be added in 2009. The two current sites are Simanjiro District in northern Tanzania (a relatively isolated agro-pastoral area adjoining the Tarangire National Park) and Kajiado District in southern Kenya (a less isolated agro-pastoral and farming area surrounding Amboseli National Park). These sites have similar climatic conditions, both have varying intensities of land use and dynamic land use change, and team members have prior field research experience and baseline data that can inform this project.

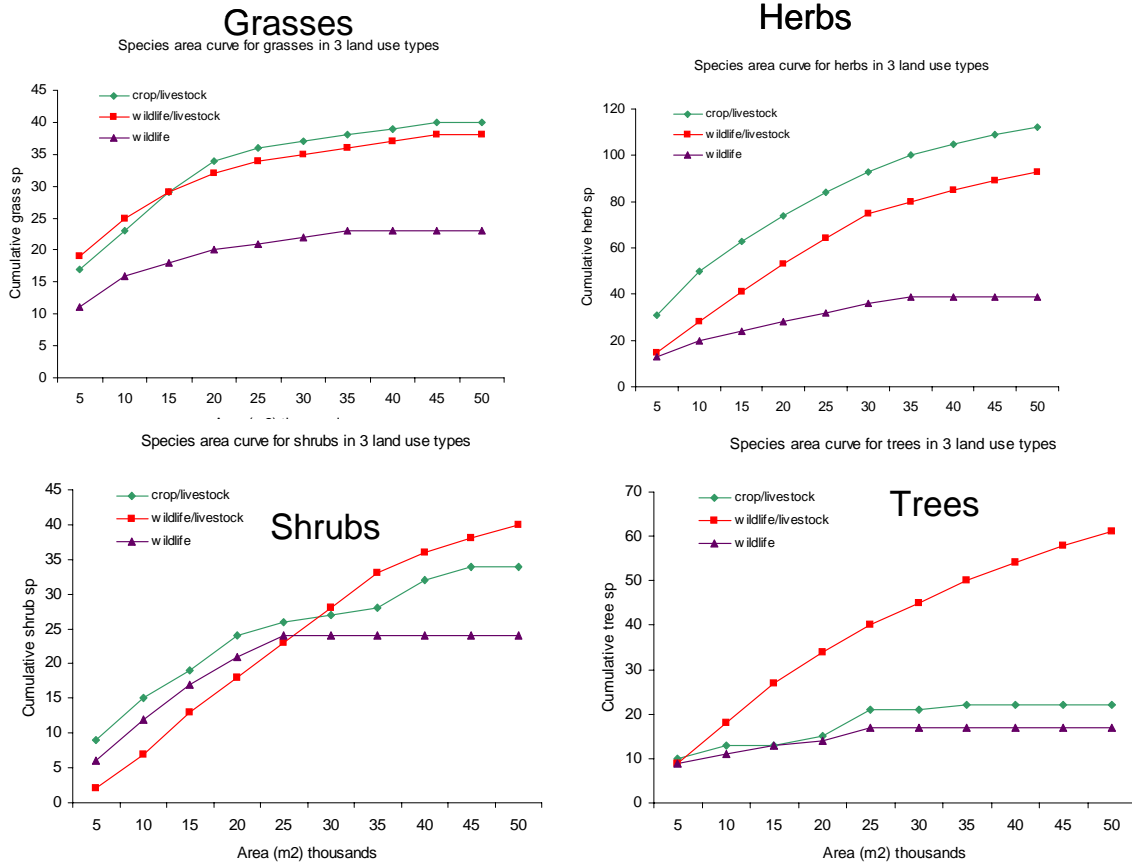
A three day field methodology workshop was held in Mto wa Mbu in northern Tanzania in June 2008 with those who would be involved in collecting ecological and socioeconomic data and information. Data collection locations and sampling strategy were discussed, and data collection instruments were prepared, pretested in the field and finalized. This included the ecological (plant species, percentage cover, etc) data sheet, the land use questionnaire (land use history, perceptions of changes in vegetation and land management changes), the community mapping, land management timeline and wealth ranking exercise approaches, and the household economic/ livelihoods questionnaire. The later questionnaire provides input data for modeling the impact of climate change (as it affects crop and livestock productivity) and other factors on household income, food security, labor allocation and decision making on livelihood and land use choices (the IMPACT model). This model has been widely used in farming communities across

Africa by International Livestock Research Institute and other scientists, but the questionnaire and model needed to be extensively modified for the agro-pastoral communities of Tanzania and Kenya. The workshop resulted in the complication of a field methodology guide for the project.

Transects in the two sites were chosen that crossed land use intensity gradients (from within a park or low intensity use, to land grazed by livestock and wildlife, to areas with cultivated fields) and vegetation type. Randomly selected points within each land use and vegetation type were selected for the ecological data collection in plots/ quadrats, and the communities whose land was crossed by the transects and plots were chosen for the socioeconomic fieldwork.

Since the workshop, research teams have been in the field. In Simanjiro, the ecological team (a botanist, an ecologist and a geographer) have completed their plots outside the park and, now that research permission has been granted to work inside the park, will complete their data collection. In Kajiado, the ecological team (a botanist and two ecologists) has completed the plots around Amoseli Park. Initial analysis of plant species diversity indicate that the more intensely used areas with cropped fields have lower species richness of trees and shrubs, but were associated with more species of herbaceous plants including grasses. Most of the richness reflected in the herbaceous layer may be a reflection of invasive species and weeds often prevalent in cultivated areas (Fig. 1).

Fig 1. Plant species area curves by land use type .



A summary of the land use survey and community meetings concerning the climate change indicates:

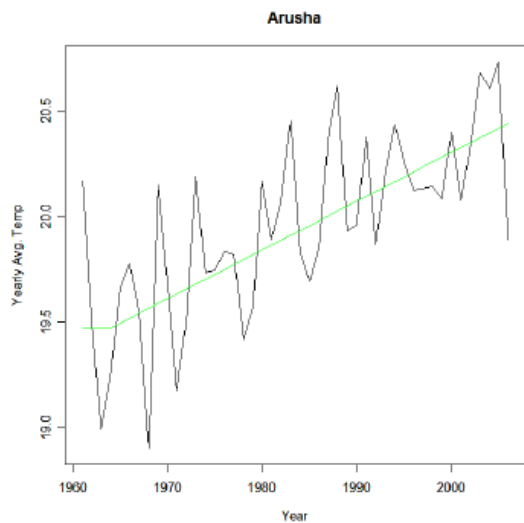
- progressive declines in rainfall as evidenced by longer dry spells, and shorter rainy seasons or complete failure of rainfall. Marked reduction in availability of surface water, and especially in the dry season the sources are contested and sometimes privatized.
- livestock forage amounts have reduced (due to lower rainfall, higher livestock densities). The daily distance traveled in search of pasture has increased considerably. But there is less nomadic (seasonal) movement. Daily movements may be longer because of sedentarization and the need to return to home at night (if nomadic stay at night nearer forage). Also daily movements are longer because of the need go further to search for water.
- Bush encroachment has increased (e.g., Kitwai in Tanzania and Kuku/Lenkiporoi in Kenya) due to fewer fires (there is less biomass to burn, and a newly implemented government policy restricting burning). Preferred forage grass species are declining while unpalatable bush species are increasing.
- Adaptation to the reduction in water availability and dryer vegetation include:
 - New livestock breeds (more camels, new goat and cattle breeds from Somalia)
 - More Maasai people cropping to cope with more frequent drought (but there may not be a large change in area under crops since commercial farmers are abandoning fields due to declining productivity).

The community mapping, timeline and wealth ranking exercises produced a rich source of information on how communities and group within the communities are responding to climate and other changes. For example, the community resource maps prepared by men and women showed significant differences in

how they are perceiving and experiencing the reduction in water availability. Also, women emphasized the effect of climate change on woody species and fuelwood availability but men did not even mention this change. In general, climate change was perceived as a critical factor affecting their resources and their decisions, even as land tenure and other factors are also affecting their land use and livelihoods. Administration of the household surveys is nearing completion.

Regional level analyses

At the regional level, analyses on climate and vegetation change have begun to reveal significant trends that parallel what people at the local level describe. Statistical analysis of meteorological station data on temperature, for example, shows a clear upward trend across the region but with regional differences in levels of rise and the point at which the change began (Fig. 2). In Tanzania, the temperature rise in interior stations started earlier, in the 1960s. The coastal stations show that the rise started later, in the 1990s, maybe because of increased cloudiness and rainfall. Changes in seasonality are being examined in both the rainfall data and the vegetation (NDVI GIMMS) data. Initial results indicate that the rainy season as reflected in the vegetation appears to be shortening in time and/or in total amount of production during the growing season across much but not all of the region. Savanna areas, especially where land use conversion to crops has been significant, have also experienced a reduction in the amounts of vegetation produced during the rains.



A PhD student is preparing her dissertation examining historical climate and vegetation (NDVI) data with the objectives (1) to identify theoretical correspondences between the two major paradigms for estimation in a spatial setting: kriging and spatial regression; (2) to explore the optimal method of prediction within a given area of application (i.e., evaluation of East African precipitation); and (3) to undertake a case study addressing causal mechanisms of precipitation in East Africa using new approaches in spatial regression. Her analyses will explore the spatial relationship between precipitation and rainfall, and identify areas where other mechanisms such as human management affect the relationship.

Fig. 2. Average Monthly Temperature. Arusha, Tanzania.

Coupled climate, vegetation and water models are being developed initially for the northern Tanzania/southern Kenya area with the team’s regional climate model for East Africa, the validation and calibration of the Century soil and vegetation model, and the surface water model SWAT with remote sensing and field measurement data.

In sum, the first year of the project has been focused on collecting existing and new data, the development of a project wide database, and initial data analyses. Insights on climate and ecosystem change from communities appears, as usual, to provide a rich source of information and explanations that modeling and statistical analysis will later quantify and upscale.