ANNUAL REPORT FOR AWARD # 0709671

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

Participant Individuals:
CoPrincipal Investigator(s) : David J Campbell
Senior personnel(s) : Jeffrey Andresen; Robert Glew; Dong-Yun Kim; Nathan Moore; Jiaguo Qi; Joseph Ogutu; Joseph Maitima; Philip Thornton; Pius Yanda; Thomas Smucker; Edna Wangui
Graduate student(s) : Chuan Qin
Senior personnel(s) : Gopal Alagarswamy
Graduate student(s) : Sarah L Hession; Matthew Williams

Participants' Detail

Partner Organizations:
Ohio University: In-kind Support; Facilities; Collaborative Research

International Livestock Research Institute: In-kind Support; Facilities; Collaborative Research; Personnel Exchanges

University of Dar Es Salaam: In-kind Support; Facilities; Collaborative Research; Personnel Exchanges

Virginia Polytechnic Institute and State University: In-kind Support; Collaborative Research; Personnel Exchanges

Other collaborators:

Honey Creek Community School, Ann Arbor, MI
Hillside Middle School, Northville, MI
Dar es Salaam University College of Education

Activities and findings:

Research and Education Activities:

Please see the attached pdf file.

Findings:

Please see attached pdf file in the Activities section.

Training and Development:

The EACLIPSE education activities have included: development of curricular materials in Michigan and Tanzania involving two Michigan schoolteachers and two members of faculty at the Dar es Salaam University College of Education (DUCE), Tanzania; the activities of two post-doctoral associates at MSU; teaching of undergraduate courses at Ohio U and MSU; and training and mentoring of PhD, MA and BA students in the US and Tanzania.

Curriculum Support for Education in Michigan and Tanzania
The EACLIPSE project proposal's 'Broader Impacts' identified development of science-based curriculum materials for Middle and High schools in the US, and for undergraduates at Dar es Salaam University College of Education

(DUCE), Tanzania preparing to become schoolteachers.

In Spring 2009 the project selected two Michigan teachers (Barbara Naess and Dwight Sieggreen) and DUCE identified two lecturers (Josta Nzilano and Dominique Lukiko), to engage in this activity. In July 2009 EACLIPSE researchers Olson, Campbell and Glew met with these four associates for two weeks in Tanzania to experience the EACLISPE field data site and climate change issues, share ideas and develop initial drafts of the curriculum materials. The team was joined by Dr John Metzler of the MSU African Studies Center and College of Education where he coordinates Exploring Africa, an outreach program for US teachers that includes web-based curriculum support materials (http://exploringafrica.matrix.msu.edu). We anticipate that the materials prepared for this project will be made available through this website and elsewhere.

The field activities began in Dar es Salaam where US and Tanzanian team members met to discuss objectives and activities. Subsequently the team moved to Mto wa Mbu in Northern Tanzania to hold a curriculum development workshop that included sharing of findings from EACLIPSE research to date, as well as additional scientific information that would provide a factual scientific basis for preparing curricular materials. The field team held a series of discussions in which the US and Tanzania based participants shared ideas as to potential curriculum structure and content that would fit into the Michigan and Tanzanian systems, respectively. Participants visited local schools, a weekly livestock market, a national park, and a rural village with severe challenges over provision of clean water during the current drought.

The US and Tanzanian teachers are developing detailed outlines of the materials that currently form the basis of their work on writing the modules that will enable EACLIPSE results to be introduced to the curricula in each country. At DUCE this work includes:
1. Developing/improvement of specific modules in geography courses e.g. Climatology, Population Redistribution, Biogeography and Environmental Resources.
2. Introduction of an independent, optional course on 'Climate Change and Drought', a course that will be taught by using case studies. This will help teacher students to have a good understanding of linkages among, drought, climate changes and all associated impacts.
3. Preparation of teachers and students materials for designed short courses. These are planned to be offered by DUCE to teachers in secondary schools to enhance them have a good capability to provide relevant environmental education to students.
In Michigan a module of eight lesson plans have been drafted:
Lesson 1 Introduction,
Lesson 2 Measuring and Predicting Changes in Climate, Land Use and Vegetation,

Lesson 3 Rising Temperatures in East Africa,
Lesson 4 The Water Cycle in East Africa,
Lesson 5 Climate Change in East Africa,
Lesson 6 Analyzing Human-Environment Interaction using the Kite Framework,

Lesson 7 Adapting to Climate Change in the East African Savanna, and
Lesson 8 International Conference.

The materials are written for Middle and High School teachers and include text, support materials (diagrams, graphs, tables and worksheets etc) and photographs taken by team members in East Africa.
Undergraduate and Graduate Students

1. Moriah Shiddat, undergraduate student at MSU worked with David Campbell for 2009 under the 2009 Ronald E. McNair Post-Baccalaureate Achievement Program. She wrote a 46-page paper and presented a poster on 'Adaptation of Pastoral Livelihoods under Climate Change.'
2. Sarah Hession, MSU PhD student, MSU fellowship. She has passed her comprehensive exams and is working on her dissertation, Fine-Scale Prediction for Modeling of Climate Change in East Africa using meteorological station and other data. She has also contributed statistical analyses for two EACLIPSE publications, and developed an R code for the EACLIPSE climate analyses.
3. Chuan Qin, MSU PhD student, supported with a GRA. She is developing her dissertation under the EACLIPSE research umbrella concerning analysis of remote sensing data to identify changing seasonality
4. Matthew Williams, VPI PhD student working for EACLIPSE as an GRA, who is conducting statistical analyses of climate data to examine trends in drought patterns.
5. The project supported the field research of two UDSM Master's students, Jacqueline Senyagwa and Euster Kibona (a summary of their research findings is in the Activities section of this report)

6. The project is contributing towards the development of both computer learning tools and traditional (paper) learning materials for Tanzanian primary and secondary schools collaborative effort with ICT4D and PPT projects at MSU (see the outreach and public welfare sections of this report for more information).

Courses that EACLIPSE material is being taught in:
Ohio University:
Geography of Africa (Edna Wangui)
Geography of Hunger and Food Security (Tom Smucker)
Gender, Environment, and Development (Edna Wangui)
Global Issues in Environmental Geography (Edna Wangui)

MSU:
People and the Environment (Nathan Moore)

Post-Doctoral Associates at MSU
Gopal Alagarswamy (Crop-Climate Modeler) has worked under the supervision of Dr Jeffrey Andresen. He has been an integral member of the EACLIPSE team, being involved in research, publication, and proposal writing. He has participated as a full member of the team at regular team meetings where all aspects of the project are discussed.

Nathan Moore (Regional Climate Modeler) has worked under the supervision of Dr Jeffrey Andresen and Dr Jiaguo Qi. Nathan Moore has recently been appointed as Assistant Professor in the Department of Geography at MSU. He has been an integral member of the EACLIPSE team, being involved in research, publication, and proposal writing. He has participated as a full member of the team at regular team meetings where all aspects of the project are discussed. He has also been involved in projects set in Brazil and China.

Outreach Activities:

The EACLIPSE project team is conducting synergistic activities with various groups and communities to enlarge the knowledge base of climate change and the links between climate and other changes occurring. The goal is to have the EACLIPSE and synergistic activities complement each other to produce an impact larger and more sustainable than any one project could accomplish. The communities involved include villagers and schools in northern Tanzania, crop breeders in Tanzania, Uganda and Kenya, engineers and telecommunications students and professors in the U.S. and in Tanzania, and journalists in Kenya and Tanzania.

The first project that EACLIPSE is informing is the Information Communication Technology for Development (ICT4D) project run out of the MSU Department of Telecommunications with the College of Engineering, collaborating with the UDSM Telecommunications Department and Faculty of Engineering. It is funded by MSU and the Lenovo Corporation (computer manufacturer). Schools in the EACLIPSE site in northern Tanzania are the location of the ICT4D field activities that include designing and installing rugged, solar powered, internet connected computers to schools. EACLIPSE provided the MSU/ UDSM/ DUCE team that the project has adopted, and EACLIPSE is contributing research and educational materials to the ICT4D computer education specialists (e.g., educational games designers) who will be developing computer-assisted and regular classroom teaching tools on climate, geography, science, etc. The products, of first of which are expected in 2010, will be tested in primary and secondary schools in northern Tanzania and eventually disseminated in all of Tanzania. They aim to enhance learning about science and other topics via the EACLIPSE products. Meanwhile US and Tanzanian university engineers and telecommunications students and professors are learning about science and climate change as well. The ICT4D project will be a regularly offered MSU study abroad program and an undergraduate specialization.

A second project that has just gotten underway is a MSU Knight Center for Environmental Journalism workshop for 20 Kenyan and Tanzanian journalists that will be held in June or July 2010 funded by the John S. and James L. Knight Foundation. The workshop will be held in the fieldwork site in northern Tanzania/ southern Kenya, and will focus on presenting and discussing EACLIPSE results. MSU, UDSM and ILRI scientists will present and lead field visits, and Knight Center faculty will provide hands-on journalism training sessions. The predecessor to EACLIPSE, the CLIP project, had several newspaper, TV and radio spots in Kenya, Tanzania and Uganda,

and the topic of the impact of climate change is of great concern to the news media so we are anticipating much interest in the workshop.

A third effort is geared towards providing CLIP and EACLIPSE climate and coupled climate-vegetation and water modeling results to national agricultural research institute scientists, especially crop breeders, in Kenya, Tanzania and Uganda. The Rockefeller Foundation approached the EACLIPSE PI Olson with the idea of engaging agricultural scientists to have them learn how to incorporate the effects of climate change in their efforts to develop improved crop breeds and technologies. This project, if funded as anticipated, will involve conducting additional regional climate simulations and crop-climate modeling to test the effectiveness of altered crop characteristics and technologies in dealing with frequent drought, rising temperatures and other projected climate changes. The EACLIPSE / CLIP team at UDSM, ILRI and Makerere will contribute their understanding of the evolution and limitations of farming systems in their countries, participate in the workshops, and conduct limited fieldwork in sites where we are already engaged to provide feedback to the agricultural researchers on their ideas, and to farmers and herders on possible climate change adaptation strategies.

Journal Publications:

Jones, P. G.; & Thornton, P. K., "Croppers to livestock keepers: Livelihood transitions to 2050 in Africa due to climate change.", *Environmental Science & Policy*, vol. 12, (2009), p. 427-437., " " Published

Ogutu, J. O.; Piepho, H.P.; Dublin, H. T.; Bhola, N.; & Reid, R. S., "Dynamics of Mara-Serengeti ungulates in relation to land use changes.", *Journal of Zoology*, vol. , (2009), p. 1-14., "10.1111/j.1469-7998.2008.00536.x " Published

Ogutu, J. O.; Hans-Peter P.; Dublin, H. T.; Bhola, N.; & Reid, R. S., "Rainfall extremes explain interannual shifts in timing and synchrony of calving in topi and warthog.", *Population Ecology*, vol. , (2009), p. ., "10.1007/s10144-009-0163-3 " Published

Moore, N.; Torbick, N.; Pijanowski, B.; Lofgren, B.; Wang, J.; Kim, D-Y; Andresen, J.; & Olson, J., "Adapting MODIS-derived LAI and fractional cover into the RAMS model for East Africa.", *International Journal of Climatology*, vol. , (2009), p. ., "10.1002/joc.2011 " Published

Book(s) of other one-time publications(s):

Other Specific Products:

Internet Dissemination:

http://www.eaclipse.msu.edu

Contributions:

Contributions within Discipline:

The project is making contributions to the fields of Geography, Statistics and Climate Change Science through application and evaluation of disciplinary theory (political ecology), attempt at linking disparate processes, and methods. Some of our statistical methods and approaches are being developed out of necessity due to conducting research in a data-poor environment. Time series analysis of spatial data, for example, has presented challenges of analysis and interpretation. The project's challenge to establish links between changing climate, vegetation and human activities is rare (perhaps because difficult), especially in Africa and especially at the resolution in which we are working. A particular topic we have needed to focus on to answer our research questions, that is changes over time and space in frequency, duration and intensity of meteorological drought, has rarely been analyzed (although examining agricultural drought has been a somewhat more common analysis).

Contributions to Other Disciplines:

This is a multi-disciplinary project grounded in Geography and Climate. It involves team members from the statistical sciences, education and ecological sciences. As the results of the project are developed and published it is anticipated that contributions will be made to the literature in these disciplines.

Contributions to Education and Human Resources:

Please see outreach and public welfare sections of this report.

Contributions Beyond Science and Engineering:

The EACLIPSE project is conducting basic research but the research topic, the impact of climate change, is of great concern to East Africans and others working to improve conditions in East Africa. EACLIPSE is thus contributing to different sorts of activities from informing international bodies to assisting in development projects for local communities.

At the international level, EACLIPSE findings have been informed the Best Practices Toolkit developed by the Pastoralist Development and Biodiversity Steering Committee of the United Nations Convention on Biological Diversity (Wangui serves as steering committee member). EACLIPSE and CLIP findings and experiences also informed a publication geared towards guiding African agricultural research and development practitioners and funders: Ziervogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F., Shale, M. & Smith, B. (2008, March). Climate change and adaptation in African agriculture. SEI Rockefellar Africa Climate Report. Stockholm Environment Institute. Available from http://www.egs.uct.ac.za/~gina/SEI%20Rockefeller%20Africa%20Climate%20Report%204April08.pdf.

At the local level, the EACLIPSE team's research results, knowledge and experience has formed the basis for a new joint MSU/UDSM/DUCE/Aga Khan research and development project, 'Tanzanian Partnership for Sustainable Community Development Program' (TPP) funded by a private foundation that prefers to remain anonymous for the time being. This multi-college and multi-institutional project is implementing integrated research and development activities in the villages in northern Tanzania where EACLIPSE fieldwork is based. A key component of the TPP project is working in schools to develop teaching tools and materials, and the EACLIPSE project is contribution materials and is fully integrated into this effort. The agricultural and livestock research and development activities have a climate change adaptation approach.

Another project focused on adaptation to climate change is using EACLIPSE results and modeling to inform local communities in northeastern Tanzania. This research project, 'Linking Local Knowledge and Local Institutions for the Study of Adaptive Capacity to Climate Change: Participatory GIS in Northern Tanzania,' is anticipated to be funded by NSF. It is aimed at understanding the linkage between local knowledge and local institutions in consideration of adaptive capacity to climate change. Ohio University (Smucker, Wangui), MSU (Olson, Moore), UDSM and others are working together to adapt the EACLIPSE climate and crop-climate modeling results to inform communities in innovative ways to develop improved adaptive capacity.

The final activity to be mentioned here is the start of what is planned to be an on-going research and development effort to improve animal and human health in communities affected by climate change, especially drought. This MSU (Kaneene PI; Veterinary Medicine, with Olson, Campbell and Moore) and UDSM project is starting with a MSU PhD/ Veterinary Medicine student doing his PhD thesis research in Northern Tanzania on the impact of climate change and climate variability on livestock and wildlife zoonotic diseases. He will be in the field conducting his research in 2009-10.

Conference Proceedings:

Special Requirements for Annual Project Report:

Categories for which nothing is reported:
Products: Book or other one-time publication
Products: Other Specific Product

Contributions to Resources for Science and Technology
Conference Proceedings
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