vistas of AFRICAN SCIENCE

Advancing Knowledge through START's Grants for Global Environmental Change Research in Africa Program

START

global change SysTem for Analysis, Research & Training

This report is based on the research and outreach activities supported as part of the grant sub-awards managed by the International START Secretariat with funds supplied by the U.S. Global Change Research Program, administered through the U.S. National Science Foundation (grants GEO-020328, GEO-0627839 and GEO-1030200).

Additional support for the 2011 Africa GEC grants was provided by Climate Development Knowledge Network (CDKN) and Climate Change Agriculture and Foods Security (CCAFS).

Dietrich, K., J. Padgham, and H. Virji. (2014). Vistas of African Science: Advancing Knowledge through START's Grants for Global Environmental Change Research in Africa Program. International START Secretariat.

Design: Jessica Boesl

Vistas of African Science

Advancing Knowledge through START's *Grants for Global Environmental Change Research in Africa* Program

START

global change SysTem for Analysis, Research & Training

TABLE OF CONTENTS

FOREWORD

Global environmental change confronts humanity with serious sustainability challenges that require swift and substantive action. Relevant and actionable knowledge about the dynamic nature of global environmental change (GEC) — driven by *inter alia* ecosystem degradation and biodiversity loss, pollution, water resource degradation, urban growth and climate change — is an essential underpinning of strategies to build resilience in the face of increasing uncertainty and change.

The need for robust knowledge systems to inform action on GEC is arguably greatest in low-income regions such as Africa. The capacity to adapt to GEC in these regions is circumscribed by multiple stresses, including widespread poverty, conflict, poor governance, and environmental degradation.

Confronting the challenges of GEC in this context requires a knowledge base that is continually infused with innovative research to inform decision making across multiple scales, from global to local from immediate to long term. The importance given to global research initiatives on GEC, including the Intergovernmental Panel on Climate Change (IPCC), Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), Climate Change, Agriculture and Food Security (CCAFS) and the emerging Future Earth: Research for Global Sustainability, underscore the importance of innovative approaches to knowledge generation and sharing that engage society around critical GEC challenges.

Africa's involvement in GEC research is growing as African research institutions become increasingly involved in GEC research. However, the region's research community is constrained by limited financial and technical resources to conduct research that is independent of donor-driven research development agendas — and that can fully reflect regional priorities and national needs.

The START *Grants for Global Environmental Change Research in Africa* Program is challenging this state of affairs by providing research funds directly to African researchers in order to promote African-led research and provide opportunities for African research institutions to contribute to GEC research initiatives. Since 2004, this START program has supported over 100 researchers to investigate the drivers and impacts of GEC as well as solutions for addressing GEC challenges in Africa.

This report, *Vistas of African Science: Advancing Knowledge through START's Grants for Global Environmental Change Research in Africa Program*, highlights eight years of START's Africa GEC Grants Program, focusing on the significance and devel-

opment of the program for GEC research in Africa and the major accomplishments of grant award recipients from 2004 to 2012. Research findings featured in this report illustrate the breadth of research and key discoveries supported by the GEC Grants Program.

The findings are organized under three themes – land dynamics, livelihoods and environmental change, and climate systems. Research on land dynamics involved studies on biogeochemical processes, drivers of land use change, land management, and biodiversity; the livelihoods and environmental change research addressed perceptions of climate variability and change, responses to climate risk, and natural resource management; and, grant awards on the climate system investigated the past and present drivers of climate variability and change through paleoclimatology fieldwork and climate modeling.

The *Grants for Global Environmental Change Research in Africa* Program has conferred multiple benefits associated with advancing GEC research-for-action in Africa. These include strengthening linkages between researchers, local communities and national decision makers; advancing scientific knowledge of GEC impacts in Africa (grant award recipients have published over 50 academic articles while another 50 are in development); and providing exposure of young African scientists to GEC research methods and approaches, with over 300 students, predominately at the post-graduate level, having participated in the research projects over the duration of the African GEC Grants Program.

The START *Grants for Global Environmental Change Research in Africa* Program is grateful to the United States Global Change Research Program (USGCRP) and the United States National Science Foundation for their long-standing support for this effort. Through the GEC Grants Program and other parts of its portfolio of work, START remains committed to the goals of USGCRP to advance science on the Earth system, provide a basis for informed decisions and action, build assessment capacity, and facilitate the communication of global environmental change issues to stakeholders. START also wishes to acknowledge the support of the Climate and Development Knowledge Network (CDKN) and the Climate Change, Agriculture and Food Security Program (CCAFS) for their support of the 2011-2012 round of awards.

WHY GLOBAL ENVIRONMENTAL CHANGE RESEARCH IN AFRICA?

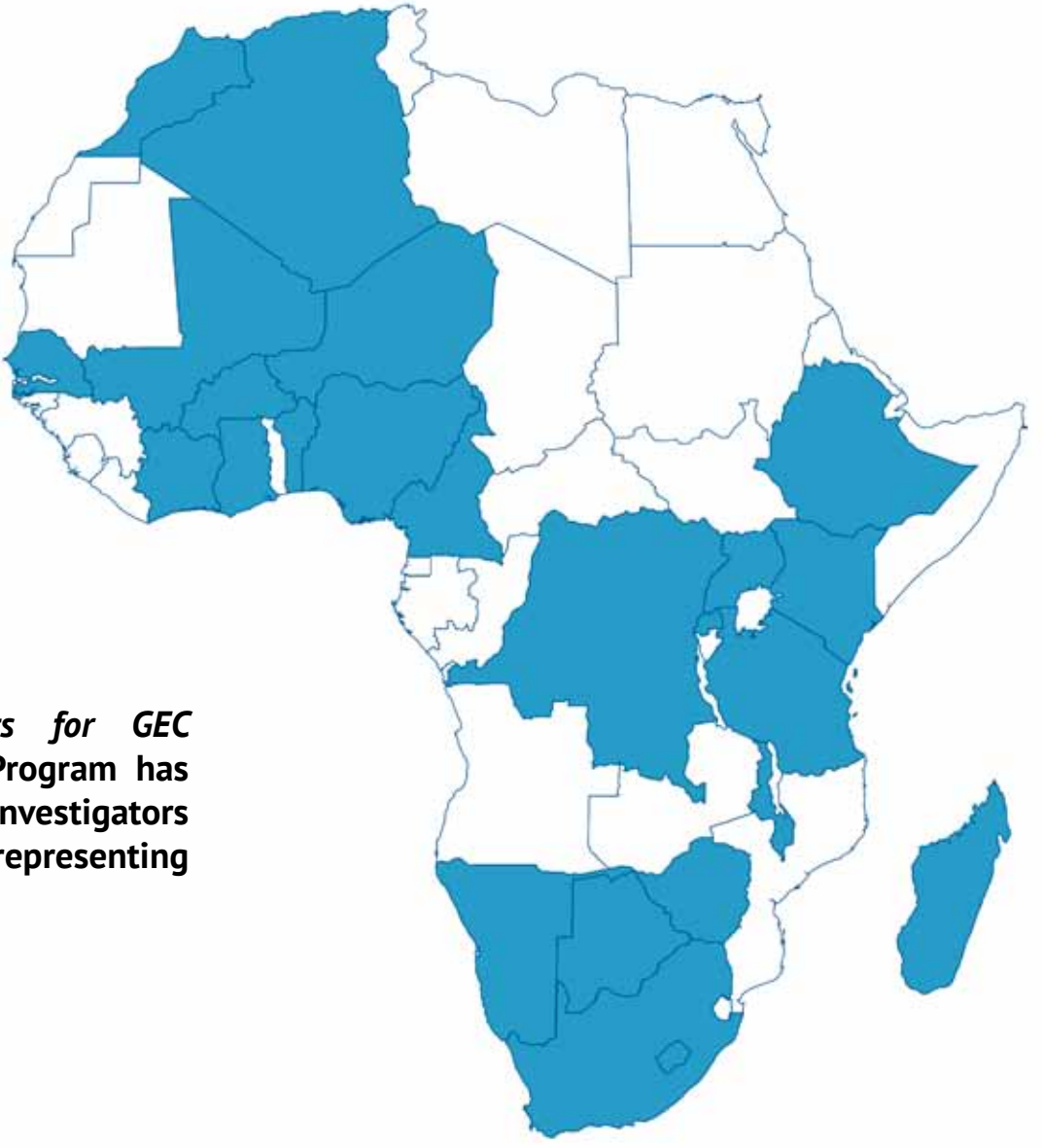
Global environmental change (GEC) encompasses a wide range of interrelated ecological and social changes within complex systems. It is driven by changes in climate and associated pressures on ecosystems often manifested in terms of threats to biodiversity and locally important environmental services, sustainable land use, food and water security and human health.

Africa is experiencing rapid rates of population growth and urbanization, land degradation is widespread, and the agriculturally based economies that underpin much of Africa are highly vulnerable to temperature rise, extreme events and changes in precipitation associated with climate change.

Advances in research are needed to address knowledge needs for responding to rapidly evolving systems in Africa; however the knowledge base to address these challenges is fragmented and inadequate. While financial resources have rapidly increased in the past few years for climate change research, scientists from donor countries often lead research teams or the donor agencies provide guidelines on approach and topic that constrain researchers' ability to engage in independent research.

Inadequate access to academic resources to support investigation of GEC issues – such as the most current literature, modeling or other software, telecommunications, and technology – also hinders participation in top-level research in a rapidly advancing field.

To address these shortcomings in GEC research in Africa by Africans, the International START Secretariat initiated the START *Grants for Global Environmental Change (GEC) Research in Africa* Program. The program provided a means for funding support and fostered initial capacity for African scientists to engage in innovative and policy-relevant research on GEC issues. The collective program, spanning from 2004 to 2011, developed a knowledge base of Africa-specific and African-led research, insights, and recommendations that address GEC issues at the local, national, and regional scales.



The START *Grants for GEC Research in Africa* Program has supported principal investigators from 24 countries representing 65 institutions.

OVERVIEW OF START GRANTS FOR GEC RESEARCH IN AFRICA PROGRAM

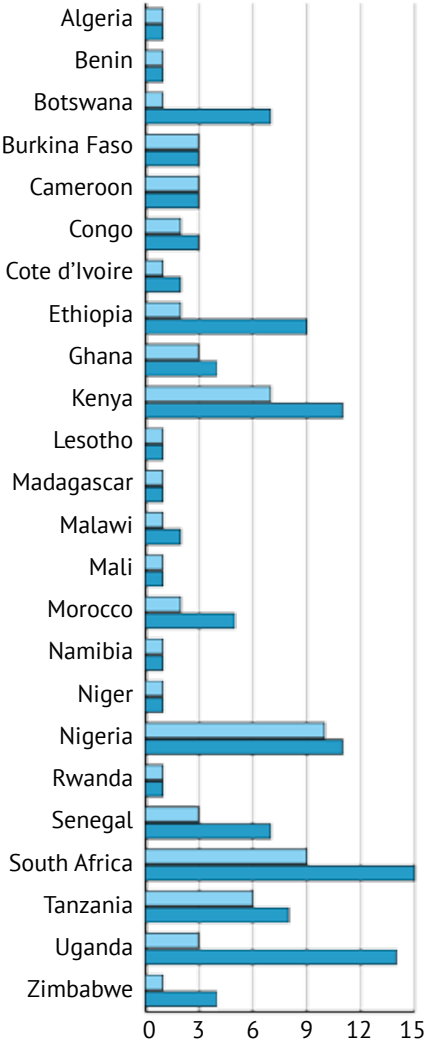
START's *Grants for GEC Research in Africa* Program supports one-year projects for researchers from African universities, research institutes, and research-oriented non-governmental organizations. The research teams are required to be multi-disciplinary (both natural and social sciences) and are typically comprised of individuals from more than one institution, sometimes in collaboration with European or North American partners. The research projects cover a range of global environmental topics, spanning such issues as livelihoods and food security in rural communities in Tanzania and South Africa to validation of regional climate models of the West African monsoon to biogeochemical processes in the Great Lakes region.

The four goals of the GEC Grants Program are to:

1. Enhance knowledge on global change science, impacts, and consequences in Africa
2. Create research partnerships and build capacity for interdisciplinary research
3. Engage scientists, policy makers and other stakeholders in global environmental change issues
4. Encourage participation of African researchers in international global change research programs

The GEC Grants Program has evolved in its approach and thematic areas since its inception in 2004. During the initial few years of the program, grant awards supported individual projects, supplemented larger projects, or enabled African researchers to attend international conferences. Beginning in 2007, START and the Pan-African START Committee (PACOM) renewed their commitment to original research projects, thus ending funding to already established projects. In 2010, the GEC Grants Program began to explicitly emphasize interdisciplinary research in response to the increasing interest in collaborative and integrative approaches to address the complex challenges of GEC.

Since 2004, START has supported 105 projects with principal investigators from 24 countries. Over 1,000 proposals have



been submitted for consideration since 2008, which suggests the high level of demand and need for such a program in Africa.

The *Grants for GEC Research in Africa* Program has, to date, involved over 125 institutions in collaborative research amongst African, and between African, European, and North American universities, research institutes, and non-government organizations. Principal investigators (PI) have represented 65 institutions across 24 countries.

Both stakeholder engagement and capacity building are core priorities of the GEC Grants Program. These priorities are met through training of students, workshops with policy makers and other stakeholders that are embedded in the research, and the development of innovative communications materials. In the capacity building realm, the training of students has been integral to the grants program since its inception. Students and other young scientists are involved as research assistants, enabling them to gain the skills in research and fostering a commitment to investigating GEC issues. Since 2004, over 300 students, predominately at the postgraduate level have worked on awarded grants.

Outreach through the GEC Grants Program has been achieved through numerous stakeholder workshops, conferences, and trainings that the investigators themselves have facilitated through their research. During the 2011 grants period alone, approximately 1,000 people were involved in outreach events, such as project workshops and trainings. Other outreach has occurred through production and dissemination of visual and broadcast media, including posters, radio programs, videos, and policy briefs. Recent examples of outreach involved a series of 'weatherman' workshops in Botswana and the development of a monitoring network for North African lagoons, both in 2011.

The outputs from START-supported awards can be found in over 50 peer-reviewed publications in journals such as *Ambio, African Journal of Ecology, Theoretical and Applied Climatology,* and *Journal of Evolutionary Biology.* An additional 50 articles are in preparation or in review from more recent grant recipients. A list of these publications is found on page 57.

RESEARCH HIGHLIGHTS
LAND DYNAMICS

Land use is changing rapidly throughout Africa as population increases, urban areas expand, and land management practices evolve in response to population pressures and urbanization. Insufficient knowledge of these land-change dynamics limits the ability to respond appropriately to these challenges, which could further intensify with future climate change.

The GEC Grants Program enabled African researchers to investigate land dynamics in varied but representative case studies throughout the region. The grant awards supported fundamental research to gather baseline data on the spatial variation and rate of change of land dynamics and its impacts across varying African ecosystems. The research produced through this program has helped to address the gap in knowledge regarding key drivers, processes, and rate of change in land dynamics.

From investigations that spanned the extent of deforestation to the possibilities of agroforestry, this research underscores the importance of monitoring land dynamics to understand natural and human impacts on local and regional ecosystems and the processes occurring within them. Such research increases understanding of local land management practices and potential for mitigating and adapting to environmental change, such as through carbon sequestration and REDD+ programs.

The GEC Grants Program has supported 26 projects on land dynamics in Africa, such as those in the following highlights.

Greenhouse gases, methane and carbon dioxide and the diminishing water resources in Lake Victoria Basin, Kenya

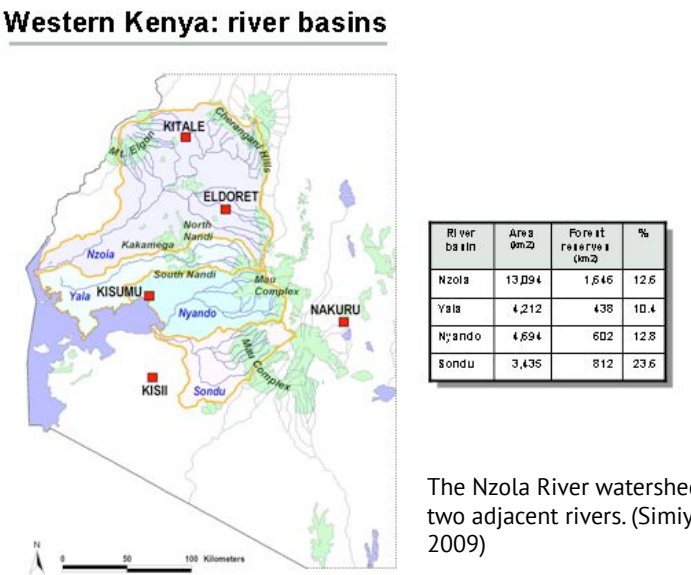
PI- Gelas Muse Simiyu, Moi University, KENYA

The Lake Victoria Basin has differential sensitivities to environmental and anthropogenic drivers. These drivers, such as seasonal fluxes, atmospheric deposition of pollutants, and altered land use, impact biogeochemical processes in the Lake Victoria Basin. However, few researchers have monitored these processes, which leads to uncertainties in the rate of change and regional consequences of change on ecosystems in and around Lake Victoria. PI-G.M. Simiyu and colleagues (2006-M, 2008-K) participated in two grant cycles to assess biogeochemical processes in the Nzoia River watershed that flows into Lake Victoria from the southwestern portion of Kenya.

The researchers sampled multiple sites in the Nzoia watershed,in order to better understand the impact of land cover change and climate change on sediment and nutrient load and greenhouse gas fluxes throughout the watershed. In 2006, they investigated nutrient loading of phosphorous, nitrogen, and sulfur in springwater discharge throughout the catchment. In 2008, Simiyu and colleagues assessed carbon-based atmospheric gases (methane and carbon dioxide) and total organic carbon in over 100 samples throughout the watershed.

Both studies indicated significant impact of anthropogenic drivers, including industrial sites and the use of nitrogen-based agriculture fertilizers. Anoxic conditions of surface waters from increased nutrient loading could lead to two plausible outcomes: increased methane levels in the water and atmosphere which contribute to climate change and the risk of transportation of nutrient-rich sedi-

Background



River basin	Area (km2)	Forest reserves (km2)	%
Nzoia	13,094	1,646	12.6
Yala	4,212	438	10.4
Nyando	4,694	602	12.8
Sondu	3,436	812	23.6

The Nzola River watershed and two adjacent rivers. (Simiyu et al. 2009)

ment deposits to Lake Victoria and leading to an anoxic zone at the mouth in Lake Victoria.

These two grant awards provided opportunities to establish baseline data, which is key for enabling further research on the causes, consequences, and rate of change of such processes. Continued monitoring of biogeochemical processes in Nzoia River will help determine consequences of change on ecosystem and ecosystem services for human use. Local communities in the catchment experience diminished water quality and quantity indicated by the nutrient load and GHG emissions, which is aggravated by increasing populations, deforestation, climate variability, and disposal of poorly treated wastes.

Two other grant awards also conducted research on biogeochemical processes in the Lake Victoria Basin. PI-I. Naigaga (2006-K) assessed methane and nitrous oxide in the wetlands and lagoons of the lake, while PI-V. Madadi (2006-I) studied phosphorus loading in the lakeshores, river mouths, and effluent discharge points along the Kenyan boundary of the lake. In a similar study in the Great Lakes region, PI-J-J. Bagalwa (2005-C) investigated atmospheric deposition of phosphorous and nitrogen composition in Lake Kivu on the border of Rwanda and the Democratic Republic of Congo and PI-T. Ayenew (2005-B) conducted research on the surface and groundwater dynamics in the Ethiopian and Kenyan rift lakes.

Other grant awards assessed water quality and quantity of water sources related to natural and anthropogenic drivers. PI-Totin (2009-P) investigated the impact of climate variability and change and population growth and land cover change, on groundwater dynamics in the coastal sedimentary basin of Benin. PI-E. Ekanem (2004-E) studied groundwater supply in Nigeria based on current water management strategies driven by the drilling of individual and corporate wells. PI-D. Belachew and colleagues (2011-E) explored the linkages between climate change, water resource quality and availability, and agricultural livelihoods in the Main Ethiopian Rift.

Adams, D.D. and G.M. Simiyu. (2009) Greenhouse gas (methane and carbon dioxide) emissions from a tropical river in Kenya: the importance of anthropogenic factors on natural gas flux rates. *Verhandlungen des Internationalen Verein Limnologie*. 30 (6): 887-889.

Simiyu, G.M., J. Ngetich, and T.A. Esipila. (2009) Assessment of spring water quality and quantity, and health implications in Tongaren division, Nzoia River catchment, Kenya. *African Journal of Ecology*. 47 (Suppl. 1): 99-104.

Simiyu, G.M. and D.D. Adams. (2009) Sediment and nutrient transport and groundwater sources in the Nzoia River watershed, Kenya, East Africa. *Verhandlungen des Internationalen Verein Limnologie*. 30 (6): 884-886.

Simiyu, G., T. Esipila, and D.D. Adams. (2009) Seasonal variability in groundwater resources available to rural communities in western Kenya. In: R. Tailor, C. Tindimugaya, M. Owor, and M. Shamsudduha, Eds. *Ground Water and Climate in Africa*. International Association of Hydrological Sciences Ltd (IAHS Press). London. 82-87.

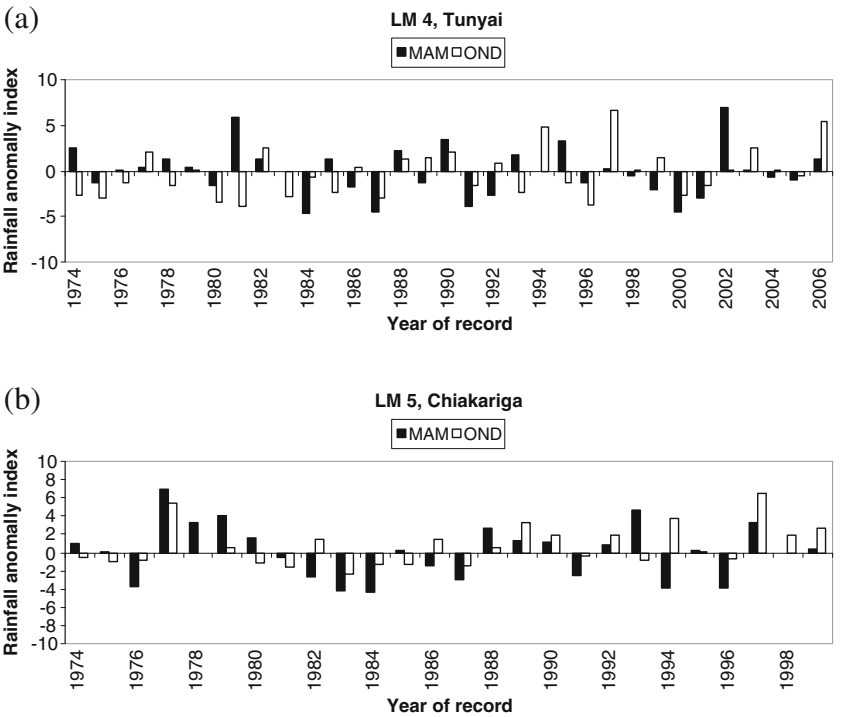
Vulnerability assessment of maize and sorghum crops to climate variability and change in Kenya

PI: Chris Shisanya, Kenyatta University, KENYA

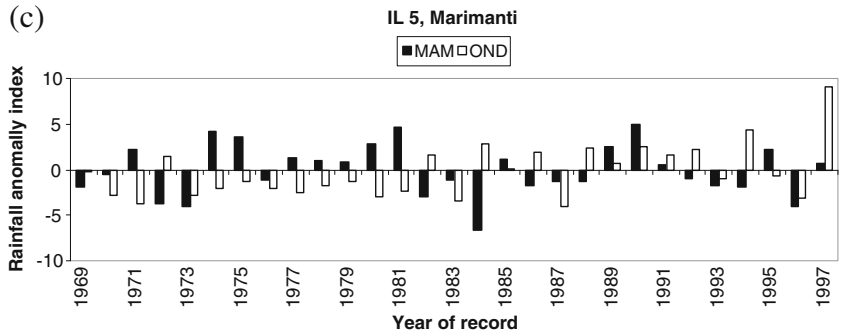
Crop and livestock production in arid and semi-arid lands (ASALs) in Africa contend with quite variable seasonal characteristics of rainfall. PI-C. Shisanya (2004-O) used NDVI and observed climate data to determine the impact of climate variability on crop production in the arid and semi-arid lands of Kenya. Remote sensing for vegetative cover provides data to inform the relationship between seasonal climate variability and crop production.

Two growing seasons occur in Kenya– the long rains of March-April-May (MAM) and the short rains of October-November-December (OND). Shisanya and colleagues explored recent climate variability experienced during these two seasons using observed climate data (Recha et al. 2012) and NDVI calculations (Shisanya et al. 2011).

Their analysis revealed a positive correlation between NDVI and observed rainfall with a one-month peak time lag. A positive relationship between NDVI and crop productivity, in particular maize, was evident during the OND growing season than MAM season. This relationship be-



A time series of rainfall anomaly index at a Tunyai, b Chiakariga and c Marimanti stations in Tharaka district, Kenya. (Recha et al. 2012)



tween short rains, NDVI, and crop productivity can possibly be applied to seasonal forecasts as a predictor of NDVI. Farmers can use the outcomes of this research to anticipate the growing season during the short rains to enable informed decision making on cultivation and use of farm inputs, which has implications for food security and livelihood vulnerabilities under current and future climate variability.

Shisanya, C.A., W. Recha, G.L. Makokha, D.N. Mutisya, J. Okolla, and A. Anyamba. (2005) Exploring the possibility to predict southeast Kenya normalized difference vegetation index (NDVI) using seasonal climate forecast. *European Journal of Scientific Research*. 12 (1): 276-287.

Recha, C.W., C.A. Shisanya, G.L. Makokha, and R.N. Kinuthia. (2008) Perception and use of climate forecast information among smallholder farmers in semi-arid Kenya. *Asian Journal of Applied Sciences* 1 (2): 123-135.

Shisanya, C.A., A. Anyamba, J. Okolla, W.C. Recha, and J. Small. (2010) Climate variability and agricultural production in arid and semi arid Kenya, In: S.P. Saikia, Ed. *Climate Change*. International Book Distributors, India. 218-217.

Recha, C.W., G.L. Makokha, P.S. Traore, C. Shisanya, T. Ladoun, and A. Sako. (2011) Determination of seasonal rainfall variability onset and cessation in semi-arid Tharaka district, Kenya. *Theoretical Applied Climatology*. 108 (3-4): 479-494.

Shisanya, C.A., C. Recha, and A. Anyamba. (2011) Rainfall variability and its impact on normalized difference vegetation index in arid and semi-arid lands of Kenya. *International Journal of Geosciences*. 2: 36-47.

Management of ecosystems services of the forests of southwest Nigeria in support of rural livelihoods and food security

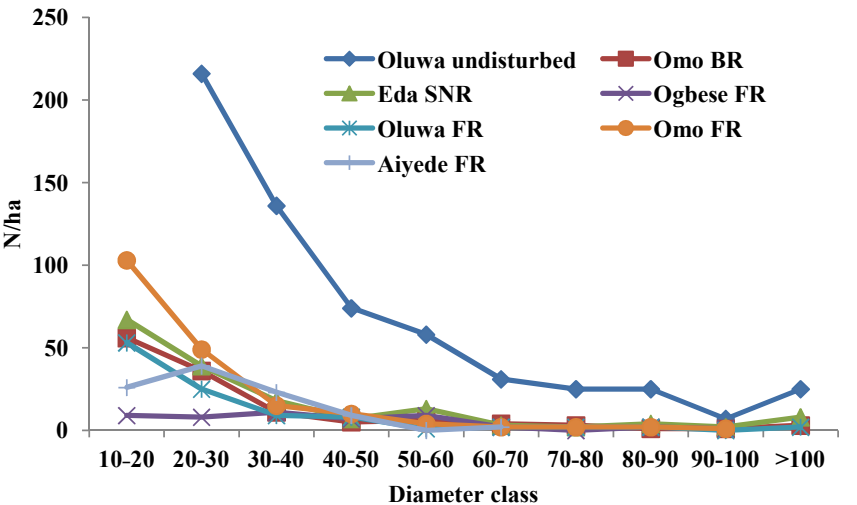
PI- Victor Adekunle, Federal University of Technology, NIGERIA

Tropical forests provide critical environmental services across multiple scales that include local livelihoods, national, and regional development, and global carbon sequestration. Physical variables related to abundance, diversity, and growth, are critical components of the ecosystem services of forests. Data on these components provides a baseline for forest resource monitoring and ecosystem management for best use and maintenance of forest ecosystem services across scales. In 2011, PI-Adekunle and colleagues (2011-A) investigated the status of the tropical forest of southwest Nigeria and the quality and quantity of its services across multiple scales.

In their assessment of seven disturbed and undisturbed forest reserves, Adekunle and colleagues found high species diversity and abundance characteristic of tropical forests. Over 180 species were encountered which belonged to 44 families. Measurements of growth variables revealed the expected inverse J-curve across ten diameter classes; however, this curve was more pronounced in the undisturbed locations (Oluwa undisturbed, Omo Biosphere Reserve (BR), and Eda Strict Nature Reserve (SNR)).

The observed forest measurements were used to estimate contribution of the forest reserve to carbon sequestration. The large diameter class contributed slightly more than half of the total carbon storage across all case study locations. Adekunle and colleagues applied these calculations to validate two models for predict carbon quantities in tropical forest ecosystems.

The measurements of forest abundance, diversity, and carbon content indicate the importance of forest ecosystem services for rural livelihoods in SW Nigeria, given



Diameter distribution curves of the individual selected reserves. (Adekunle et al. 2013, Final Report

the extent to which rural communities depend on the forest for food, firewood, and non-timber forest products. Yet, these ecosystems are increasingly disturbed by poor forest management, including increased logging, which is rampant in SW Nigeria, large scale afforestation projects of exotic species by federal and state governments, and the need for more farm land to accommodate food demand from a rapidly growing population. This disturbance has implications for the global carbon cycle, especially because loggers target the largest trees, which have the most sequestration potential. Thus, Adekunle and colleagues recommended the Nigerian government improve forest monitoring and management through capacity training and awareness raising among forest officers and local communities.

Other similarly focused grant awards have assessed the rate of change on carbon stocks, including biomass and soil organic carbon. Two grants considered carbon management in different land use. PI-A. Lufafa (2006-G) investigated the impacts of agriculture and grazing in carbon management in the cattle corridor of Uganda, while PI-M. Majaliwa (2007-G) completed a field study of above and below ground biomass of different land covers around Lake Tanganyika Basin in D.R. Congo. PI- Getachew Testafaye Abebe (2006-A) and PI-O. Faboye (2007-E) measured the carbon load in both plants and soils of dry tropical forests of Ethiopia and Nigeria, respectively, to understand the importance of these forest regions to the global carbon pool.

Other grant awards focused on carbon sequestration potential. PI-G. Ajonina and colleagues (2011-B) argued that carbon stock management through agroforestry can support global REDD+ initiatives to reduce atmospheric carbon and mitigate climate change. PI-J. Tukahirwa (2004-P) estimated the carbon sequestration potential of sustainable land use systems in southwestern Uganda. PI-C. Mbow (2008-F) led a multi-day training workshop with participants from Mali, Burkina Faso, Ghana, and Senegal to learn techniques for field research to measure carbon stocks. Each country team completed their own practice survey in their country and the collectively results indicated that the measurement of carbon sequestration depends on the methods and calculations used.

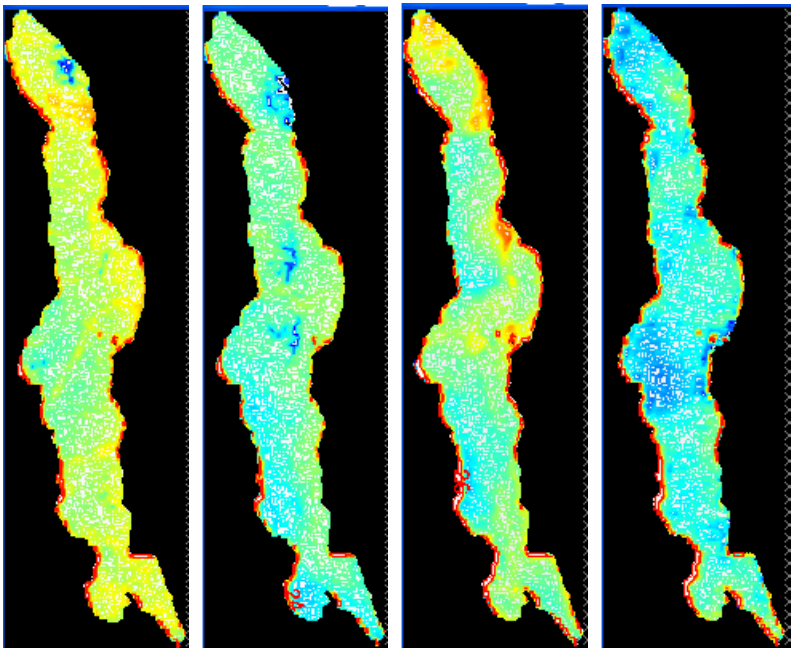
Development of remote sensing tools to improve understanding and management of Lake Malawi and other African Rift Valley lakes

PI: Geoffrey Chavula, University of Minnesota and University of Malawi (The Polytechnic), MALAWI

Lake Malawi contains rich fisheries that provide over 70 percent of the protein for populations near the lake. However, land degradation through changes in agricultural practices and deforestation is affecting the health of the lake, in particular through increasing eutrophication in critical areas. Field studies on or near the lake offer only a limited assessment of the health of the lake. In an effort to understand the overall dynamics of Lake Malawi, PI-G. Chavula (2006-C) used Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery to develop algorithms to estimate lake surface temperature, chlorophyll-a concentration, and land use change throughout the lake system.

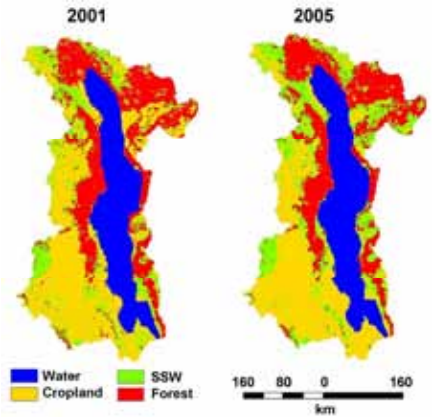
In a resulting article, Chavula et al. (2009) explained that chlorogphyll-a values obtained from satellite imagery confirmed the oliogotrophic state (low levels of nutrients and high oxygen content) of the Lake. In two articles produced through this research, Chavula and colleagues (2009; 2012) showed that temperature distribution of Lake Malawi maintained seasonal fluctuation, including a cooling period from May to October attributed to the strong southeast trade winds, called Mwera winds; however, there is a consistent cold zone along the south central portion of the western shore of the Lake.

Chavula and colleagues also investigated land use changes occurring around the Lake and its implications for sur-



Temperature distribution maps for Lake Malawi, MOD11A1 imagery. (Chavula et al. 2009)

face runoff, using MODIS imagery classified into four land-use and land-cover (LULC) categories. The Lake Malawi Basin is experiencing an increase in savanna, shrubs, and woodland (SSW). Yet, forests have experienced the most significant decrease due to agricultural expansion, especially for maize and tobacco production. The conversion to cropland has the potential to increase the lake level through increased runoff. This research has helped to inform the management of fisheries by the government and the possibilities for economic development from fish exports, thus creating opportunities for research to directly inform action for fisheries management and community livelihoods.



Distribution of the four LULC classes in Lake Malawi basin from MODIS imagery for (a) 2001 and (b) 2005. (Chavula et al. 2011)

Chavula, G., P. Brezonik, P. Thenkabail, T. Johnson, and M. Bauer. (2009) Estimating chlorophyll concentration in Lake Malawi from MODIS satellite imagery. *Physics and Chemistry of the Earth* 34: 755–760.

Chavula, G., P. Brezonik, P. Thenkabail, T. Johnson, and M. Bauer. (2009) Estimating the surface temperature of Lake Malawi using AVHRR and MODIS satellite imagery. *Physics and Chemistry of the Earth* 34: 749–754.

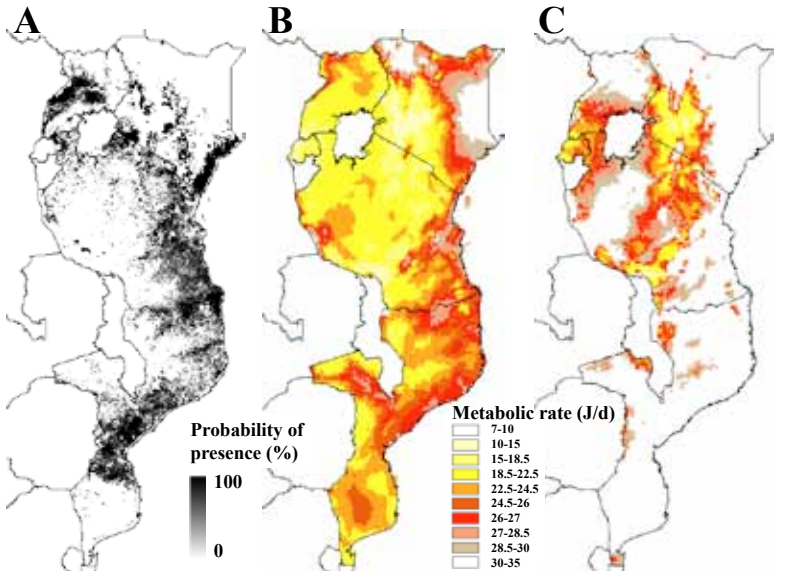
Chavula, G., P. Brezonik, and M. Bauer. (2011) Land use and land cover change (LULC) in the Lake Malawi drainage basin, 1982-2005. *International Journal of Geosciences*. 2: 172-178.

Chavula, G., H. Sungani, and K. Gondwe. (2012) Mapping potential fishing grounds in Lake Malawi using AVHRR and MODIS satellite imagery. *International Journal of Geosciences*. 3: 650-658.

Physiological responses of tsetse flies, vectors of trypanosomiases to simulated climate change: implications for prediction, management and control

PI: John Terblanche, Stellenbosch University, SOUTH AFRICA

Understanding how climate change may influence the dynamics of vector-borne diseases is important for developing appropriate responses over time and space. Research supported by the GEC Grants Program in 2009 allowed PI-J. Terblanche and E. Kleynhans (2009-O) to study how the water balance physiology of the Tsetse fly (*Glosina* spp.), which vectors Trypanosomiasis (Human Sleeping Sickness) and Nagana, an animal form of Trypanosomiasis, is affected by environmental conditions and how these water balance traits may be influenced by climate change. A key facet the researchers sought to understand was how the species range and disease transmission of *G. pallidipes*, which is present throughout southern and eastern Africa, could be affected by changes in temperature and humidity under future climate change.



(A) Known current G. pallidipes probability of presence estimates by Wint and Rogers (2000) and the mechanistic model predictions (B–C) of metabolic rate (J/d) under current (B) and future (C) climate scenarios where the optimum metabolic rate is given in red. The NicheMapper simulation results represents a predicted metabolic rate of *G. pallidipes* under the current climatic conditions (B) given from WorldClim (1960 – 2000) and the HadCRUT A2a global climate change scenario for 2080 (C) at a spatial resolution of 2.5 arc–minutes. (Terblanche and Kleynhans 2011, Final Report)

The researchers began their investigation by examining water loss rates of *Glosina* species under varying conditions of temperature and humidity, and showed that there is high variation in response to these variables within and among species, sub–groups and ecotypes of the tsetse fly. They used the NicheMapper model to examine how the range and disease transmission of *G. pallidipes* would change under an A2a emissions scenario compared with the current climate.

Their findings indicated that the habitat suitability for *G. pallidipes* would generally decrease under future climate change but that reproductive rates, where the fly remains prevalent, would increase nearly two-fold due to increased metabolic rates under warmer conditions. This increase in optimum metabolic conditions could lead to as much as a 3-fold increase in *Trypanosoma vivax* disease to cattle in Tanzania and Uganda.

Terblanche and Kleynhans' work has implications for long-term tsetse fly management in that future range shifts and areas of high prevalence can be identified and control efforts concentrated to potentially smaller areas. The researchers cautioned, however, that the large variability across *Glosina* species in response to changes in temperature and humidity requires species–specific information if water balance physiology is incorporated into mechanistic models for prediction of climate change influences on the tsetse fly.

The GEC Grants Program has supported other similar work related to climate influences on insect behavior and population dynamics. PI-M. McLeish (2008-G) investigated fig-wasp pollination of fig trees and PI-H. Talwana (2009-N) studied the impact of climate change on parasitic nematodes affecting banana production in East African highlands. PI-F. Babeweteera and colleagues (2011-D) explored insect pollinator assemblages in different forest types, while PI-J. Kyomo (2008-E) used benthic microinvertebrate assemblages as a predictor of water quality.

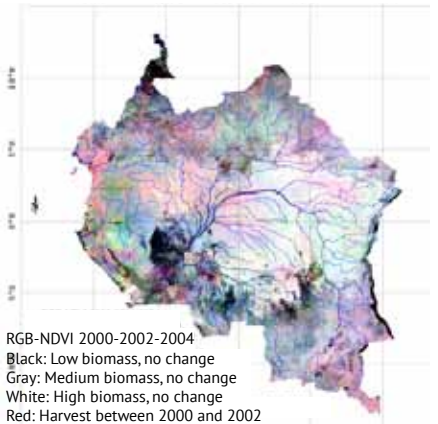
Terblanche, J.S. and E. Kleynhans. (2009) Phenotypic plasticity of desiccation resistance in *Glossina puparia*: are there ecotype constraints on acclimation responses? *Journal of Evolutionary Biology*. 22: 1636-1648.

Kleynhans, E. and J.S. Terblanche. (2011) Complex interactions between temperature and relative humidity on water balance of adult tsetse (*Glossinidae, Diptera*): implications for climate change. *Frontiers in Physiology*. 2: 74.

Mapping deforestation rates and carbon fluxes in the Congo Basin Forest using multi-date SPOT-VGT imagery for 1999 to 2003

PI: Donatien Njomo, University of Yaounde I, CAMEROON

Deforestation through logging and slash and burn agriculture significantly affects the ecosystem of the Congo Basin, the second largest continuous tropical forest in the world after the Amazon Basin.



RGB-NDVI 2000-2002-2004
Black: Low biomass, no change
Gray: Medium biomass, no change
White: High biomass, no change
Red: Harvest between 2000 and 2002
Green: Harvest before 2000, regrowth by 2002 and then harvest between 2002 and 2004
Blue: Harvest before 2000, regrowth by 2004
Yellow: Harvest between 2002 and 2004
Magenta: Harvest between 2000 and 2002, regrowth by 2004
Cyan: Harvest before 2000, regrowth by 2002

RGB-NDVI change detection in the Congo Basin forest for the years 2000, 2002 and 2004 with the colour legend used to depict changes in forest cover. (Njomo 2008)

Comprehensive estimates of deforestation and land use change can inform management of the Congo Basin at the local, national, and regional level. PI-D. Njomo (2004-J) used a normalized difference vegetation index (NDVI) analysis of SPOT-VEGETATION S10 imagery to assess land use change for the entire Congo Basin.

Njomo investigated land cover change over the period January 2000 to December 2004 in order to produce a composite vegetation map of change over time, published in Njomo (2008). Eleven classes were applied to annual NDVI composites in the years 2000, 2002, and 2004.

This project demonstrated the usefulness of remote sensing imagery for determining land use change through vegetation classification. Njomo explained that such projects for the Congo basin provide timely information on the location and extent of deforestation, indicate spatial variation of deforestation patterns, and inform analysis of biomass and CO2 flux, with implications for carbon sequestration.

Other grant awards classified and validated vegetative ecosystems. PI-R. Lumbuenamo (2006-I) detected land use change using Landsat and ASTERS imagery for two study sites within the Congo Basin. PI-M. Messouli and colleagues (2010-A) classified and validated vegetative ecosystems throughout Morocco using Moderate Resolution Imaging Spectroradiometer-MODIS data to generate vulnerability and risk levels for ecosystems and various land cover changes.

Njomo, D. (2008) Mapping deforestation in the Congo basin forest using multi-temporal SPOT-VGT imagery from 2000 to 2004. *EARSeL eProceedings 7*.

RESEARCH HIGHLIGHTS
LIVELIHOODS & ENVIRONMENTAL CHANGE

Africa currently experiences tremendous impacts from environmental change, including climate change. Important livelihoods, including farming, pastoralism, and fishing, will face greater pressures in the coming decades as population growth and climate change effects intensify. Yet, Africans are not passive victims to present and future environmental change. Individuals and communities maintain local knowledge, practice land management strategies, and already cope and adapt to climate variability and change.

Research on livelihoods reveals the successes, challenges, and opportunities to manage and adapt to environmental change. Such research is rapidly growing in Africa, and is providing a more comprehensive overview of the causes and consequences of environmental change as perceived and realized by local community members and other stakeholders. African-led research on livelihoods provides a culturally sensitive approach to the experiences of environmental change and possibilities for recommendations and outreach to support informed action. Research on livelihood strategies and perceptions of change helps to match information with decision needs.

START's GEC Grants Program supported 12 projects that explore the relationship between livelihoods and environmental change. The research considers the linkages between physical drivers of change and people's perceptions of change and its affect on their livelihoods. This research informs how people can learn about and further manage and adapt to future environmental change.

Integration of indigenous knowledge systems in adapting to climate change and enhancing food security among the Kalenjin community of Rift Valley, Kenya

PI- Emmanuel Chessum Kipkorir, Moi University, KENYA

Local communities have a wealth of knowledge about climate risks that helps them to monitor agricultural practices and serves as early warning systems for hazards. However, the changing climate challenges the accuracy and usefulness of established local knowledge. START grantees have documented this knowledge to determine its usefulness for managing climate risk, such as food insecurity, drought, and floods, and uncover possibilities for integrating local practices with more scientific approaches.

In 2009, PI-E.C. Kipkorir (2009-C) completed a participatory research project in two districts in Western Kenya that identified local knowledge practices for monitoring the weather and climate and ensuring food security. In a chapter published from this project, Songok et al. (2011) listed the various climate indicators identified in surveys and focus group discussions. The indicators included observing the behavior and characteristics of flora and fauna and attention to wind patterns to help predict appropriate timing for planting crops, harvesting, and storage. Examples of these observations include blowing of east winds, clouds thickening on the horizon, and flowering of the flame tree.

Yet the changing climate patterns have affected the reliability of local knowledge in the case study areas. Shifts in seasonality, duration, and intensity of rainfall have led to altered timing of crop production and intensified pests and crop and livestock disease, thus impacting food security. Participants suggested that their local practices are increasingly unreliable and need to be supplemented by scientific approaches, such as access to a diversity of seeds. The challenge is to integrate these two knowledge systems to better ensure food security under climate risk.

In similar studies, two projects, PI-B. Dovie (2008-C) and PI-O. Fabiyi and colleagues (2011-G), investigated how rural communities forecast flood events, for dryland systems in Ghana and coastal systems in Nigeria, respectively. Both projects concluded that local knowledge of flooding was useful but inadequate for forecasting flood events, thus requiring integration with modern techniques, such as weather monitoring and flood disaster management. Similarly, PI-E. Liwenga (2006-F) completed a study in the southern highlands of Tanzania using participatory approaches to understand community attributes and experiences of climate variability and change.

Songok, C.K., E.C. Kipkorir, and E.M. Mugalavai. (2011) Integration of indigenous knowledge systems into climate change adaptation and enhancing food security in Nandi and Keiyo Districts, Kenya. In: W.L. Filho, Ed. *Experiences of Climate Change Adaptation in Africa: Climate Change Management*. Springer Berlin Heidelberg. 69-95.

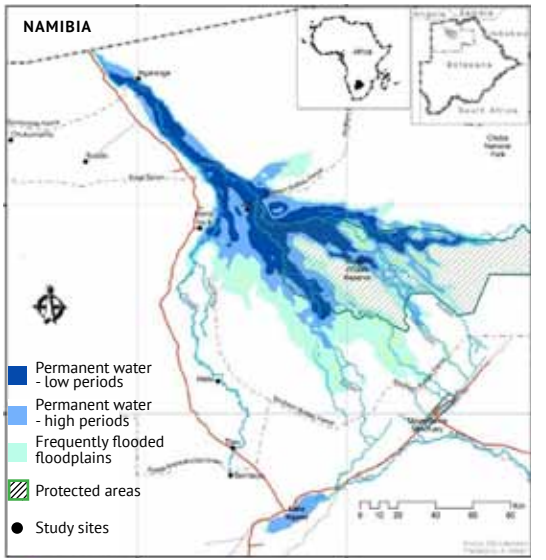
Engaging farmers and climatologists in adaptation to climate variability and change in the Okavango Delta of Botswana

PI- Oluwatoyin Kolawole, Okavango Research Institute, BOTSWANA

Confronting the complexity of climate change and its impacts on livelihoods requires recognition of scientific and local knowledge. Farmers have rich knowledge about weather and climate to navigate their farming practices, while farmers' access to scientific information such as weather forecasting is slowly increasing. However, the ways that these knowledge streams are perceived and integrated remains poorly understood, which has implications for communication towards action to manage current and future weather and climatic change. In 2011, PI-O. Kolawole and colleagues (2011-I) investigated the perceptions of local and scientific knowledge about weather and climate by farmers and local scientists in Ngamiland of northwestern Botswana.

Through nearly 600 farmer surveys, Kolawole and colleagues found that farmers perceived their local knowledge as more effective than scientific information, with older farmers (not surprisingly) favoring local knowledge and younger farmers being more receptive to scientific knowledge.

Kolawole and colleagues used the same questionnaire about perceptions of local and scientific knowledge with 18 weather scientists. The weather scientists recognized local knowledge as inclusive, but only two had worked with farmers and other local people to share weather monitoring approaches and weather and climate information such as seasonal forecasts.



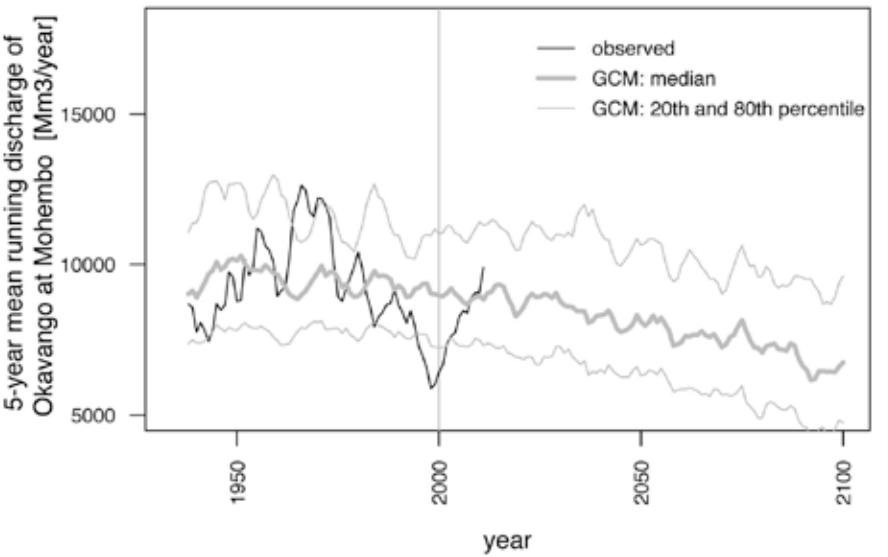
Community members and weather scientists dicuss weather and climate indicators during a "weatherman's workshop". These workshops help farmers to better understand recent changes and weather patterns. (Kolawole et al. 2012, Final Report)

The impact of environmental change on ecosystem services supporting human livelihoods: the case of Okavango River channel flows and Boteti River, Botswana

PI- Gagoitseope Mmopelwa, Harry Oppenheimer Okavango Research Centre, BOTSWANA

The river channels of the Okavango Delta provide critical ecosystem services for various livelihood activities. In recent years, these river channels have experienced increased dessication, either seasonally or permanently, and hydrological models of the Delta suggest decreased levels of terminal river flow under climate change. In 2010, PI-G. Mmopelwa and colleagues (2010-C) investigated the possible impact of future dessication of the Okavango Delta under climate change on local livelihoods.

Dessication in the Okavango Delta is a natural occurrence driven by tectonic movements or blockages of channels from sediment and vegetation. Rural



Five-year running averages of Okavango River discharges at Mohembo, observed and simulated, 20th, 50th and 80th percentile of inter-GCM range. (Mmopelwa et al. 2011, Final Report)

households within the area have managed the variability of the waters; however, current socio-economic drivers, including rapid population growth and land use change due to restrictions, will challenge household adaptive capacity, further exacerbated by future climate change.

In a survey of three villages, dessication was found to most severely affect flood-recession farming, or *molapo* farming, livestock farming, and provisioning of plant products for food and construction material. Livelihood diversification has been a primary adaptive strategy with increasing periods of dry rivers. For example, some households are shifting their livelihoods to dryland agriculture because of dessication and other land use changes. However, dryland farming produces lower yields, especially during poor rainy seasons. Barriers may limit the ability to diversify livelihoods in periods of dessication, such as increasing population, lack of communal land, and further regulations on access to environmental resources.

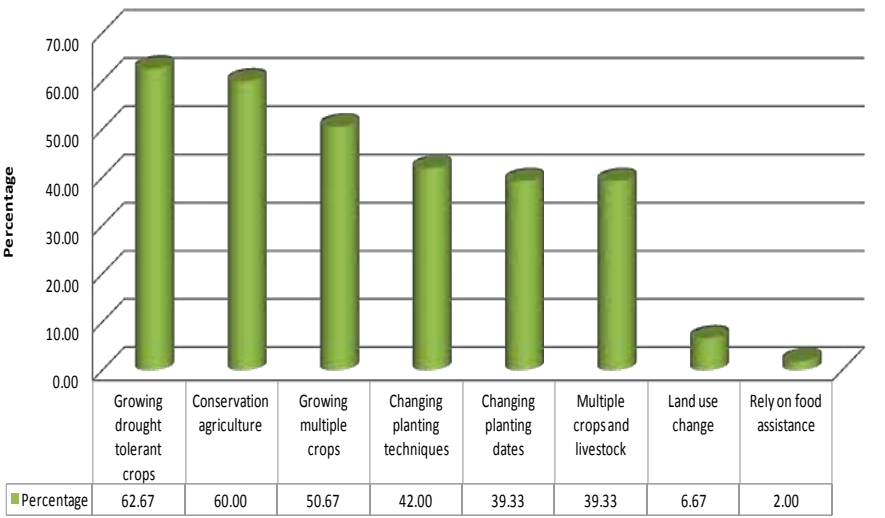
Climate change adaptation for rural communities dependent on agriculture and tourism in marginal farming areas of the Hwange District, Zimbabwe

PI-Charles Nhemachena, Council for Scientific and Industrial Research, ZIMBABWE

Community-based adaptation (CBA) research provides insights into current coping strategies, possible future adaptations, and the limits to coping and adaptation. In 2011, PI-C. Nhemachena and colleagues (2011-L) completed CBA research in the Hwange District of Zimbabwe to identify vulnerabilities, explore perceptions of climate change adaptation, and distinguish key community interventions and recommendations for adaptation actions.

Communities in the Hwange District participated in crop agriculture, livestock rearing, forest-based livelihoods (ie. logging), and tourism. This diversity of livelihoods is impacted by climate variability, which could potentially continue under future climate change. Respondents from three communities already recognized changes in the amount and timing of precipitation over the past years, which result in increased food insecurity, especially amongst poor respondents. With acute awareness of possible climatic changes, communities have identified several current and desired adaptation options. The majority of these adaptation options focused on agricultural crop activities, which are classified as increased diversification and protection of sensitive growth stages to avoid mid-season drought.

However, respondents identified limits to adaptation that increase their vulnerability and reduce their adaptive capacity. Lack of knowledge was recognized as the primary limit, despite the observations of climatic change. Poor policy support was mentioned as another limit, attributed to the poor awareness of local and national



	Growing drought tolerant crops	Conservation agriculture	Growing multiple crops	Changing planting techniques	Changing planting dates	Multiple crops and livestock	Land use change	Rely on food assistance
Percentage	62.67	60.00	50.67	42.00	39.33	39.33	6.67	2.00

Crop related strategies used by communities to cope with climate change. (Nhemachena et al. 2012, Final Report)

policy and institutional frameworks to support adaptation. Nhemachena and colleagues argued that clarifying these limits provides entry points for supporting local communities in adaptation actions; however, they should be mainstreamed into other developmental programs that address more pressing challenges like food security.

In a similar study, PI-H. Mloza-Banda and colleagues (2010-B) found that Malawian farmers used agriculture technologies and techniques, such as water harvesting mechanisms, intercropping, and conservation agriculture, to improve crop productivity under climate variability and land degradation. PI-Y. Osei-Owusu and colleagues (2011-M) determined several opportunities for supporting Ghanaian households in responding to climate variability and change, including farmer to farmer extension, weather monitoring, radio announcements, and off-farm income generating activities. PI-J. Wasige and colleagues (2011-P) worked with communities in Rwanda and Uganda near Lake Victoria to develop community action plans based on current and possible future adaptation strategies.

Poor soils and changing rainfall patterns are affecting food security in the Hwange District. Farmer Melusi Ndlovu-Kampisi and co-investigator Reneth Mano survey conservation agriculture as a livelihood response to these challenges. (Nhemachena 2012, Final Report)

Community-based management of ecosystems and natural resources for the improvement of rural livelihoods and food security in the Nigerian savannah

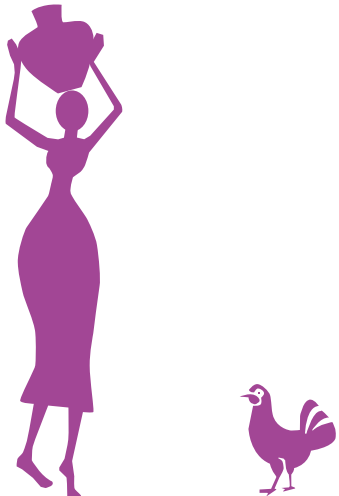
PI-Mayowa Fasona, University of Lagos, NIGERIA

Many rural livelihoods depend on the sustainability of natural resources, and thus require management strategies that strike a balance between use and conservation of ecosystem services. Natural resource management is shaped by community members' perceptions of the ecosystem and its services and the policies and programs established by government or other organizations that enable or constrain resource management. Few studies have captured the relationships between community perceptions and policy practices for natural resource management in Africa. In 2011, PI-M. Fasona and colleagues (2011-H) used an interdisciplinary approach to investigate the linkage between policies and experiences of rural communities of resource management in the Nigerian savannah.

An assessment of Nigerian national policies and programs on natural resource management and rural livelihoods revealed thorough and sympathetic policies for community-based management. However, interactions with communities indicated a failure to implement such well articulated programs. The government lacked the capacity and the government-community partnership to sustain past management projects.

Fasona and colleagues worked with participants to identify recommendations for alternative livelihoods and agricultural practices to improve their livelihoods in conjunction with government policy and programs. Recommendations included forest management through private and community woodlots for charcoal and firewood, the local use of solar energy, planting of threatened plant species with seedlings provided by government or other organizations, and silviculture on government provided land.

A similar study by PI-P. Munishi (2008-I) identified the various government and non-government organizations involved in supporting climate change response and adaptation initiatives in semi-arid central Tanzania. A plethora of organizations, including government programs, non-government organizations, and financing organizations, are involved in climate change adaptation initiatives for agriculture development in particular; however, long term mitigation options are largely overlooked.



RESEARCH HIGHLIGHTS
CLIMATE SYSTEM

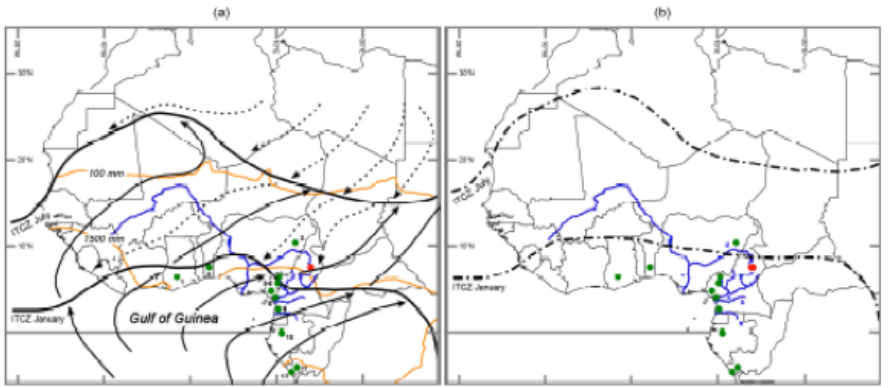
The African climate system is characterized by complex local and regional dynamics. Local to regional processes over Africa that shape the climate regime remain poorly understood, and there are significant capacity and resource gaps in climate monitoring systems as well as in climate modeling. START support has enabled African-led research on the climate system and in doing so has helped to address the lack of access to robust datasets, training, technology, and other resources.

The GEC Grants Program has involved nine projects on the climate system throughout Africa. Grants awarded through the program supported investigations of past, present, and future climate dynamics. Paleoclimatology research was an important emphasis in the initial years of the program, leading to studies that reconstructed climate records from the Quaternary period to the past 100 years. Climate modeling projects supported through this program validated a range of key parameters that characterize the complex climate system and used the validated models to project future change. Important findings of the climate system research are highlighted below.

Climate changes across West and East Africa during the Holocene

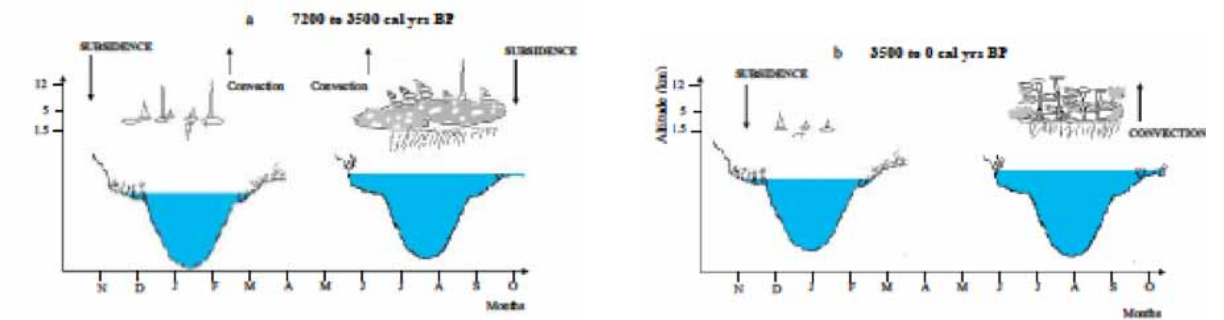
PI: Victor François Nguetsop, University of Dschang, CAMEROON

The West African climate system underwent significant changes during the most recent deglaciation of the northern hemisphere. PI-V.F. Nguetsop (2008-J) received a grant from START to examine the evidence for such changes in Northern Cameroon. During the field campaign, he obtained water, sediments, planktonic, and epiphytic algae samples and many sediment cores from two lakes in the Adamawa plateau region of northern Cameroon to analyze fossil diatoms and sedimentary carbon isotopic records and distil information on ambient conditions.



Map showing the (a) modern positions of Intertropical Convergence Zone (ITCZ) during the northern summer (ITCZ July) and northern winter (ITCZ January). The solid arrows represent the monsoon flux while dotted arrows represent the NE trade winds (Harmattan) (Leroux, 2001). Orange full lines represent isohyetal lines 1500 mm and 100 mm (New et al., 2000). Colored dots correspond to sites where paleorecords (green dots) are available: 1 - Bosumtwi, 2 - Sele, 3 - Tilla, 4 - Djupi, 5 - Shum Laka, 6 - Bambili, 7 - Barombi Mbo, 8 - Ossa, 9 - Nyabessan (Ntem River), 10 - Nguene, 11 - Sinnda, 12 - Kitina and Mbaland (red dot). (b) Possible position of ITCZ before 3600 cal yr BP inferred from diatom and 8^{13} C isotopic data. Rivers of the Gulf of Guinea: Ntem (a), Nyong (b), Sanaga (c), Benoue (d) and Niger (e). (Nguetsop et al. 2011)

In a published journal paper, Nguetsop et al. (2011) illustrated past limnological conditions of Lake Mbalang and watershed vegetation type reconstructed from diatoms and sedimentary stable carbon isotope records since 7200 years BP. These stable conditions that predominated between 7200 and 3500 years BP are evidence of a strong monsoon and relatively northern position of the intertropical convergence zone (ITCZ) and related increased rainfall that enabled development of mountainous forest taxa during this period. However, after 3500 years BP, the full water column became quite mixed as a result of more intense northeast trade winds, associated Harmattan wind conditions and reduced rainfall, conditions which favored establishment of savannah landscapes at around 3000 years BP. A strong seasonality with a marked dry season was established during that period, which persists to present day.



Sketch of atmospheric features (clouds cover and air movement) and relative modifications of Lake Mbaland level, in the dry season (January) and rainy season (August) before 3500 cal yr BP (a) and afterwards (b). Before 3500 cal yr BP, stratiform cloud cover were abundant, convective cloud are dominant after 3600 cal yr BP. (Nguetsop et al. 2011)

The primary implication of this project is that climatic conditions across millennia over the northern Cameroon region are consistent with the changes in the ambient monsoon seasonality caused by changes in the incoming solar radiation due to orbital variations.

Two other grant awards used similar sedimentary records from lakes to compile a climate reconstruction and assess the hydrology and hydrochemistry of the lake system. PI-S. Kebede (2004-G) used sedimentary archives of the last 2000 years from three Ethiopian lakes to construct climate and lake-groundwater relations. PI-A. Benkadduor (2005-D) investigated sediment cores from the remote lakes of the Moroccan mountains to reconstruct the paleoclimate and determine past lake levels and salinity. In another project, PI-Y. Shagude (2009-M) extensively analyzed a marine sediment core obtained in the coastal zone of Tanzania in East Africa to show that the near coastal zone of East Africa is a potential sink for carbon.

Nguetsop, V.F., I. Bentaleb, C. Favier, C. Martin, S. Bietrix, P. Giresse, S. Servant-Vildary, and M. Servant. (2011) Past environmental and climatic changes during the last 7200 cal yrs BP in Adamawa plateau (Northern Cameroun) based on fossil diatoms and sedimentary carbon isotopic records from Lake Mbalang. *Climate of the Past*. 7: 1371-1393.

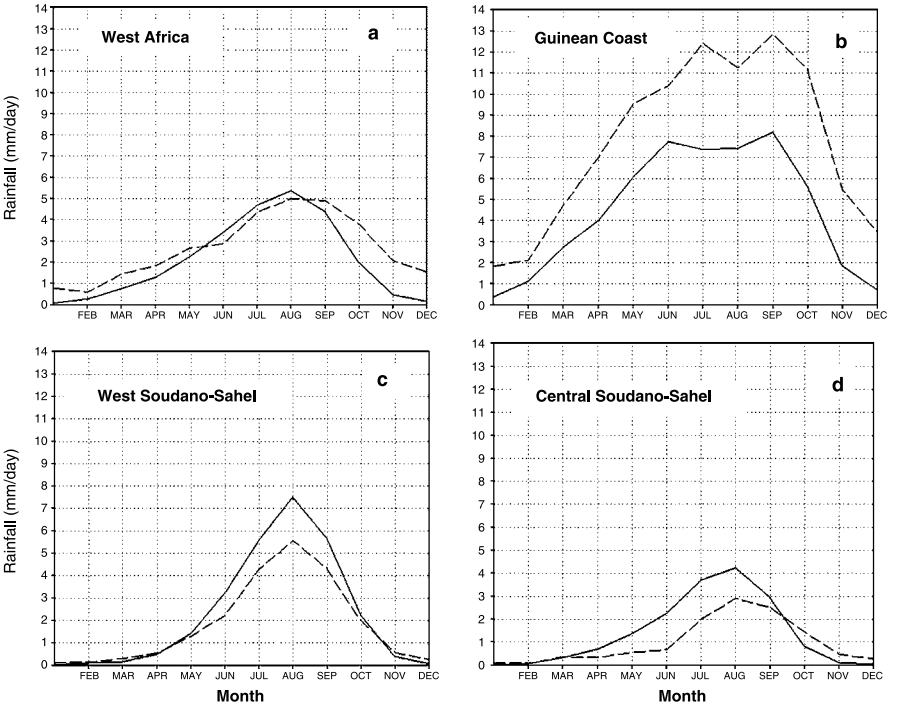
Nguetsop, V.F., I. Bentaleb, C. Favier, S. Bietrix, C.Martin, S. Servant-Vildary, and M. Servant. (2013) A late Holocene palaeoenvironmental record from Lake Tizong, northern Cameroon using diatom and carbon stable isotope analyses. *Quaternary Science Review*. 72: 49-62.

Simulation of West African climate variability and change with an adapted regional climate model

PI-Ernest A. Afiesimama, Nigerian Meteorological Agency, NIGERIA

The GEC Grants Program has supported several projects that validated and modified parameters of the International Centre for Theoretical Physics (ICTP) Regional Climate Model version 3 (RegCM3) for West Africa. West Africa, especially the Sahelian region, has a complex monsoon regime whose dynamics and variability is related to the incursions of the intertropical convergence zone (ITCZ) and the intensity of the upper level tropical westerly jet. An international research program called African Monsoon Multidisciplinary Analysis (AMMA) under the auspices of the World Climate Research Programme (WCRP) has focused collaboration between African and northern scientific communities to investigate the dynamics and variability of the climate system in West Africa. START has supported research of a number of African AMMA scientists highlighted below.

In 2005, PI-E.A. Afiesimama (2005-A) evaluated the impact of land cover on the mean state and interannual climate variability in the region over a 10-year period (1981-1990) in Guinea Coast, West Soudano-Sahel, and Central Soudano-



Monthly mean preceipitation (mm/day) pattern over West Africa and the three subdivided zones for 1981-1990 (solid lines: observation, dashed lines: model simultation). (Afiesimama et al. 2006)

Sahel zones. The research focused on examining impacts of land cover change on surface temperature, rainfall, and prevailing wind. In their resulting article, Afiesimama et al. (2006) assessed the validity of RegCM3 model for three climate variables – precipitation, temperature, and wind - across the three zones at annual and seasonal time scales.

Afiesimama et al. (2006) found the RegCM3 models reasonably represented averaged rainfall over the three zones. Based on these results, Afiesimama and colleagues concluded that RegCM3 models could simulate climate variability and other physical processes, such as land cover change, in the region. Once RegCM3 was confirmed to adequately simulate the annual cycle of West African Monsoon, Afiesimama and colleagues used the validated model to explore the impact of land cover change on the monsoon. In related research, Abiodun et al. (2008) described how reduced vegetative cover through deforestation and desertification and the linkage to soil moisture can help explain the dry period in West Africa throughout the 1980s. They simulated vegetation for the summer rainfall from July-August-September as the control to determine the moisture budget, including evapotranspiration, soil moisture, and rainfall, for a 10 year time period (1981-1990).

Afiesimama, E.A., J.S. Pal, B. J. Abiodun, W.J. Gutowski Jr., and A. Adedoyin. (2006) Simulation of West African monsoon using the RegCM3. Part I: Model validation and interannual variability. *Theoretical and Applied Climatology*. 86: 23-27.

Abiodun, B.J., J.S. Pal, E.A. Afiesimama, W.J. Gutowski, and A. Adedoyin. (2008) Simulation of West African monsoon using RegCM3 Part II: impacts of deforestation and desertification. *Theoretical and Applied Climatology*. 93: 245-261.

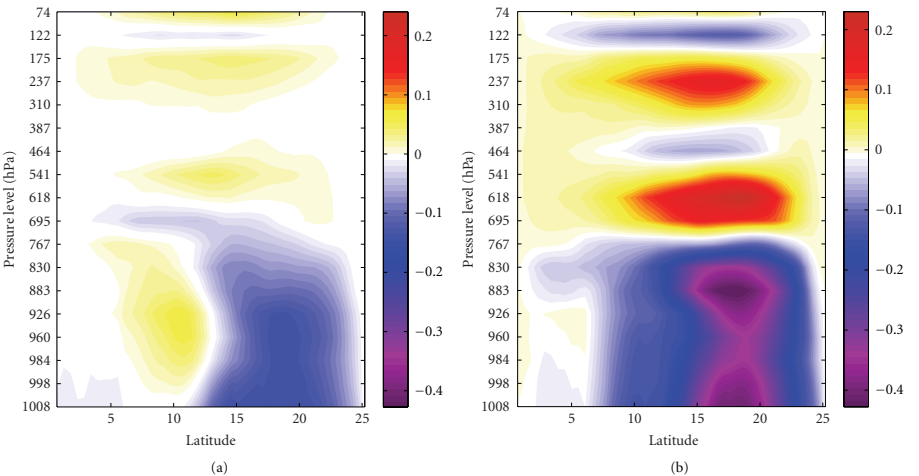
Climatic feedback of dust and biomass burning aerosol over West Africa

PI-Abdourahamane Konare, Université Cocody, COTE D'IVOIRE

Africa produces a significant amount of aerosols that affects geochemical processes and the climate system. The Sahara-Sahelian zone of West Africa is particularly rich in aerosols, both mineral and carbonaceous (black carbon and organic carbon). These aerosols result from natural as well as human causes, including population demographics and related deforestation, across the diverse land cover regimes comprising desert, maritime, and urban zones (Touré et al. 2012). While regional climate models include aerosols as a key parameter for assessing the influence of dust lofted across the Sahel on the climate system, a validation between observed aerosol inventories and regional climate simulations is an essential research task. The GEC Grants Program supported a group of scientists in the Ivory Coast, Niger, and Ghana to work with French and Italian researchers to validate a regional climate model (RegCM) to understand the aerosol loads and transport across West Africa[1].

In their first of two START grants, Konare and colleagues (2006-E) parameterized a specialized carbonaceous aerosol module of RegCM3 model with two emissions inventories. The emissions inventories are differentiated by their biomass burning sources, seasonal emphasis, and spatial heterogeneity; however, their monthly totals for West Africa follow a similar pattern. The RegCM3 model was run using both emissions inventories and compared with MODIS satellite observations to validate the aerosol module for aerosol optical thickness.

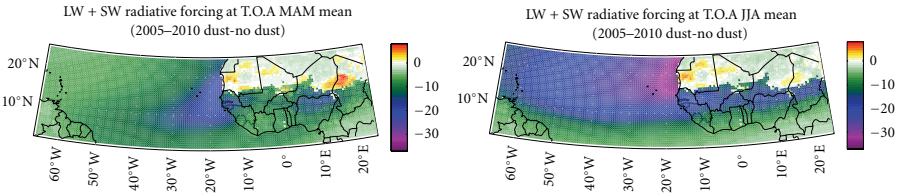
Meridian vertical profile of dust effect on termperatures in °C, averaged between 60°W and 23°E during the periods (a) MAM and (b) JJA. Cooling is indicated with cool colors while warming with hot colors. (Touré et al. 2012)



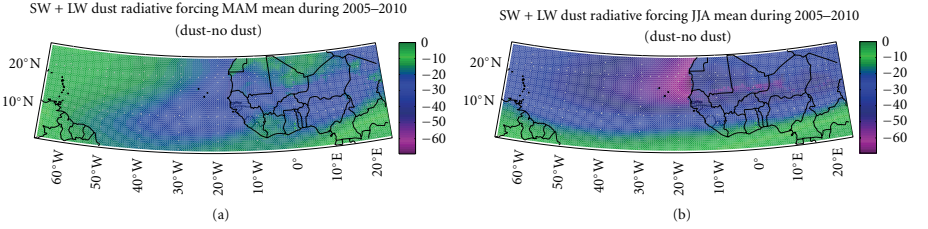
In 2009, Konare and colleagues (2009-D) received a second START grant to further their analysis of aerosols using a refined RegCM4 model. In their subsequent article, Touré et al. (2012) explored the seasonality of dust emissions, transport, and deposition for the Sahara and Sahel regions. Specifically, they modeled the winter (December-January-February), spring (March-April-May) and summer (June-July-August) dust characteristics, validated

based on MISR satellite and AERONET ground stations in Africa .

They reported that the dust concentrations varied by altitude depending on the season. The varied seasonal heights of the dust plumes have implications for the pattern of the ambient climate, as dust affects radiation at the surface and microphysical properties of clouds. Elevated albedo levels caused by dust plumes reduce radiative forcing during March-April-May and June-July-August, exerting a relative cooling effect. The model shows that cooling of the surface reduces local precipitation during the monsoon period (MAM) with the exception of Central Africa and portions of West Africa (Southern-Guinea and Northern Liberia).



Solar radiation forcing (Longwave and shortwave) in W/m^2 due to the presence of dusts at the top of the atmosphere.



Solar radiation forcing (Longwave and shortwave) in W/m^2 due to the presence of dusts at the surface. (Touré et al. 2012)

[1] The report also assesses seasonal dust emissions for Barbados Islands as Sahara-Sahelian dust has been known to be transported vast distances across the Atlantic Ocean.

Konare, A., C. Liousse, B. Guillaume, F. Solmon, P. Assamoi, R. Rosset, J.M. Gregoire, and F. Giorgi. (2008) Combustion particulate emissions in Africa: regional climate modeling and validation. *Atmospheric Chemistry and Physics Discussion*. 8: 6653–6681 http://www.atmos-chem-phys-discuss.net/8/6653/2008/acpd-8-6653-2008.html

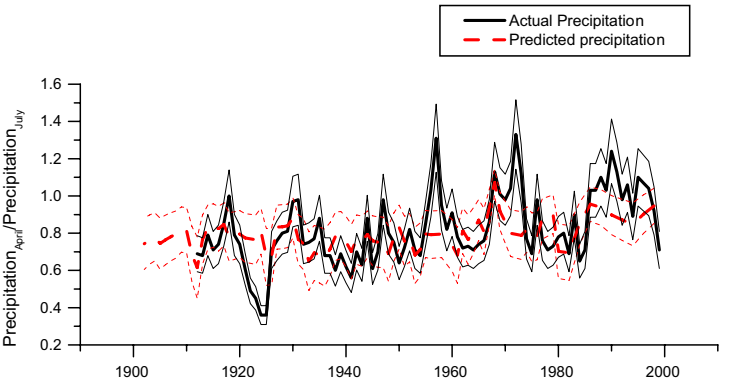
Touré, N.E., A. Konare, and S. Silue. (2012) Intercontinental transport and climatic impact of Saharan and Sahelian dust. *Advances in Meteorology*. http://dx.doi.org/10.1155/2012/157020

High-resolution, multi-proxy study of speleothems and formation drip waters from Mechara caves, southeastern Ethiopia: A tool for predicting drought frequency and long term climate variability

PI-Asfawossen Asrat, Addis Ababa University, ETHIOPIA

Temperature, rainfall, and humidity measurements are relatively recent in the climate records. These records are particularly lacking in African countries where inadequate resources and relatively poor access to appropriate technology have impacted the ability to collect long-term consistent measurements. PI-A. Asrat (2006-B) used speleothems, specifically stalagmites, as a proxy for climate reconstruction of nearly 100 years from caves in southeastern Ethiopia. Amongst other analyses, this project compared the laminae, morphology, and isotope data of two stalagmites (Asfa-3 and Merc-1) from the Merchara Karst region. ∂18O measurements and growth rate were used as proxies of the surface climate signal.

The analysis of both stalagmites revealed a seasonal climate response. In a resulting article, Baker et al. (2007) explained how the Asfa-3 compared to instrumental records reveals both the utility of stalagmite reconstruction as a proxy, especially during periods of slow stalagmite growth rates.



Reconstructed precipitation records from stalagmites Asfa-3 and Merc-1. (a) Ratio of April-July rainfall reconstructed from Merc-1 ^{18}O. Errors on actual precipitation are based on a 10% transfer function error. (Baker et al. 2007)

Blyth, A., A. Asrat, A. Baker, P. Gulliver, M. Leng, and D. Genty. (2007) A new approach to detecting vegetation and land-use change using high-resolution lipid biomarker records in stalagmites. *Quaternary Research*. 68: 314–324.

Baker, A. and A. Asrat. (2008) Precipitation records of the last century reconstructed from annual growth-rate parameters of two Ethiopian stalagmites. *Environmental Sustainability Publications*. Paper 827. http://scholarcommons.usf.edu/tles_publications/827

Lowland and highland ecosystem dynamics in Kenya

PI- Stephen Rucina, National Museums of Kenya, Kenya

The climate system is intricately linked to natural and anthropogenic drivers that affect the patterns and processes of environmental change. Paleo-environmental studies use natural proxies to reconstruct past climatic and other driving forces. PI-S. Rucina (2007-L) received a grant award to complete his dissertation research on historical ecosystem dynamics in low and high altitude sites throughout Kenya.

In two published articles, Rucina and colleagues (2009; 2010) described the ecosystem dynamics related to climate, fire, and human impact in two of four study sites. They explored the montane vegetation and fire regimes in the Late Quaternary (500,000 – 1,000,000 years BP) from the Rumuiku Swamp on the southeast of Mount Kenya. Their results indicate that fire regimes greatly influenced vegetation composition in the transition to the Holocene (11,700 years BP) to more mixed montane forest. The increase in anthropogenic impact characterized the late Holocene, leading to more open vegetation and greater fire frequency (Rucina et al. 2009).

A further analysis of the late Holocene in the Namelok Swamp in the Amboseli Basin (Kenya) captured the dynamics of savanna vegetation. The composition of vegetation indicated oscillating moist and drier climates between 2000 and 550 years BP. The increased presence of pollen from *Cannabis sativa*, cereal crops, and castor oil (*Ricinus communis*) from as early as 2000 year BP with more consistency since 1600 calendar year BP suggests the impact of human presence in the basin.

The implications of this research are many, but two outcomes are particularly noteworthy. First, paleoenvironmental data provide a historical example of vegetative responses to slow and abrupt climate shifts, such evidence can help in understanding future ecosystem dynamics from anthropogenic climate change. Secondly, this study provided access to a rich trove of data for the National Museums in Kenya.

A similar study was conducted by PI-P. Huntsman-Mapila (2005-F) who used paleo records of the Quaternary period to understand human impact in the vicinity of Lake Ngami, Botswana. The research, including an archeological survey, confirmed the importance of the lake for early habitants and corroborated the evidence of humid and drier episodes in tropical Africa during the Quaternary period.

Rucina, S.M., V.M. Muiruri, R.N. Kinyanjui, K. McGuiness, and R. Marchant. (2009) Late Quaternary vegetation and fire dynamics on Mount Kenya. *Palaeogeography Palaeolimnology Palaeoecology* 283: 1-14.

Rucina, S.M., V.M. Muiruri, L. Downton, and R. Marchant. (2010) Late Holocene savanna dynamics in the Amboseli Basin, Kenya. *The Holocene* 20: 667-677.

START GRANTS FOR GEC RESEARCH IN AFRICA: PROJECT TITLES, 2004-2011

2004

	Title	PI	Institution	Country
A	A global change: monitoring the Indo-Atlantic connections south of Africa (GOODHOPE)	Isabelle Ansorge	University of Cape Town	South Africa
B	Assessing the impacts of climate change and variability on water resources in Uganda: developing an integrated approach at the sub-regional scale	Charles Basalirwa	Makerere University	Uganda
C	Inventory and mapping maritime pine populations in Morocco using satellite data and evaluation of their physiological response to environmental stresses	Abdelali Boulli	Université Cadi Ayyad	Morocco
D	Natural resource utilisation and land use conflicts in the Okavango Delta, Botswana	M.B.K. Darkoh	University of Botswana	Botswana
E	Societal pressures on groundwater resources in southeastern Nigeria	Ekanem Michael Ekanem	University of Uyo	Nigeria
F	Representativeness and long-range transport of carbon monoxide at Mount Kenya Global Atmospheric Watch (GAW) station	Josiah Murageh Kariuki	Kenya Meteorological Department	Kenya
G	Modeling the isotopic composition of Ethiopian lakes: a tool for understanding past and future variations in climate and water resources	Seifu Kebede	Addis Ababa University	Ethiopia
H	Methane and nitrous oxide fluxes In different ecosystems Of Botswana	Wellington Masamba	H. Oppenheimer Okavango Research Center	Botswana

	Title	PI	Institution	Country
I	Variability and predictability of West African monsoon onset	Aïda Diongue Niang	Direction de la Météorologie Nationale du Sénégal	Senegal
J	Mapping deforestation rates and carbon fluxes in the Congo Basin Forest using multi-date SPOT-VGT imagery for 1999 to 2003	Donatien Njomo	University of Yaounde I	Cameroon
K	Environmental assessment of Lake Victoria Basin for the Africa Environmental Outlook (AEO) Report	Eric Odada	University of Nairobi	Kenya
L	Pan Africa PAGES Workshop on "African paleoperspectives: linking the past to the present and the future"	Daniel Olago	University of Nairobi	Kenya
M	Strengthening agricultural research capacity to generate technologies that adapt to climatic shifts and variability in Nigeria's dry belt	Olwasemire Olatunji	Ahmadu Bello University	Nigeria
N	Fire and climate change feedback in southern Africa	Mary Scholes	University of Witwatersrand	South Africa
O	Vulnerability assessment of maize and sorghum crops to climate variability and change in Kenya	Chris Shisanya	Kenyatta University	Kenya
P	Assessment of land use / land cover changes, socio-economic drivers and associated carbon fluxes in southwestern Uganda	Joy M.B. Tukahirwa	The Environmental Conservation Trust of Uganda, ECOTRUST	Uganda
Q	Setting the benchmark – what do we know/what is our future? A science review and synthesis workshop on the long-term impacts of environmental change in West Africa	Souleye Wade	Université Cheikh Anta Diop	Senegal

2005

	Title	PI	Institution	Country
A	Simulation of West African climate variability and change with an adapted regional climate model	Ernest A. Afiesimama	Nigerian Meteorological Agency	Nigeria
B	Vulnerability of selected Ethiopian lakes to climatic variability, neo-tectonism and water use	Tenalem Ayenew	Addis Ababa Unviersity	Ethiopia
C	The influence of atmospheric deposition on biogeochemical cycles in Lake Kivu	Jean-Jacques Bagalwa	Center of Research in Natural Science	Democratic Republic of the Congo
D	Stable isotope records of Holocene environmental change from Moroccan lakes: an emerging synthesis	Abdelfattah Benkaddour	Université Cadi Ayyad	Morocco
E	Supporting African expert contributions to LOICZ II (Land Ocean Interactions in the Coastal Zone) development at the IGBP/IHDP LOICZ II Inaugural Open Science Meeting 27-29 June 2005	Julius Francis	Western Indian Ocean Marine Science Association	Tanzania
F	Paleo-environmental reconstruction of Lake Ngami Basin, Botswana – the role of climate change in human biogeography	Philippa Hunstman-Mapila	University of Botswana	Botswana
G	African participation at the PAGES (Past Global Changes) Open Science Meeting	Mohammed Umer	Addis Ababa Unversity	Ethiopia
H	Pilot project to strengthen the Nigerian meteorological agencies capacity to provide reliable rainfall prediction for use in making adaptive agricultural decisions	Nnadozie Okonkwo Nnoli	Nigerian Meteorological Agency	Nigeria
I	Trace gas and aerosol emissions from domestic burning in southern Africa	Stuart Piketh	University of the Witwatersrand	South Africa
J	Understanding the relative risks posed to agricultural productivity by air pollution and drought across the southern African region	Mark Zunckel	CSIR Division of Water, Environment and Forestry Technology	South Africa

2006

	Title	PI	Institution	Country
A	A structure, biomass and net primary production in a dry tropical afromontane forest of Ethiopia	Getachew Tesfaye Abebe	Addis Ababa University	Ethiopia
B	High-resolution, multi-proxy study of speleothems and sormation drip waters from Mechara Caves, southeastern Ethiopia: a tool for predicting drought frequency and long term climate variability	Asfawossen Asrat	Addis Ababa University	Ethiopia
C	Development of remote sensing tools to improve understanding and management of Lake Malawi and other African Rift Valley lakes	Geoffrey Chavula	University of Minnesota and University of Malawai (The Polytechnic)	Malawi
D	ARGO capacity building workshop for the Atlantic countries of Africa, 5-7 December 2006	Regina Folurunsho	Nigerian Institute for Oceanography and Marine Research	Nigeria
E	Climatic feedback of dust and biomass burning aerosol over West Africa	Abdourahmane Konare	Université Cocody	Cote d'Ivoire
F	Research protocols for assessing the impact of climate variability and change in rural Tanzania: water, food systems, vulnerability and adaptation	Emma T. Liwenga	University of Dar es Salaam	Tanzania
G	Land use and climate change effects on terrestrial C stocks in Uganda's cattle corridor	Abel Lufafa	Makerere University	Uganda
H	Assessment of land cover degradation following forest harvesting in the Mai- Ndombe and the Lisala region	Raymond S. Lumbuenamo	University of Kinshasa	Democratic Republic of the Congo
I	Mitigating phosphorous load into Lake Victoria catchment	Vincent O. Madadi	University of Nairobi	Kenya
J	Workshop to address issues relating to the prediction and predictability of east and southern Africa climate, May/June 2006, in Tanzania	Mohamed S. Mhita	Tanzania Meteorological Agency	Tanzania

	Title	PI	Institution	Country
K	Environmental change assessment in Africa: seasonal fluctuation in the atmospheric and water levels of methane and nitrous oxide in selected aquatic ecosystems in Uganda and Nigeria	Irene Naigaga	Makerere University	Uganda
L	Modeling landuse – dust-climate feedbacks in West Africa	Ibrah Seidou Sanda	Université Abdou Mounmouni	Niger
M	Greenhouse gases, methane and carbon dioxide and the diminishing water resources in Lake Victoria basin, Kenya	Gelas Muse Simiyu	Moi University	Kenya
N	Projected changes in summer climate and the implications for growing maize in southern Africa	Mark Alexander Tadross	University of Cape Town	South Africa
O	Great hydraulic installations and food security in Burkina Faso: the case of the Bagré Dam	Tanga Pierre Zoungrana	Université de Ouagadougou	Burkina Faso

2007

	Title	PI	Institution	Country
A	Climate change and ecosystem: assessment of CO2 fluxes and potential impacts on estuarine water resources and coastal environment of Bight of Bonny, Nigeria	Nsikak Udom Benson	Covenant University	Nigeria
B	Vulnerability of coastal habitats and dependent livelihoods to climate change	Jared Bosire	Kenya Marine and Fisheries Research Institute (KMFRI)	Kenya
C	Adapting to climate variability in the Senegal River basin in West Africa	Aliou Mamadou Dia	Université Cheikh Anta Diop	Senegal

	Title	PI	Institution	Country
D	The integration of climate change management into local air quality management planning in South Africa	R.D. Diab	University of KwaZulu-Natal	South Africa
E	Evaluation of impact of land use and land cover changes on climate, carbon cycle, and ecosystems in southwestern Nigeria	Olufunke Olubusayo Faboye	University of Ibadan	Nigeria
F	Assessment of climate variability impacts on coastal communities of East Africa	Juliet Hermes	University of Cape Town	South Africa
G	Land use and climate change effects on livelihoods and sediment and carbon loading in the Lake Tanganyika region	Mwanjalolo Majaliwa	ISP / Bukavu-DRC	Rwanda
H	Short-term impact of cultivating Miombo Woodlands on greenhouse gas exchange	Farai Mapanda	University of Zimbabwe	Zimbabwe
I	ENSO-based rainfall prediction and crop production in southern Ghana	Ferdinand Mawunya	University of Ghana	Ghana
J	Satellite-derived rainfall estimates (TRMM products) used for hydrological predictions of the Congo River flow: overview and preliminary results	Yoland Munzimi	University of Kinshasa	Democratic Republic of the Congo
K	Sources and distribution of volatile organic compounds in the marine boundary layer	Carl Palmer	University of Cape Town	South Africa
L	Lowland and highland ecosystem dynamics in Kenya	Stephen Rucina	National Museums of Kenya	Kenya
M	Impact of urban growth on surface climate: a case study in Oran, Algeria	A. Safia	National Center for Space Techniques	Algeria
N	Investigating projected climate change over Sahel and impact studies on selected crops using a modeling approach	Abdoulaye Sarr	Direction de la Météorologie Nationale du Sénégal	Senegal

2008

	Title	PI	Institution	Country
A	Project of support to the integration of the adaptation to the climate changes in the policies and national strategies of food safety in Burkina Faso	Mathieu Badolo	Institut d'applications et de vulgarisation en sciences	Burkina Faso
B	A case study: savannas and environmental change in Africa	Fadiala Dembele	Institut Polytechnique Rural de Katibougou	Mali
C	Ghana's post-2007 floods and households' vulnerability: gender, Age and Spatial Analysis	Benjamin Dovie	University of Ghana	Ghana
D	Effects of climate variability on species diversity and biomass productivity of a humid afromontane tropical forest of Ethiopia: Evidence from postfire forest regrowth	Tesfaye Abebe Getachew	Addis Ababa University	Ethiopia
E	The effects of anthropogenic disturbance and global climatic change to benthic macroinvertebrates assemblages in Uluguru Mountains Forest streams in Morogoro-Tanzania	Jeremiah Kyomo	University of Dar es Salaam	Tanzania
F	Developing capacities in carbon stock measurement across ecologies and land use systems in West Africa	Cheikh Mbow	Université Cheikh Anta Diop	Senegal
G	Comparative population-level responses to aridification: implications for future range changes of parasite, parasitoid, and pollinator communities given global warming scenarios	Michael McLeish	South African National Biodiversity Institute (SANBI)	South Africa
H	Landscape processes and biodiversity change along the Kwandu River in Caprivi, Namibia	Alfons Mosimane	University of Namibia	Namibia
I	Climate change and variability in semi arid central Tanzania: Assessment of farmer responses, adaptation and coping strategies to rainfall variability and the role of civil societies in enhancing farmer adaptations	P.K.T. Munishi	Sokoine University of Agriculture	Tanzania

	Title	PI	Institution	Country
J	Past climatic changes in Northern-Cameroon (Adamawa plateau) during the late Holocene	Victor François Nguetsop	University of Dschang	Cameroon
K	Integrated assessment of land use changes, organic carbon, greenhouse gases and spring water variability in the middle Nzoia River catchment, Kenya	Gelas Simiyu	Moi University	Kenya
L	Assessment of the impact of climate change and climate variability on maize production in the Lake Victoria Basin Uganda	John Wasige	Makerere University	Uganda
M	Ecotope water and CO_2 fluxes for assessment of climate change effects on the Okavango Delta wetlands	Piotr Wolski	University of Botswana	Botswana

2009

	Title	PI	Institution	Country
A	Influence of fire and precipitation on woody vegetation composition and structure in Serengeti National Park, Tanzania	John Bukombe	Tanzania Wildlife Research Institute	Tanzania
B	Economic analyses of adaptation strategies of the fisheries sector of Senegal in relation to climate change	Ndiaga Diop	Université Cheikh Anta Diop	Senegal
C	Integration of indigenous knowledge systems in adaptoing to climate change and enhancing food security among the Kalenjin community of Rift Valley, Kenya	Emmanuel Chessum Kipkorir	Moi University	Kenya
D	Regional impacts of aerososl on West Africa climate	Abdourahamane Konare	Université Cocody	Cote d'Ivoire

	Title	PI	Institution	Country
E	Volta Basin water resource management in present and future climate regimes	Benjamin L. Lamptey	International Water Management Institute	Ghana
F	Support for seven African scientists to participate in the 3rd International Conference: "African Monsoon Multidisciplinary Analysis (AMMA)" to be held in Ouagadougou, Burkina Faso, 20-24 July 2009	Thierry Lebel	Institut de Recherche pour le Développement	Burkina Faso
G	Modelling the dynamics of the Tanzanian coastal waters	Shigalia B. Mahongo	Tanzania Fisheries Research Institute	Tanzania
H	Impacts and adaptation to climate change for subsistence communities: lessons from Lesotho	Caxton Matarira	National University of Lesotho	Lesotho
I	Mapping wetland flooding regimes for improved methane emissions estimates	Kelebogile Mfundisi	H. Oppenheimer Okavango Research Centre	Botswana
J	Impact of climatic change on alpine plant species distribution, land cover and edaphic systems on Rwenzori Mountains in Uganda	Bob Nakileza	Makerere University	Uganda
K	Land use and climate change: potential impacts on human socio-economic developments, human-biodiversity conservation and management of southern Rift Valley wetlands, Kenya	Alfred Owino	Kenya WIldlife Service	Kenya
L	Climate change planning inside and outside protected areas	Andriaman-dimbisoa Razafimpaha-nana	Résau de la Biodiversité de Madagascar (REBIOMA)	Madagascar
M	Quaternary sedimentary record of monsoon winds variability and associated carbon and nitrogen burial rates on the East African continental margin	Yohanna Shagude	Institute of Marine Sciences	Tanzania

	Title	PI	Institution	Country
N	Pathogenicity and species shifts in plant parasitic nematodes affecting banana production in the East African Highlands: what is the influence of climate change?	Herbert Talwana	Makerere University	Uganda
O	Physiological responses of tsetse flies, vectors of trypanosomiases to simulated climate change: implications for prediction, management and control	John Terblanche	Stellenbosch University	South Africa
P	Assessment of global change impacts on groundwater in the coastal sedimentary basin of Benin (West Africa)	Henri Totin	University of Abomey-Calavi	Benin
Q	Support for five African scientists to participate in the 2nd East African Quaternary Research Association (EAQUA) Workshop to be held in Addis Ababa, Ethiopia 20 to 25 May 2009	Mohammed Umer	University of Addis Ababa	Ethiopia

2010

	Title	PI	Institution	Country
A	Vulnerability assessment and risk level of ecosystem services for climate change impacts and adaptation in Moroccan oases	Mohammed Messouli	Université Cadi Ayyad	Morocco
B	Strengthening the capability of communities and local institutions in southern Africa to respond to climate change through land use changes	Henry Raphael Mloza-Banda	University of Malawi	Malawi
C	The impact of environmental change on ecosysterm services supporting human livelihoods: the case of Okavango River channel flows and Boteti River, Botswana	Gagoitseope Mmopelwa	H. Oppenheimer Okavango Research Centre	Botswana
D	Assessing soil-based ecological services and opportunities to sequester soil organic carbon in selected watersheds of Ethiopia	Abebe Shiferaw	International Livestock Research Institute	Ethiopia

2011

	Title	PI	Institution	Country
A	Management of ecosystems services of the forests of southwest Nigeria in support of rural livelihoods and food security	Victor Adekunle	Federal University of Technology	Nigeria
B	Reducing tropical deforestation and the protection of ecosystem services to support food security in southwest Cameroon	Gordon Ajonina	Cameroon WIldlife Conservation Society	Cameroon
C	Sustainable farmland management in the context of climate change in inland valleys of southern Benin	Irénikatché Akponikpe	Université de Parakou	Benin
D	Changes in tree reproductive phenology: causes and implications in and around Budongo Forest Reserve, Uganda	Fred Babweteera	Budongo Conservation Field Station	Uganda
E	Impact of climate change on water resources, agriculture and food security in the Ethiopian Rift Valley: risk assessment and adaptation strategies for sustainable ecosystem services	Dagnachew Legesse Belachew	Addis Ababa University	Ethiopia
F	Improving seasonal forecast information for managing on-farm decisions	Olivier Crespo	University of Cape Town	South Africa
G	Integrating indigenous knowledge and scientific methods for flood Risk analyses, responses and adaptation in rural coastal communities in Nigeria	Oluseyi Olubunmi Fabiyi	Regional Centre for Training in Aerospace Surveys	Nigeria
H	Community-based management of ecosystems and natural resources for the improvement of rural livelihoods and food security in the Nigerian savannah	Mayowa Fasona	University of Lagos	Nigeria
I	Engaging farmers and climatologists in adaptation to climate variability and change in the Okavango Delta of Botswana	Oluwatoyin Kolawole	Okavango Research Institute	Botswana
J	The role of urban and peri-urban agriculture in enhancing food security and climate change resilience in East and West African cities	Shuaib Lwasa	Makerere University	Uganda

	Title	PI	Institution	Country
K	The application of earth observation methods for monitoring and assessment of agro-forestry in Senegal and Ghana	Cheikh Mbow	Université Cheikh Anta Diop	Senegal
L	Climate change adaptation for rural communities dependent on agriculture and tourism in marginal farming areas of the Hwange District, Zimbabwe	Charles Nhemachena	Council for Scientific and Industrial Research	Zimbabwe
M	Assessing adaptation responses by smallholder farmers in northern Ghana to climate change and biodiversity loss	Yaw Osei-Owusu	Conservation Alliance	Ghana
N	The impact of climate change on food security among coastal communities of Keiskamma, in the Eastern Cape, South Africa	Anthony Ribbink	Sustainable Seas Trust	South Africa
O	Sensitivity of coastal lagoon ecosystems to climate and related global changes: developing a North African lagoons network	Maria Snoussi	Institut de Recherche pour le Développement and University Mohamed V-Agdal, Rabat	Morocco
P	Targeting crop yield increases under future climate for greater food vvecurity in the upstream catchment of Lake Victoria Basin	John Wasige	Makerere Unviersity	Uganda

PUBLICATIONS FROM START GRANTS FOR GEC RESEARCH IN AFRICA

2004

Ansorge I.J., S. Speich, J.R.E. Lutjeharms., G.J. Gõni., C.J.de W. Rautenbach., P.W. Froneman., M. Rouault and S. Garzoli. (2005) Monitoring the oceanic flow between Africa and Antarctica: Report of the first GoodHope cruise. *South African Journal of Science*. 101: 29-35.

Legeais, J-F, S. Speich, M. Arhan, **I. Ansorge**, E. Fahrbach, A. Klepikov. (in press) Inferring the baroclinic transport of the Antarctic Circumpolar Current south of Africa from upper ocean temperatures. *Geophysical Research Letters*.

Darkoh, M.B.K. and J.E. Mbaiwa. (2009) Perceived effects of veterinary fences on subsistence livestock farming in the Okavango Delta, Botswana. *Uniswa Research Journal of Agriculture, Science, and Technology*. 12(1): 65-74.

Darkoh, M.B.K. and J.E. Mbaiwa. (2009) Land-use and resource conflicts in the Okavango Delta, Botswana. *African Journal of Ecology*. 47(Suppl. 1): 1610-163.

Ekanem, E.M. and M.O. Nwagbara. (2005-2006) Climate change, desertification, and dust generation in Nigeria: A review. *Journal of Environmental Systems*. 32(1): 5-15.

Njomo, D. (2008) Mapping deforestation in the Congo Basin Forest using multi-temporal SPOT-VGT imagery from 2000 to 2004. *EARSeL eProceedings 7*.

Odada, E.O., D.O. Olago, K. Kulindwa, M. Ntiba, and S. Wandiga. (2004) Mitigation of environmental problems in Lake Victoria, East Africa: Causal chain and policy options analysis. *Ambio*. 33(1-2): 13-23.

Odada, E.O., D.O. Olago, and W. Ochola, Eds. (2006) Environment for development: An ecosystems assessment of Lake Victoria Basin, UNEP/PASS.

Odada, E.O., W.O. Ochola, and D.O. Olago. (2009) Drivers of ecosystem change and their impacts on human well-being in Lake Victoria basin. *African Journal of Ecology*. 47: 46-54.

Recha, C.W., **C.A. Shisanya**, G.L. Makokha, and R.N. Kinuthia. (2008) Perception and use of climate forecast information among smallholder farmers in semi-arid Kenya. *Asian Journal of Applied Sciences*. 1(2): 123-135.

Sanni, S.A., **K.O. Oluwasemire**, and N.O. Nnoli. (2012) Traditional capacity for weather prediction variability and coping strategies in the front line states of Nigeria. *Agricultural Sciences*. 3(4): 625-630.

Shisanya, C.A., W. Recha, G.L. Makokha, D.N. Mutisya, J. Okolla, and A. Anyamba. (2005) Exploring the possibility to predict southeast Kenya normalized difference vegetation index (NDVI) using seasonal climate forecast. *European Journal of Scientific Research*. 12(1): 276-287.

Shisanya, C.A., A. Anyamba, J. Okolla, W.C. Recha, and J. Small. (2010) Climate variability and agricultural production in arid and semi-arid Kenya. In: S. P. Saikia, Ed. *Climate Change*, International Book Distributors, India, 218-217.

Shisanya, C.A., C. Recha, and A. Anyamba. (2011) Rainfall variability and its impact on normalized difference vegetation index in arid and semi-arid lands in Kenya. *International Journal of Geosciences*. 2: 36-47.

2005

Afiesimama, E.A., J. S. Pal, B. J. Abiodun, W. J. Gutowski Jr., and A. Adedoyin. (2006) Simulation of West African monsoon using the RegCM3. Part I: Model validation and interannual variability. *Theoretical and Applied Climatology*. 86: 23-27.

Ayenew, T. and R. Becht. (2007) Comparative study of the hydrology and hydrogeology of selected Ethio-Kenyan rift lakes. Lake and Catchment Research Symposium (LARS).

Ayenew, T., R. Becht, A. van Lieshout, Y. Gebreegziabher, D. Legesse, J. Onyando. (2007) Hydrodynamics of topographically closed lakes in the Ethio-Kenyan Rift: The case of lakes Awassa and Naivasha. *Journal of Spatial Hydrology*. 7(1): 81-100.

Ayenew, T. and D. Legesse. (2007) The changing face of the Ethiopian rift lakes and their environs: call of the time. *Lakes and Reservoirs: Research and Management*. 12: 149-165.

Thambiran, T., **R. Diab**, and **M. Zunckel**. (2007) Integration of climate change considerations into local air quality management plans in South Africa. *Clean Air Journal*. 16(2): 18-25.

2006

Baker, A. and **A. Asrat**. (2008) Precipitation records of the last century reconstructed from annual growth-rate parameters of two Ethiopian stalagmites. *Environmental Sustainability Publications*. Paper 827. http://scholarcommons.usf.edu/tles_publications/827

Blyth, A., **A. Asrat**, A. Baker, P. Gulliver, M. Leng, and D. Genty. (2007) A new approach to detecting vegetation and land-use change using high-resolution lipid biomarker records in stalagmites. *Quaternary Research*. 68: 314–324.

Bedou, M., **A. Konare**, **I. Seiduo-Sanda**, P. Assamoil, and A. Diedhiou. (2007) Hygroscopic properties of aerosols in the Sahel: preliminary results. *Scientific Research and Essay*. 2(6): 177-183.

Chavula, G., P. Brezonik, P. Thenkabail, T. Johnson, and M. Bauer. (2009) Estimating chlorophyll concentration in Lake Malawi from MODIS satellite imagery. *Physics and Chemistry of the Earth.* 34: 755–760.

Chavula, G., P. Brezonik, P. Thenkabail, T. Johnson, and M. Bauer. (2009) Estimating the surface temperature of Lake Malawi using AVHRR and MODIS satellite imagery. *Physics and Chemistry of the Earth.* 34: 749–754.

Chavula, G., P. Brezonik, and M. Bauer. (2011) Land use and land cover change (LULC) in the Lake Malawi drainage basin, 1982-2005. *International Journal of Geosciences*. 2:172-178,

Chavula, G., H. Sungani, and K. Gondwe. (2012) Mapping Potential fishing grounds in Lake Malawi using AVHRR and MODIS satellite imagery. *International Journal of Geosciences*. 3: 650-658

Konare, A., C. Liousse, B. Guillaume, F. Solmon, P. Assamoi, R. Rosset, J.M. Gregoire, and F. Giorgi. (2008) Combustion particulate emissions in Africa: regional climate modeling and validation. *Atmospheric Chemistry and Physics Discussion*. 8: 6653–6681 www.atmos-chem-phys-discuss.net/8/6653/2008/

Touré, N.E., **A. Konaré**, and S. Silué. (2012) Intercontinental transport and climatic impact of Saharan and Sahelian dust. *Advances in Meteorology*.

Wandiga, S.O. and **V.O. Madadi.** (2009) Water quality issues in East Africa. In: S. Ahuja, Ed., *Handbook of water purity and quality.* 1st Ed. Academic Press Elsevier. 39-65.

Zoungrana, T.P. (2008) L'impact du barrage de Bagré sur la sécurité alimentaire des populations riveraines. Cahiers du CERLESHS n° 30, Univ. Ouagadougou, 213-229.

Zoungrana, T.P. (2007) Problématique de l'accès à l'eau potable sur les rives du lac de Bagré, Burkina Faso. *Rev. Sc. Envi. Univ.*, Lomé (Togo), 25-44.

2007

Bounoua L., **A. Safia**, J. Masek, C.P. Lidars, and M. Imhoff. (2009) Impact of urban growth on surface climate: A case study in Oran, Algeria, *Journal of Applied Meteorology and Climatology*. 48(2):217-231.

Kuyper, B., C. Labuschagne, R Philibert, N. Moyo, H. Waldron, C. Reason, and **C. Palmer**. (2012) Development of a simplified, cost effective GC-ECD methodology for the sensitive detections of bromoform in the troposphere. *Sensors*. 12:13583-13597.

Mawunya, F.D., S.G.K. Adiku, K.B. Laryea, M. Yangyuoru and E. Atika. (2011) Characterisation of seasonal rainfall for cropping schedules. *West African Journal of Applied Ecology*. Ecological Laboratory, University of Ghana, Legon.

Rucina, S.M., V.M. Muiruri, R.N. Kinyanjui, K. McGuiness, and R. Marchant. (2009) Late Quaternary vegetation and fire dynamics on Mount Kenya. *Palaeogeography Palaeolimnology Palaeoecology*. 283: 1-14.

Rucina, S.M., V.M. Muiruri, L. Downton, and R. Marchant. (2010) Late Holocene savanna dynamics in the Amboseli Basin, Kenya. *The Holocene*. 20: 667-677.

2008

Adams, D.D. and **G.M. Simiyu.** (2009) Greenhouse gas (methane and carbon dioxide) emissions from a tropical river in Kenya: the importance of anthropogenic factors on natural gas flux rates. *Verhandlungen des Internationalen Verein Limnologie*. 30 (Part 6): 887-889.

Badolo, M., L. Yigo, and A. Sidibe. (2011) Design of an intervention scheme for increasing the resilience of food security to climate risks in Burkina Faso. IAVS Working Paper No. 1 Category 1: Governance and climate change.

McCandless, M., X. Chen, and **J.E. Wasige**. (2011) Impacts of climate change on maize and beans in Rakai and Kapchorwa Districts, Uganda. Draft. Climate Risk Management Technical Assistance Support Project (CRM TASP) Uganda. The International Institute for Sustainable Development (IISD). Winnipeg, Manitoba

McLeish, M.J., S. van Noort, and K.A. Tolley. (2010) African parasitoid fig wasp diversification is a function of Ficus species ranges. *Molecular Phylogenetics and Evolution* 57: 122–134.

McLeish, M., D. Guo, S. van Noort, and G. Midgley. (2011) Life on the edge: rare and restricted episodes of a pan-tropical mutualism adapting to drier climates. *New Phytologist*. www.newphytologist.com;

Nguetsop, V.F., I. Bentaleb, C. Favier, C. Martin, S. Bietrix, P. Giresse, S. Servant-Vildary, and M. Servant. (2011) Past environmental and climatic changes during the last 7200 cal yrs BP in Adamawa plateau (Northern--Cameroun) based on fossil diatoms and sedimentary carbon isotopic records from Lake Mbalang. *Climate of the Past*. 7: 1371-1393.

Nguetsop, V.F., I. Bentaleb, C. Favier, S. Bietrix, C.Martin, S. Servant-Vildary, and M. Servant. (2013) A late Holocene palaeoenvironmental record from Lake Tizong, northern Cameroon using diatom and carbon stable isotope analyses. *Quartnery Science Review*. 72: 49-62.

Simiyu, G.M. and D.D. Adams. (2009) Sediment and nutrient transport and groundwater sources in the Nzoia River watershed, Kenya, East Africa. *Verhandlungen des Internationalen Verein Limnologie*. 30(Part 6): 884-886

Simiyu, G., T. Esipila, and D.D. Adams. (2009) Seasonal variability in groundwater resources available to rural communities in western Kenya. In: R. Tailor, C. Tindimugaya, M. Owor, and M. Shamsudduha, Eds. *Ground Water and Climate in Africa*. International Association of Hydrological Sciences Ltd (IAHS Press). London. 82-87.

Simiyu, G.M., J. Ngetich, and T.A. Esipila. (2009) Assessment of spring water quality and quantity, and health implications in Tongaren division, Nzoia River catchment, Kenya. *African Journal of Ecology*, 47 (Suppl. 1): 99-104.

2009

Amoussou, E., **V.S.H. Totin**, P. Chamberlin, and J. Perard. (2011) Evénements hydroclimatiques et risque d'inondation au sud-ouest du Bénin. Actes colloque ''Climat montagnard et risques. XXIVème colloque de l'Association Internationale de Climatologie (AIC), ISBN 978-2-907696-17-3, MART - Rovereto (TN), Italie, pp 39-44.

Kleynhans, E., and **J.S. Terblanche**. (2011) Complex interactions between temperature and relative humidity on water balance of adult tsetse (Glossinidae, Diptera): Implications for climate change. *Frontiers in Physiology*. 2: 74.

Gondwe, M.J. and **W.R.L. Masamba**. (2013) Spatial and temporal dynamics of diffusive methane emissions in the Okavango Delta, northern Botswana, Africa. Wetlands Ecology and Management.

Mahongo, S. and **Y. Shaghude.** (in review) Modelling the Dynamics of the Tanzanian Coastal Waters. *Journal of Earth Science and Engineering*

Mahongo, S. and **Y. Shaghude.** (in review) Modelling the Dynamics of the Tanzanian Coastal Waters. *Journal of Oceanography and Marine Science*. 5(1): 1-7.

Songok, C.K., **E.C. Kipkorir**, and E.M. Mugalavai. (2011) Integration of indigenous knowledge systems into climate change adaptation and enhancing food security in Nandi and Keiyo Districts, Kenya. In: W.L. Filho (ed.) *Experiences of Climate Change Adaptation in Africa: Climate Change Management*. Springer Berlin Heidelberg. 69-95.

Terblanche, J.S., and E. Kleynhans. (2009) Phenotypic plasticity of desiccation resistance in Glossina puparia: are there ecotype constraints on acclimation responses? *Journal of Evolutionary Biology*. 22: 1636-1648.

Totin, V.S.H., M. Boukari, and M. Boko. (2009) Groundwater Recharge Mechanisms and Water Management in the Coastal Sedimentary Basin of Benin (West Africa). Groundwater and Climate in Africa (Proceedings of the Kampala Conference, June 2008) IAHS Publ. 334-21, 127-134.

2010

Babqiqi, A., **M. Messouli**, and A. Kasmi. (2011) High resolution climate change scenarios for Morocco for the 21st century. In: P.K. Joshi and T.P. Singh, Eds. *Geoinformatics for Climate Change Studies*. TERI Press, New Delhi, 321-336.

Shiferaw, A., H. Hurni, and G. Zeleke. (2013) Long-term changes in soil-based ecological services at three sites in Ethiopia. *Journal of Ecology and Natural Environment*. 5(8): 172-180.

Sherifaw, A., H. Hurni, and G. Zeleke. (2013) The role of indigenous knowledge in land management for carbon sequestration and ecological services in Southern Ethiopia. *Journal of Economics and Sustainable Development*. 4(17): 79-92.

Sherifaw, A., H. Hurni, and G. Zeleke. (2013) A review of soil carbon sequestration in Ethiopia to mitigate land degradation and climate change. *Journal of Environment and Earth Science*. 3(12): 187-200.

2011

Adedayo, V., **M. Fasona**, F. Olorunfemi, P. Elias, and G. Oloukoi. (in review) Some implications of policy inactions for natural resource management and sustainable rural livelihoods in Nigeria. *Journal of Social and Business Studies*.

Al-Hassan, R.M., P.M. Etwire, J.K. Kuwornu, and **Y. Osei-Owusu**. (in review) Determinants of choice of indigenous climate related strategies by smallholder farmers in northern Ghana. British *Journal of Environment and Climate Change*.

Etwire, P.M., R.M. Al-Hassan, J.K.M. Kuwornu, and **Y. Osei-Owusu**. (2013) Application of the livelihood vulnerability index in assessing vulnerability to climate change and variability in northern Ghana. *Environment and Earth Science*. 3(2): 157-170.

Etwire, P.M., R.M. Al-Hassan, J.K.M. Kuwornu, and **Y. Osei-Owusu**. (in review) Smallholder farmers' adoption of technologies for adaptation to climate change in northern Ghana. *Agricultural Extension and Rural Development*.

Fabiyi, O.O. and J. Oloukoi. (2013) Indigenous knowledge and local adaptation strategies to flood in coastal communities of Nigeria. *Journal of Indigenous Social Development*. 2(1): 1-19.

Fabiyi, O.O. and G. Yesuf. (in review) Dynamics and characterization of coastal flooding in Nigeria; implication for local community management strategies. Ife geography Journal.

Kolawole, O.D., B. Ngwenya, G. Mmopelwa, and P. Wolski. (2012) Reading the weather: How local farmers mitigate climate change and variability in the Okavango Delta of Botswana. Indigenous Knowledge Development Research (Proceedings)

Oke D.O., **V.A.J**. **Adekunle**, and J.O. Okunlola (in review) Soil carbon pool as affected by forest degradation in some reserved natural forests in southwest Nigeria. *Forests and Forest Products*.

Wasige, J.E., J.Bemigisha, T. Lubanga, W.N. Mukisa, G. Eilu, K. Michael, D. Nkodola, and R.Mwerera. (in review) Planning Adaptation practices to Mitigate climate change impact on Crop yield in the upper catchment of Lake Victoria Basin. *Global Environmental Change*.

OVERVIEW OF START & START'S MISSION

START, founded in 1992, promotes research-driven capacity building that advances knowledge generation and sharing on issues around global environmental change, including climate change. Our work is carried out by regionally based affiliates and centers in Africa and Asia-Pacific, together with the International START Secretariat based in Washington, DC.

START's efforts strengthen skills and capacity for understanding and managing global environmental change through capacity development efforts that include grants and fellowships for research and assessment, university curricula development and advanced training institutes, and multi-stakeholder dialogues and other activities that promote communication at the science-policy-practice interface. START's work advances science and strengthens communications between science, policy, and practice on issues where global environmental change and sustainable development intersect. On an annual basis, START engages between 500 and 1,000 scientists, policymakers and practitioners from developing countries in its research, training and communications/outreach programs.

One important way that START achieves its mission and objectives is through the START *Grants for Global Environmental Change Research in Africa*. This program enables innovative research in Africa by Africans. This research-support program aims to enhance knowledge and inform action for addressing the causes and consequences of GEC in Africa.

START International, Inc. is a 501(c)3 international non-governmental organization

International START Secretariat
2000 Florida Avenue NW, Suite 200
Washington, DC 20009, USA
http://www.start.org
+1 202 462 2213