Socioeconomic Consequences of Climate Change in Sub-equatorial Africa (SoCoCA), Sunbird Capital Hotel, Lilongwe, Malawi, 25 to 27 September 2012

Workshop Proceedings

Disclaimer

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Foreword

It is our pleasure to present to you the Proceedings of the Socioeconomic Consequences of Climate Change in Sub-equatorial Africa (SoCoCA) Dissemination Workshop conducted in Lilongwe, Malawi, 25 – 27 September, 2012. The workshop was organized by the Lilongwe University of Agriculture and Natural Resources (LUANAR), University of Malawi (UNIMA) and University of Oslo. The proceedings contain abstracts from SoCoCA project partners and other climate change related research conducted in the Southern and East African Region.

Abstracts covered in these proceedings cover topics of Climate and water resources, Agriculture and food security and Socio-economy & adaptation. The workshop was used as a conduit for disseminating research results to various stakeholders. SoCoCA values dissemination of research findings as a crucial and integral part of the research process.

Workshop Summary and Resolutions

1. The Research Council of Norway supported project: *Socio-economic Consequences of Climate Change in Sub-equatorial Africa (SoCoCA)* organized a conference from 25-27 September 2012 in Lilongwe, Malawi. The Lilongwe University of Agriculture and Resources (LUANAR), and the Faculty of Science at Chancellor College, University of Malawi, hosted the conference. The Conference was officially opened on 25 September 2012 by the Hon Minister of Environment and Climate Change Management, Mrs Catherine Gotani Hara (MP) and the Ambassador of the Kingdom of Norway, His Excellency Mr Asbjorn Eidhammer. The official speeches were preceded by welcome remarks by the Vice Principal of Bunda College of LUANAR, the Vice Chancellor of the University of Malawi and Prof Frode Stordal, representing the University of Oslo. The conference was officially closed by the Director of Malawi Environmental Affairs Department on 27 September, 2011.

2. The Conference was funded by the BILAT program of the Research Council of Norway and the Royal Norwegian Embassy in Lilongwe. However, some delegates were supported by their own institutions.

3. The expected outcomes of the workshop were threefold:
   (a) Dissemination of results from the SoCoCA project whereby stakeholders were made aware of the results of the research carried out as part of the project. It is expected that this will contribute towards the development of strategies to manage and adapt to climate change impacts on agriculture in the region.
   (b) Feedback SoCoCA researchers expected from the stakeholders. This feedback is important to direct future research in the SoCoCA project as well as other projects beyond the lifetime of SoCoCA.
   (c) Sharing of experiences by the regional participants on the socio-economic consequences of climate change in the region. This exchange of knowledge will further assist in the identification of gaps and key challenges in climate change research within the region.

4. The conference attracted 10 international delegates (Norway 5, Italy 1, African neighbouring countries 4) and 25 local participants drawn from universities (LUANAR, University of Malawi, Mzuzu), government, public water utilities and the media, including the Malawi Broadcasting Corporation. Participants included senior academics and postgraduate students.

5. The conference was characterized by key note addresses and technical papers covering the three subthemes under the main theme- ***Climate Change in Sub-Saharan Africa and Impacts on Agriculture and Economic Development.*** The three sub-themes were:
   (a) Climate and Water Resources
   (b) Agriculture and Food Security.
   (c) Socio-Economy and Adaptation.

6. The Conference identified various users of the information such as water managers, national disaster preparedness agencies, impact modelers, various subsectors in the agricultural sector (subsistence farmers, irrigation needs), forestry, fisheries, economists, media, health experts, navigation and industry (including hydropower), ecologists, policy makers and the public.

7. The Conference noted some important needs and expectations of the users of the disseminated information. These are:
   (a) Providing projections for the near future.
   (b) Provision of more clearer and simplified scientific results, and
   (c) Ensuring more dialogue workshops between scientists and information users, as science is always progressing.

8. The Conference noted the following key challenges to the adaptation process:
   (a) Capacity constraints.
   (b) Need to distinguish between climate change and global change of other origins as the adaptation processes are different.
   (c) Need for more data (new stations as well as continuous long time series) and raise awareness of all those involved in data collection and management.
   (d) Lack of local capacity in terms of breeding and supply of adapted seeds.
   (e) Need for successful adaptation stories to be shared for up scaling and inclusion into policies.
   (f) Need to integrate climate change adaptation into the development process to create robust and less vulnerable societies.
   (g) Climate change, in terms of increased temperature and more frequent droughts and floods, and its effects agricultural productivity negatively.
   (h) Small-scale farmers have limited capacity to adapt and are often unable to cope with situations with less or more than normal rainfall during the growing season.
   (i) Livestock are affected negatively by the warmer climate because of impact on digestibility of grazed vegetation and added heat load on the animals.
   (j) Changed precipitation has resulted in lake recession and negative consequences for fisheries and environment in Malawi. Lake Chilwa, which is one of the most

productive lakes in Malawi, is receding leading to decline in fish population and loss of livelihoods for the fish-dependent communities.

(k) Identification and dissemination of best practices is essential

(l) Use of drought tolerant crops for adapting to climate change. However, caution should be taken when introducing new varieties to ensure that they do not cause problems in the areas where they are introduced.

(m) Women's room for flexibility and options for choosing coping strategies and thereby adapting to climate change is limited considerably for cultural reasons.

(n) A better understanding of the role indigenous knowledge plays in how people perceive and prepare for weather anomalies may help in predicting upcoming extreme events and making seasonal weather forecasts.

(o) Environmental impacts of climatic changes as well as climate effects of environmental degradation needs to be integrated in the development of local climate policy.

(p) There is a huge potential for improving the preparedness to climate change by strengthening north-south partnerships.

9. Participants identified several research gaps which required urgent attention

(a) Need to link perceptions of change to scientific proof of change.

(b) More studies on the detection of changes and trends using standard techniques.

(c) More regional climate model simulations to support ensemble modeling.

(d) Extensive naturalized as well as human impact model runs.

(e) Analyse how changes in land use (e.g. deforestation) have impacted regional and local climate as well as the water balance.

(f) More integration and holistic approaches: e.g. further improve the understanding of environmental consequences of climatic changes and climate consequences of environmental degradations.

(g) Climate change impacts studies on groundwater (quality and quantity).

(h) Quantitative assessment of agriculture and food security for the sub Saharan African region utilising climate related quantitative data that would link observed changes to climate change.

(i) Quantitative assessment of the uncertainty in model simulations.

(j) Global change impacts on large water bodies (e.g. Lake Tanganyika, Lake Kariba, Lake Malawi, Lake Chilwa etc.).

(k) Find means to combine scientific knowledge with indigenous knowledge systems, in order to draw more extensively on knowledge generated by local people, to enhance the relevance of scientific knowledge to the local people and to facilitate communication between experts and users.

(l) Research on how to communicate scientific results to a wider audience.

10. The plenary considered the recommendations from the working groups covering the three sub-themes, and agreed on the following:

(a) Local ownership to problem statement, e.g. NUFU Water Sciences project provides a model of research network collaboration, design and implementation (involving all partners) and fellowships. In the future it is essential to include follow ups of PhD candidates in their home organisations.
(b) Facilitate capacity building at all levels, i.e. scientific, technical and administrative staff and ensure commitment to home institutions by trainees.
(c) Gender awareness at all levels, through project formulation, involvement of female researchers and leadership, and representation of female students (work towards an increase in the recruitment base of female students).
(d) Integrating natural and social sciences.
(e) Formation of an online discussion forum.
(f) Generate and utilise more quantitative data in research to validate model simulations.

Remarks and Speeches

Welcome Remarks

Professor Frode Stordal
SoCoCA Project Coordinator, University of Oslo

Firstly and foremost, I would like to welcome you all to this important workshop on Socio-Economic Consequences of Climate Change in Sub-Equatorial Africa (SoCoCA). Gathered here are researchers, technocrats, policy makers, politicians and stakeholders from many parts of the world. We have here amongst us a mix of people with various backgrounds in terms of specializations and personal research interests. We have scientists, social scientists and environmentalists among others. All of us are gathered here for one common goal; to better understand climate change and how it affects people's socio-economic activities in the region.

Our guest of honour, Ladies and Gentlemen. Why is this workshop taking place in Africa, particularly in Malawi? We may all be aware that climate change is *one* of the major challenges Africa has to overcome. Adverse impacts of climate change are exerting serious threats to many economies in Africa and posing threats to future development and stability. There is significant reduction in agriculture production and access to food by the people in the region as result of climate change. However, although the region has the most vulnerable people, the irony is that Africa has in turn contributed *the most negligible* amounts of greenhouse gases, the main cause of the observed global warming responsible for climatic changes, as compared to rich countries and other emerging economies. Malawi, with its predominantly agro-based economy just as its neighboring counties, therefore provides an ideal example of nations at the most risk from adverse impacts of climate change in the region.

Our guest of honour, Ladies and Gentlemen. A key element in SoCoCA is capacity building. Perhaps the most important capacity needed in our times is the ability to adapt to change. In Africa, as in many parts of the world, a major challenge is to care for what is often termed as "global public goods", among which climate is clearly one, but certainly not the only one. We need to see climate change in relation to other environmental stresses, and not to forget health and security.

The SoCoCA group is coming to Malawi this week with some answers, but in fact with more questions. Let us work together to prepare for adaptation to climate change in the region. Let us be critical in identifying future research gaps in this respect.

Our guest of honour, Ladies and Gentlemen. This workshop would have been impossible without the goodwill and financial support from various organizations. I hereby wish to acknowledge the financial support from the Royal Norwegian Embassy in Malawi, which has facilitated the participation of the regional and local participants gathered here. Further support especially for participants from Europe came from the Norwegian Research Council and I sincerely thank them. The Lilongwe University of Natural Resources and the University of Malawi played tireless and pivotal roles in assisting with the organization of the workshop, and I say thank you a

million and more times. To the Malawi Government, I thank you for your presence and for providing the peaceful environment and these excellent facilities.

With these few remarks, I wish you all a pleasant workshop.

Thank you for your attention.

Welcome Remarks

Dr. Charles Masangano
Vice Principal of Bunda College

Distinguished ladies and gentlemen, It is my pleasure to speak to you today on the occasion of this workshop on Socio-Economic Consequences of Climate Change in Sub-Equatorial Africa (SoCoCA) on behalf of Bunda College of the Lilongwe University of Agriculture and Natural Resources (LUANAR). My humble duty this morning is not too big but to welcome you all to the Capital city. I would also like to thank SoCoCA project team for selecting Lilongwe to host this workshop.

Ladies and Gentlemen, Bunda College boosts a long standing relationship with the people of the Kingdom of Norway for more than 15 years; the collaboration has been cemented through Bunda's participation in research and outreach activities with University of Oslo and the Norwegian University of life Sciences (UMB). All these activities were possible through funding sourced through the Royal Norwegian Embassy in Lilongwe.

Distinguished ladies and gentlemen, this dissemination workshop will provide answers to most difficult questions as far as climate change is concerned. Therefore, we as Bunda would like to wish you all the best in the next three days as scientists strive to provide answers on climate change.

Ladies and gentlemen,

With these few remarks, allow me to call upon Vice Chancellor for the University of Malawi to give a few remarks.

Thank you and God bless you.

Welcome Remarks

Dr. Emmanuel Fabiano
Vice Chancellor of University of Malawi

Our Guest of Honor, distinguished ladies and gentlemen. Before I say anything more, allow me to welcome our foreign visitors to this workshop on Socio-Economic Consequences of Climate Change in sub-equator Africa (SoCoCA). This is jointly organized by the University of Oslo, Lilongwe University of Agriculture and Natural Resources (LUANAR) and the University of Malawi. I am informed that the workshop has drawn participants from all over the world who are actively involved in climate change research studies.

Our Guest of Honor, distinguished ladies and gentlemen. Climate change continues to be a very key development issue globally with considerable negative consequences on the socio-economic status of the people and their livelihoods. It is however well known that many countries of the sub-equator Africa are among the most vulnerable to effects of climate change. This emanates from the fact that most of the people in the region largely depend on rain fed subsistence agriculture. The majority of these people also live in rural areas under widespread poverty. In Malawi, like other parts of the sub-equator Africa, the impacts of climate change over the years are being manifested in various ways such as intense rainfall, changing rainfall patterns, floods, droughts and prolonged dry spells. In turn, these have had devastating effects on the socio-economic status of the people in the region as agriculture is the backbone of the country.

Our Guest of Honor, distinguished ladies and gentlemen. It is therefore imperative from the foregoing that effective response to effects of climate change requires a strong applied-science base as well as an understanding of the science behind climate change. However, there are key challenges impeding such effective responses among our scientists and researchers in the region. Such constraints include limited capacity, data constraints, little research collaboration and networking, lack of political will viz-a-viz provision of research capital including infrastructure and facilities. To this end, workshops and conferences such as this for the SoCoCA project are important for sharing knowledge and experiences, and building sound approaches to the challenges we face.

Our Guest of Honor, distinguished ladies and gentlemen. I am therefore very pleased to note that there is considerable representation of local and regional researchers at this workshop. I am very optimistic that that the participation of these locally and regionally drawn researchers will not only add substantial value to the workshop but will also bring out pertinent issues peoples of the region are facing with regards to climate change. Therefore, it is my expectation that such issues may assist in shaping the future research agenda on climate change science and possible

adaptation mechanisms in the region. Furthermore, our research colleagues from afar may also learn a lot from any success stories on climate change adaptation from the region. I therefore urge our regional colleagues to be pro-active during workshop and initiate research collaborations or networks that may assist in easing the constraints they face in their research undertaking.

Our Guest of Honor, distinguished ladies and gentlemen. Finally, but not in the least, I wish to acknowledge the financial assistance from the Norwegian Government through its various channels that has made this workshop possible. I wish to extend special thanks to the Royal Norwegian Embassy in Malawi for proving sponsorship to all regional and local participants.

With these few remarks, I thank you for your attention.

Opening Remarks

His Excellency Mr. Asbjørn Eidhammer
Royal Norwegian Ambassador to Malawi

Good morning to all of you.

First of all, allow me to extend, on behalf of the Norwegian Embassy, the warmest welcome to all the workshop participants and all distinguished invited guests. Thank you for coming to the Lilongwe, the Capital City of the Republic of Malawi.

I am indeed much honored to grace this official opening of the workshop on Socio-Economic Consequences of Climate Change in sub-equator Africa (SoCoCA). This workshop is jointly organized by the University of Oslo, Norway, Lilongwe University of Agriculture and Natural Resources (LUANAR) and the University of Malawi. The importance of the workshop is demonstrated by the multi country and multi-disciplinary nature of the participants.

Our Guest of Honour, distinguished ladies and gentlemen, Climate change is a real threat and one of the biggest challenges facing mankind today. According to the 4th assessment report of the International Panel on Climate Change (IPCC) released in 2007, changes in frequency and severity of extreme climatic events in addition to the impacts of projected higher surface temperature have significant consequences for food production and other socio-economic activities. I understand that there is generally a global consensus on threats from climate change to all natural and human systems which has induced large scale research and development in terms of climate projections at global and regional scales and also in terms of modeling and assessment of impacts from the changing climate on various aspects of agriculture and food security.

Our Guest of Honor, distinguished ladies and gentlemen. The socio-economic impacts of climate change are very challenging as they occur much more rapidly than the environmental changes that cause them. These impacts, are nevertheless the most crucial as they directly influence on mankind. We are all aware of their effects on crop yields. This in turn has negative effects on the economies of most nations whose economies are largely dependent on agriculture.

Our Guest of Honor, distinguished ladies and gentlemen. The SoCoCA project started as a direct response to a clear need to strengthen the capacity for adaptation to climate change which is needed to secure a sustainable development of the societies in Sub-equatorial Africa. The project, whose implementation is being led by the Department of Geosciences at the University of Oslo, Norway, started in 2009 with funding from the Norwegian Research Council. SoCoCA

takes an inter-disciplinary approach combining natural and social sciences. It is also worthy pointing out here that international partners are an integral part of the project, including those from Sub-equatorial African countries, where SoCoCA will contribute to capacity building including funding educational activities.

Our Guest of Honor, distinguished ladies and gentlemen. This workshop is therefore an output from the project aimed at disseminating its results to various stakeholders in the region and also learns from them. I am informed that the workshop will cover five broad themes namely: Climate change in Sub-Saharan Africa: past and future changes in precipitation and temperatures; Changes in hydrology; Impacts and adaptation in the agricultural sector; Impacts on pasture yields and livestock; and Impacts on economic development. I wish to highlight that all these themes broadly cover three tenets of sustainable development namely: economic sustainability, social sustainability and environmental sustainability.

Our Guest of Honor, distinguished ladies and gentlemen. Finally, but not in the least, I wish to acknowledge the unfettered support from the Malawi Government. This is clearly summed up by the gracing of the occasion by the Hon Minister of Environment and Climate change Management, Catherine Gotani Hara and other top Government officials. I wish to take this opportunity to express our sincere gratitude for all the works done by the workshop organizers to make this workshop a success. I know you have worked and are working almost around the clock to ensure the success of the workshop.

With these few remarks, I wish you a pleasant and productive workshop. I thank you for Your attention.

Opening Remarks

Dr. Aloysious Kamperewera
Acting Director of Environment Affairs Department, Malawi

Distinguished participants from Norway, South Africa, DRC, Tanzania, China, Italy, Swaziland and Malawi.

Ladies and Gentlemen, It is my pleasure to speak to you today on this occasion. My humble duty today is not overwhelming but to ask the Honourable Minister to officially open the dissemination workshop which has been organized by the Universities of Oslo, Malawi & Lilongwe University of Agriculture and Natural Resources.

Distinguished participants. Before I do so, Honourable Minister, allow me to underscore the relevancy of this workshop to Malawi and to the entire world. Malawi Government realizes the importance and the role which research plays. This has been evidenced the by government's adoption of Climate Change as one of the major priorities in Malawi's overarching policy frame.
Distinguished participants

It is my hope and belief that the lessons to be shared at this three days workshop should be utilized as the world is striving to adapt and mitigate the effects of Climate Change.

Distinguished participants. I wish to thank our development partners especially Royal Norwegian Embassy in Lilongwe, Research Council of Norway, and SoCoCA organizing committee for the job well done. Honourable Minister, Distinguished Ladies and Gentlemen, with these few remarks, it is now my honour and humble duty to ask the Guest of Honour, Honourable Catherine Gotani Hara, MP to officially open the dissemination workshop.

Opening Speech by Guest of Honour

Hon. Catherine Gotani Hara, MP
Minister of Environment and Climate Change Management, Malawi

It is my pleasure to speak to you today on the occasion of this important workshop on Socio-Economic Consequences of Climate Change in Sub-Equatorial Africa. On my own behalf, and on behalf of the Government of Malawi, I would like to extend my warmest welcome to all distinguished participants, some of whom have travelled long distances from afar to be present here for the next two days.

Ladies and Gentlemen, Malawi is called the warm heart of Africa, with its very friendly people and I believe experiences of our international guests so far will attest to this. I therefore wish to encourage you all distinguished participants to also spare your time and consider visiting our beautiful Lake Malawi and any other parts of Malawi which may be of interest to you.

I am informed that this workshop has attracted participants from countries around the world including Malawi, Norway, United States of America, Brazil, Italy, South Africa, Tanzania, Swaziland and Democratic Republic of the Congo. Let me thank the organizers from the University of Oslo, Norway, University of Malawi and Lilongwe University of Agriculture and Natural Resources (LUANAR) for convening this highly meaningful event here in Lilongwe.

Distinguished ladies and gentlemen, there is general consensus that climate change is happening globally due to global warming induced by human activities. The Malawi Government, through the able leadership of Her Excellency Mrs Joyce Banda, President and Head of State of the Republic of Malawi, recognizes the impacts of climate change and considers the socio-economic impacts a priority among priorities in the Malawi Growth and Development Strategy.

Assessments conducted in the country have established that Climate change is having considerable impacts on agricultural and livelihood systems, especially among rural and other vulnerable communities.

As you may be aware, our economy is predominantly agro-based and climate change and regular shocks therefore have negative effects. The Malawi Government is therefore committed to, among other things, creating the right environment for addressing climate change impacts through interventions meant to address both adaptation and reduction of emissions of greenhouse gases. This commitment was demonstrated in February 2008 with the launching of the country's National Adaptation Programmes of Action (NAPA) as well as reports on Vulnerability and Adaptation Assessments, First and Second National Communications on Climate Change. The

NAPA identified priority issues aimed at increasing local understanding of the impacts of climate change and aims to engage a wider population in tackling climate change adaptation efforts. Key priority areas in the NAPA include improving community resilience, restoring forests, improving agricultural production and preparedness for floods and droughts and boosting climate monitoring.

Ladies and Gentlemen, I also want to assure this workshop that the Government of Malawi is committed to supporting research activities of this nature, as our country and the southern Africa region are very vulnerable to effects of climate change and variability.

Distinguished Ladies and Gentlemen, It is very encouraging to note that our Universities and other research institutions have partnered with international institutions in complimenting such efforts by conducting relevant and meaningful research. I am informed that some results from such research studies and activities will be presented at this workshop. This is a very important function, where local and international researchers will share their experiences in the scientific and social aspects of climate change. I am very optimistic that such knowledge sharing is vital not only for capacity building but also may create a platform for up-scaling success stories both locally and internationally so that communities in the region can learn from what is happening elsewhere to adapt to climate change and variability.

However, my Ministry, in its capacity as the Focal point for Climate Change issues in the country has noted with concern that there are a number of stakeholders engaged in implementation of climate change-related activities. Our observation is that these are not well coordinated, as most of these are conducted without my Ministry's knowledge. It is with this in mind that Government, through my Ministry, is currently developing a National Climate Change Policy and Climate Change Investment Plan, which will guide coordination, formulation, implementation and funding of climate change programmes.

I therefore encourage all distinguished participants gathered here to use this forum in devising ways to understand climate change better so that we can effectively confront the negative consequences of climate change, to ensure sustainable development for the sake of future generations.

In closing, I would like to once again extend my gratitude to all the participants and I look forward to a most successful and fruitful workshop.

I thank you for your attention and I declare this workshop officially open.

Climate and Water Resources

Abstracts

UiO : University of Oslo

LUANAR

UNIVERSITY OF MALAWI

The Research Council of Norway

NORWEGIAN EMBASSY

FLOOD FREQUENCY UNDER CHANGING CLIMATE IN THE UPPER KAFUE RIVER BASIN, SOUTHERN AFRICA: A LARGE SCALE HYDROLOGICAL MODEL APPLICATION

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The projected impacts of climate change and variability on floods in the southern Africa has not been well studied despite the threat they pose to human life and property. In this study, the potential impacts of climate change on floods in the upper Kafue River basin, a major tributary of the Zambezi River in southern Africa, were investigated. Catchment hydrography was delineated using the Hydro1k at a spatial resolution of 1 km. The daily global hydrological model WASMOD-D model was calibrated and validated during 1971-1986 and 1987-2001 with the simple-split sample test and during 1971-1980 and 1981-1990 with the differential split sample test, against observed discharge at Machiya gauging station. Predicted discharge for 2021-2050 and 2071-2100 were obtained by forcing the calibrated WASMOD-D with outputs from three GCMs (ECHAM, CMCC3 and IPSL) under the IPCC's SRES A2 and B1 scenarios. The three GCMs derived daily discharges were combined by assigning a weight to each of them according to their skills to reproduce the daily discharge. The two calibration and validation tests suggested that model performance based on evaluation criteria including the Nash-Sutcliffe (NS) coefficient, Pearson's correlation coefficient (r), Percent Bias (PBIAS) and R^2 was satisfactory. Flood frequency analysis for the reference period (1960-1990) and two future time slices and climate change scenarios was performed using the Peak Over Threshold (POT) analysis. The magnitude of flood peaks was shown to follow Generalised Pareto Distribution (GPA). The simulated floods in the scenario periods showed considerable departures from the reference period. In general, flood events increased during both scenario periods with 2021-2050 showing larger change. The approach in our study has a strong potential for similar assessments in other data scarce regions.

Keywords: Climate change, floods, WASMOD-D, POT, Kafue River, southern Africa.

DYNAMICAL DOWNSCALING OF RAINFALL AND TEMPERATURE OVER SOUTHERN AFRICA USING REGCM4

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We use the newest version of the International Centre for Theoretical Physics' (ICTP) regional climate model (RegCM4) nested in the National Center for Atmospheric Research Community Atmospheric Model (NCAR-CAM4, hereafter referred as CAM4) data to perform and analyze multi-decadal present-day and early future climate simulations over Southern Africa. The simulations are conducted at a horizontal resolution of 25 km for a continuous period from 1990 to 2029. To evaluate models, simulated mean climatology and annual cycle of rainfall and temperature have been compared to a set of observational data. The results show that, whilst CAM4 exhibits wetter and cooler biases, RegCM4 simulates accurately the rainfall intensity but reveals some warm temperatures biases around Congo desert. Therefore, RegCM4 provides a more realistic spatial distribution of these variables over the region. Annual cycles over the Central Southern Africa (CSA) and South Africa (SA) are better captured by RegCM4 than by CAM4, while, over the West Central Equatorial Africa (WCEA), annual cycles mostly follow the driving field. This suggests that the annual cycle over the CSA and SA is driven by regional processes represented by the internal regional climate model dynamics and physics, and, over the WCEA sub-region, the influences of large-scale conditions induced by boundary forcing are dominant. For this region we show that dynamical downscaling of the CAM4 global climate model data with the RegCM4 model leads to an improved description of the seasonal precipitation and temperature characteristics. For the early future (2012-2029), the two models estimate a comparable slight increase in the air temperature. We also perform a high resolution simulation at 10 km horizontal resolution over the Malawian region. In this simulation, RegCM4 is coupled with a 1D lake model and driven at the boundary by output from the 25 km run. Results show that the lake model reproduces accurately the observed Lake Malawi surface temperature at seasonal and annual scale. We conclude that the lake model is well suited for the simulation of the regional climate over the Malawian region.

Keywords: Dynamical downscaling, temperature, precipitation, Malawi.

DROUGHT UNDER CLIMATE CHANGE; A GLOBAL PERSPECTIVE

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Drought is considered one of the most severe and costly natural hazards, and is the single most important factor affecting world food security. The most severe human consequences of drought are often found in arid or semi-arid regions where water availability is already low under normal conditions, demand is close to, or exceeds, natural availability and society often lacks the capacity to mitigate or adapt to drought.

Observational evidence suggests that more intense droughts affecting an increasing number of people have been observed since the 1970s in Africa, the Mediterranean, Southeast Asia and eastern Australia. Such droughts have been linked to higher temperatures and decreased precipitation, which are considered to be the result of large scale changes in atmospheric circulation patterns in response to changing sea surface temperatures, wind patterns and decreased snow pack and cover. Moreover, climate models project increased drying in the 21st century in mid-continental regions, indicating a greater risk of drought. In 2050, IPCC expects that the annual average runoff will have increased by 10-40% at high latitudes and decreased by 10-30% over some dry regions at mid-latitudes and semi-arid low latitudes, some of which are already water-limited areas. In many dry and water scarce regions, the effects of climate change will come in addition to population increase and land use change.

One-third of the people in Africa live in drought-prone areas and are vulnerable to the impacts of drought. Major droughts have affected the Sahel, the Horn of Africa and southern Africa, particularly since the end of the 1960's. Climate change will likely lead to a further warming, causing a drying in the northern and southern parts of the continent. A significant decrease in runoff in sub-equatorial Africa is predicted, however, large variability among the models suggests high uncertainty in this region. The agricultural section is particularly sensitive to climate variability and change; with small farms and rain fed agriculture being most affected.

There are two main approaches to assess the impacts of climate change on water availability and drought, (i) analyse observed data for changes and trends and (ii) impact modelling using climate scenarios and physically based, hydrological models. In this presentation, a summary of observed and projected future changes in annual runoff and drought are given, globally and for Africa in particular. Further details can be found in Tallaksen, L.M. (2012) Drought and water availability under current and future climate.

Keywords: Drought, water resources, climate change, water stress, Africa.

CLIMATE CHANGE AND IMPACTS ON THE HYDROLOGY OF THE CONGO BASIN: THE CASE OF THE NORTHERN SUB-BASINS OF THE OUBANGUI AND SANGHA RIVERS

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It has been widely recognised that large river basins of Africa such as the Congo, with considerable total renewable water resources, will play a prominent role in regional cooperation to alleviate the pressure of water scarcity due to future climate change. However, very little is known about the hydrological response of the Congo Basin's runoff to future changes in environmental conditions. Water resources planning and management within the Congo Basin is an important issue, but there is always a lack of relevant information over various temporal and spatial scales to formulate decision making strategies. This study assesses the hydrological response of the Congo Basin's runoff to future changes of climatic conditions. The study is carried out at the sub-basin scale in the northern part of the Congo Basin for which downscaled GCM data have been obtained. In order to assess the impacts of climate change scenarios on water resources availability of the Congo Basin, three downscaled, skilful and and bias corrected GCMs were used to drive a semi-distributed rainfall-runoff model which was initially established for the whole Congo Basin through manual calibration and physically-based *a priori* parameter estimation approaches. The analysis focuses on the variables of the hydrological processes such as rainfall, interception, potential evapotranspiration, soil moisture store, surface runoff, soil moisture runoff, and recharge. In general terms, the study shows that there is a decrease in runoff for the near-future projections in the northern part of the Congo Basin which has a tropical transition regime. For the three GCMs used in this study, there is very little change in rainfall from the historical conditions. The major change is observed in evapotranspiration, due to an increase in air temperature. There is a clear indication of the translation of climate signal into flows with more than 10% decrease in total runoff, which is a consequence of relatively little increase in rainfall and a consistent increase in potential evapotranspiration. Increase in monthly potential evapotranspiration counter-balance the increase in monthly rainfall with a net effect on runoff.

Keywords: Climate change, Congo Basin, hydrology, uncertainty.

MODELING WATER TABLE DEPTH AND DRAINAGE DISCHARGE DYNAMICS IN ARID CONDITIONS OF SOUTH AFRICA, USING DRAINMOD 6.1

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Irrigation development still remains one of the world's well accepted climate change adaptation technologies. However, the increase in evaporation rates from surface water sources is also reducing the irrigation water quality quite significantly. More water is required for the leaching of salts; resulting in shallow water tables and soil salinisation. Installation of accurately designed subsurface drainage systems in irrigated areas is of paramount importance in order to prevent such consequences. The challenge, however, is on how to determine optimum combinations of drain depth, spacing and drainage discharges (DDs) suitable for different cropping systems. This study investigated the reliability of the DRAINMOD model – a soil hydrological model, as subsurface drainage design tool in the sugarcane fields of Pongola, South Africa. Water table depths (WTDs) were monitored in piezometers installed mid-way between two drains by using an electronic dip meter with a beeper, while DDs were manually measured at drain lateral outlet points. Results of the DRAINMOD model evaluation in predicting WTD showed that there was a very strong agreement between simulated and observed WTDs, with a Goodness of fit (R^2) of 0.826 and a Mean Absolute Error (MAE) of 5.341 cm. A further application of the validated DRAINMOD model revealed that drain pipes installed at a spacing ranging from 25 to 40 m and their respective drain depths between 1.4 and 1.8 m were adequate to maintain a mean seasonal WTD of 1.0 to 1.5 m in clay soil. For clay-loam soil, drain depths ranging from 1.4 to 1.8 m installed at a drain spacing of between 55 to 70 m were found to be appropriate in maintaining a mean seasonal WTDs between 1.0 and 1.5 m. Based on these results, DRAINMOD 6.1 can reliably be used as a subsurface drainage design tool in the Pongola region.

Keywords: Drain depth, drain spacing, DRAINMOD model, water table depth.

DROUGHT COPING STRATEGIES IN A RURAL AREA IN SWAZILAND: A CASE OF LONHLUPHEKO COMMUNITY

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Climate change predictions for Swaziland suggest that temperatures will increase by 2.5^{o}C and annual rainfall will decrease by about 100 mm by the year 2050. The frequency of drought and its intensity is likely to increase in the future. The occurrence of drought cannot be divorced from the effects of climate change. A study was undertaken to determine drought coping strategies in a rural, semi-arid area in Swaziland. A questionnaire was developed and administered to a total of 57 homesteads. The information sought by the questionnaire included coping strategies employed at household level and external and institutional support to cope with drought and their perceptions on weather forecasts.

The drought coping strategies practiced at household level included marketing and selling of vegetables, provision of labor for food and money, and brewing and selling of traditional brew. Female members of the households played a major role in coping with drought, as they were involved in most of the strategies. External and institutional support obtained by the respondents included food aid and farming inputs from non governmental organizations, free primary education, and feeding schemes benefiting school going children. The drought adaptation measures proposed by respondents included construction of dams and rainwater harvesting structures.

The feeling of the respondents was that the weather forecast by the National Meteorological Services department was not helpful in their deciding on the crop to grow in any season, as it was on daily predictions, and not for the whole season. They expressed the need for drought tolerant crops as climate variability and drought has made the production of maize in the area not viable. Swaziland does not have any crop breeding activities. Seed is mainly imported from South Africa, Zambia and Zimbabwe. The country does not have a climate change policy or climate change adaptation strategy, and as such climate change and adaptation activities lacked coordination. The government may have to request for assistance in the form of funds and experts from international organizations to develop the climate change adaptation strategy that will be holistic and practical.

Keywords: Drought, coping strategies, climate change adaptation, Swaziland.

FUTURE CHANGES IN EXTREME PRECIPITATION EXTREMES OVER SOUTHERN AFRICA

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The extreme precipitation events, defined as the number of days exceeding 1961 – 1990 95th percentile precipitation (R95d), over southern Africa are analyzed using coupled climate model simulations. Two future scenario experiments, namely RCP4.5 and RCP8.5, spanning 2006 – 2035 period are compared with historical simulation during 1976 – 2005 period. We used daily precipitation data from an ensemble of 20 global climate models which participate in the fifth generation Climate Model Inter-comparison Project (CMIP5). Different sub-regions of Africa are selected for detailed analysis, based on the climatological pattern of seasonal mean precipitation. All the selected regions are found to have increasing trends during December – February (DJF) season in R95d in both RCP4.5 and RCP8.5 scenarios. A large area covering central part of southern Africa is found to have stronger trends in precipitation extremes. The DJF mean precipitation is also found to be increased over the central southern Africa, covering Malawi, Zambia, parts of Tanzania, D.R. Congo, and Angola, with RCP8.5 scenario showing the strongest increase.

The dry extremes are also analyzed using the index, maximum number Consecutive Dry Days (CDD) where a dry day is defined as a day with less than 1 mm precipitation. The CDD did not show any discernible trends in both future scenarios as in the case of R95d. However, the inter-annual variability in CDD is found to be increased in the future scenario simulations when compared to historical simulation. The results suggest increased chances of frequent precipitation extremes over southern Africa in the future as well as longer periods of droughts.

Keywords: Extreme Rainfall, GCMs, future climate scenarios, southern Africa.

HYDROLOGICAL MODELING CLIMATE CHANGE IN SOUTHERN AFRICA

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Three global datasets with different spatial scales were used, including i.e. Tropical Rainfall Measuring Mission (TRMM), the Water and Global Change (WATCH) Forcing Data (WFD) and Regional Climate Modeling (RegCM4), for driving a large-scale hydrological model (WASMOD-D) in southern Africa in history period. Then the potential impacts of climate change on hydrological changes i.e. runoff and evapotranspiration (ET), in southern Africa were investigated. Three GCM (ECHAM, CMCC3 and IPSL) under the IPCC's SRES A2 and B1 and RegCM4 scenarios were used in this study for regional projection of climate change. The consistency and differences of TRMM and WFD precipitation datasets in southern Africa were compared by several statistic tests and methods which include the Mann-Kendall (M-K), the Kolmogorov-Smirnov (K-S) and the Student's t-test and F-test. The performance of the daily large scale hydrological model (WASMOD-D) was evaluated in the simulation of the water balance of 22 gauged basins and the whole southern Africa region with these two global datasets as inputs. Two datasets were used to drive the large scale hydrological model (WASMOD-D) in water balance simulations in southern Africa during their overlapping period 1997-2001. The modeling results were compared and assessed based on commonly applied indices. Finally, the water balance for the southern Africa was simulated with regionalized model parameter values based on the calibrated values of the 22 gauged catchments.

The results reveal that WASMOD-D simulations based on the two data sets in Southern Africa result in model performances above 0.5 for NS, below 10% for VE and good reproduction of the observed flow duration curves for majority of the basins. The simulated runoff and ET in the future scenario showed considerable departures from the history period. In general, ET increased during both scenario periods with 2010-2029 and 2050-2069, while runoff also increased during both scenario periods, with the A2 scenarios projecting a slightly higher increase than the B1 scenario and periods of 2010-2029 projecting a higher increase. The scenario results from GCMs and RCM (RegCM4) with different spatial resolutions showed large differences in hydrological changes.

Keywords: TRMM, WATCH Forcing Data, Hydrological modeling, Southern Africa.

Agriculture and Food Security

Abstracts

FODDER SECURITY AND CLIMATE CHANGE

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Climate change affects livestock and crop production differently. Herded animals must survive through the entire annual cycle while annual crops depend on the growing season only. Moreover, herders have no means of improving their rangeland environments. Cultivators, however, can aid their crops by supplementary irrigation in case of dry spells within the growing season. When the issue is pastoral livestock systems we need data on how climate change affects the rangeland vegetation during rainy seasons and also how it affects the severity of the dry periods during which animals may depend on body reserves for survival.

Relevant climatic parameters include temperature and rainfall. Quantitative effects of temperature on fodder quality varies between 0,5 and 1 percent units of reduction of digestibility per degree centigrade of increased temperature. Rainfall distribution determines the duration of the productive period when high quality fodder is available and the duration of the dry season when fodder availability is below the animals' body maintenance requirements in terms of amount and quality.

While temperature projections are fairly reliable, rainfall data are more uncertain. Generally climate scenarios indicate a progressively drier climate in arid and semi-arid tropics where pastoral livestock production is the prevailing means of livelihood. To analyse impacts and discuss possible means of adaptation we need more specific rainfall scenarios. Huge rangeland areas have bimodal rainfall. For case studies in the horn of Africa SoCoCa partners have reanalysed climate data separating the two rainy seasons and shown different patterns using such parameters as CDD (consecutive dry days) and RR5 (no of days with more than 5 mm of rainfall).

We have collected data on how pastoral production has been affected by climate variation in recent history and discuss climate scenarios showing that future impacts may exceed traditional adaptive capacity. Avoiding collapse of the systems may require innovative measures including increasing off-take through commercialisation and enhanced marketing, establishment of fodder banks in wetter or irrigated areas, fodder conservation, establishment of feed depots for drought emergencies and enhancing effective utilization of low quality roughages, including crop residues in agro-pastoral areas.

Keywords: Livestock, Climate change, fodder security, Africa.

A CRITICAL REVIEW OF COMMUNITY FORESTRY IN ZOMBA AS A CLIMATE CHANGE MITIGATION MEASURE: IS IT WORTH THE MONEY AND EFFORT?

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This report examines the performance and future of community forestry in Zomba in abating effects of climate change and meeting the ever increasing demand for various forest goods and services in the light of the increased climate change debate. Using EU public works program which promoted community forestry on customary land and Improved Forest Management for Sustainable Livelihood which promote community participation on management of forests on public land, as case studies, lessons are drawn on whether these program improved or worsened the state of forests and their ability to cushion the effects of climate change on communities. Available reports and interviews with project staff and field visits paint a grim picture. The forest resources in general is on the decline, most of the community institutions created during the projects have disintegrated, the capacity of local communities to court climate change funding has failed to establish, in general donor and government funding for community forestry is on the decline and the number of experts to assist with community forestry is also on the decline. Despite this bleak scenario, the report suggests a more holistic approach that does not focus on the biological resources alone, but also include social and economic issues such historical ills, poverty, population pressures and macro and micro-economic issues that are intricately nested in the problem to develop long lasting solutions to achieve success.

Keywords: Forestry management, social and economic issues, Zomba.

ASSESSMENT OF AGRICULTURAL PRODUCTION VULNERABILITY IN THECONTEXT OF CLIMATE VARIABILITY IN CENTRAL TANZANIA

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Climate variability is an immediate challenge with a practical inter-linkage with most of the main priorities affecting the economy of poor people, and poses threats to agriculture production and food security in rural communities. The agricultural outputs, as well as the livelihoods of people who depend on climate sensitive agricultural resources are particularly vulnerable. This study envisages assessing the dynamics and vulnerability of agricultural production to climate variability so as to increase resilience and creating opportunities for increasing agricultural production and environmental sustainability. The results indicated that more frequent and severe extreme climatic events especially drought are the challenge of agricultural production and on ensuring food security in the area. Changes in temperature and rainfall (timing and quantity) potentially affect agriculture production. It was revealed that the area suitable for agriculture, length of growing season, yield potential and yields from rain-fed agriculture have been decreased and local food supplies are negatively affected due to increased of temperatures, and unpredictability of rainfall. About 80% of farmers are not sure on harvesting their crops as evidenced by the loss of harvest for three consecutive years due to unpredictable rainfall and an increase of temperature. It was further indicated that 90% of losses on crop produce was due to impacts associated with the unpredictability of rainfall and increases in pests and diseases. Addressing adverse effects of climate variability is among the critical challenges facing the rural communities in central Tanzania because of their reliance on rain-fed subsistence agriculture which is one of the climate-sensitive livelihood activities. Such situation had posed a challenge in agricultural production, livelihoods and sustainable development and resources management. In addressing such challenges agricultural production was recommended to be improved through growing drought and pest/disease resistance crops, early maturing crops, adjustment of planting time, development of irrigation infrastructure where ever possible, subsidization of agricultural inputs and implements of rural social services as coping and adaptation strategies.

Keywords: Agriculture, climate variability, adaptation, food security, vulnerability and central Tanzania.

INTEGRATING CLIMATE CHANGE ADAPTATION IN AGRICULTURE AND NATURAL RESOURCE MANAGEMENT IN MALAWI

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Climate change has caused extreme weather events such as frequent droughts, floods, heat and cold waves. Farmers and communities lack contextualized information on adaptation to climate change, however, farmers and extension workers need to understand causes of weather disruptions and strengthen their adaptation and coping mechanisms. The study aimed at building capacity of communities to support development of effective climate change adaptation strategies in dealing with agriculture and natural resources management. The project targeted Chikhwawa and Nsanje districts to gather information on practices that are adopted in adapting to extreme weather and climate change. A household survey was conducted in two villages in Chikhwawa and three villages in Nsanje District. The information collected was synthesized and presented to stakeholders from different sectors. It was observed that climate change has brought climate refugees where heavily affected communities relocated to upland areas. The communities were practising conservation of catchment areas, construction of dykes, growing of drought-tolerant crops and early maturing varieties. Thus, rainwater harvesting technologies, irrigation agriculture, winter cropping, crop diversification and growing of drought tolerant crops are adopted to improve survival and productivity of crops. Improved tillage practices to conserve moisture and soil including conservation tillage, planting of vetiver grass, crop residue management and ridge alignment and better crop husbandry practices including Agroforestry technology are being practiced. Coping mechanisms to climate change impacts include sale of livestock, taking up casual labour and migration to other sites. The communities in the two districts also use indigenous knowledge for forecasting early indicators of weather changes mostly using changes in the animal and plant behaviour and astronomical features. Information gathered has been synthesized to produce four modules and have since been used for training and creating awareness to over 30 pupils, 40 teachers and over 75 households.

Keywords: Adaptation, climate change, climate refugees, coping mechanisms, indigenous knowledge.

DECLINING VALUE OF INDIGENOUS KNOWLEDGE IN WEATHER CLIMATE AND FORECASTS: CHALLENGES OF AGRICULTURAL ADAPTATION TO CLIMATE VARIABILITY IN MPASU AND MPHAMPHA, CHIKHWAWA, MALAWI

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Subsistence rain fed agriculture underpins most rural livelihoods in Sub Saharan Africa. Reliable climate and weather forecast is therefore crucial to guide farm-level decisions. Scientific forecasts have spatial limitations at lower spatial scales such as village level where they are required most. Traditionally farmers in Africa have therefore relied on indigenous knowledge (IK) to understand weather and climate patterns in selecting crops and farming practices. However, increased rainfall variability associated with climate change in recent years has reduced their confidence in indigenous knowledge, hence reducing their adaptive capacity and increasing their vulnerability to climate change. A study was therefore conducted in Mpasu and Mphampha villages to establish commonly used IK indicators in weather and climate forecasting and analyse people's perception of climate change and variability in the villages. The villages are in Mbewe EPA situated in Chikhwawa, a semi arid and highly vulnerable district to rainfall variability in Malawi. The study employed focus group discussions, key informant and household interviews. Some data on climate change and variability was also scientifically validated. The results revealed various forms of traditional indicators including environmental conditions and certain patterns of flora. However, the value of these indicators is declining in guiding farm operations. Major climatic events reported by the villagers agree with empirical evidence. These include warming temperatures and declining rainfall trends. These trends have impacted their crop and livestock production – cropping patterns and yields. The villagers therefore, suggested localizing scientific weather and climate prediction and enhancing farmers' capacity through training in collection and use the weather data as one of the prioritized adaptation strategies aimed at reducing their vulnerability. In the long term these data are expected to be linked with local observations, hence making both IK and conventional science more reliable. Recognizing existing challenges of managing the existing physical weather stations, the study suggests use of localized automated weather stations.

Keywords: Indigenous knowledge, weather forecast, rainfall variability, rain fed agriculture.

THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE PRODUCTION, FOOD SECURITY AND NUTRITION IN MALAWI

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Malawian economy is largely dominated by the agricultural sector which has a direct impact on economic growth of the country. Given that 90 percent of agriculture is rain fed, the majority of the population engaged in agricultural production as smallholder subsistence farmers are highly vulnerable to any climatic changes. This continued exposure to risks and vulnerability impact heavily on livelihoods of rural households. Vulnerability is further compounded by limited access to irrigation facilities. The nutritional status in Malawi has been deteriorating over the past years due to a number of factors ranging from inadequate knowledge, floods, droughts, inefficient marketing system, poor policy and management of national strategic reserves. Aggravating the problem of food and nutrition insecurity is the impending threat of climate change. Climate change will worsen food security, nutrition and rural poverty. The direct effects of climate change in Malawi include an increase in severity and the areas affected by droughts such as Balaka, Ntcheu, Mzimba Kasungu and floods in Karonga, Salima, Chikhwawa Nsanje, reduced water in rivers and lakes such as lakes Chirwa, Kazuni etc. There will be more deforestation as the increasing communities try to cope with the problems by plundering natural resources and more soil erosion. Crop production will decline, livestock numbers will dwindle due to insufficient feed, there will be high food prices, reduced nutritional standards and increased poverty. This paper looks at the current agriculture practices, the impacts of climate change on agriculture nutrition, poverty and general livelihoods. It also examines some of the alternative mitigation factors that could be adopted by the communities such as use of drought tolerant seeds, change in food types and eating habits, improved production techniques and an increased number of water holding structures. It recommends enhanced actions among all stakeholders such as the Government, NGOs and local communities.

Key words: Climate change, impacts on agriculture, nutrition and livelihoods, mitigation measures.

LITERACY AND CLIMATE CHANGE

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All stations in Malawi receive more that 700 mm rainfall, sufficient for rain-fed agriculture. Bolero, in Rumphi]has over the last 30 years received only **618.2** mm (12% less than 700mm minimum), with a 7 out 10 year-probability of less than sufficient rain-fed agriculture. Paradoxically, and despite with the least rainfall, Rumphi is the most food secure district in Malawi. When it comes to when own food run out, Rumphi is least or has the lowest percent of those without own food by October [2008/9], thanks to being with the highest overall in literacy [the women level is also fabulously high] in Malawi.

The study uses the Department of Climate and Meteorological Services 30 years of rainfall data to calculate average rainfall from Bolero station in Rumphi. Then the study analyses the 2008/9 NSO Welfare Monitoring Survey information to gauge, specifically the question, "When does own food run out?" and child nutrition levels. The Ogive is used to graph the results of when own food runs out. The study finally links the results to the levels of literacy in Malawi.

An Ogive (cumulative distribution) analysis shows Rumphi as the best. However, nationally, those without own-produced food are almost one third by October in the best of seasons in Malawi. All economic and social indicators follow the same trend. Despite the district receiving less than the 700 mm required for normal rain-fed agriculture and the least rainfall in Malawi, the district is overall the most food secure thanks to the highest levels of literacy, especially for women who mainly produce food crops.

Therefore, Literacy can weather down the effects of climate change experienced locally and globally. Economic development will follow when people can basically read and write. Such people are in a better position to fight poverty, disease and challenges like climate change.

Keywords: Less than sufficient, 700mm minimum, ogive, literacy, climate change.

CLIMATE CHANGE AND VARIABILITY IN THE LAKE CHILWA BASIN: IMPLICATIONS FOR FOOD SECURITY

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Lake Chilwa is among the most productive wetlands in Malawi that sustains the livelihoods of approximately 1.4 million people in the three basin districts of Machinga, Phalombe and Zomba. It supports an estimated 91% of smallholder farmers with agriculture, fishing and forestry as their main sources of food and income. The fishery is the most important natural resource in and around the lake, yielding about 25,000 tonnes per year and contributing substantially to the nutrition and economy of the basin and the country. Income from fish sales is, in turn, used for food and agricultural input purchases. Water is the critical resource linking the agro-ecological zones and sustaining forests, farming and the fishery but supply and quality are threatened by destructive land-use practices. This study analyses rainfall and lake level patterns to build a case for informing decision-making on the integration of food security strategies in the existing Lake Chilwa Management plans using historical hydrological methods. Analysis of total annual precipitation from 1982 – 2008 and mean annual Lake Chilwa water levels from 1949 to 1999 show fluctuations on a generally declining trend, interspaced with periods of droughts that result in the recession of lake water levels. The recessions lead to reduced catches, increased fish mortalities, dramatic increase in waterfowl hunting and trapping and habitat destruction. The drying of Lake Chilwa in 1995, the current receding lake water levels and the resultant loss of livelihoods are a manifestation of the expected impacts of climate change and variability on natural resources exploitation and food security in the basin. Under the Ramsar Convention, Malawi is committed to conserving and managing the Lake Chilwa Wetland wisely through which water and food security for the people of the basin would be improved and sustained. We recommend that as measures are being taken to address climate change in the basin, special effort should be made to incorporate strategies aimed at increasing the availability, accessibility, utilisation and the stability of food among basin households.

Keywords: Climate change, climate variability, food security, Lake Chilwa basin, Malawi.

IMPACT OF ENVIRONMENTAL DEGRADATION ON THE FISHERY AND LIVELIHOODS – A CASE FOR THE SOUTH EAST ARM OF LAKE MALAWI IN MANGOCHI

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Livelihoods entirely dependent on natural resources and lack of consolidated interventions are compromising on the environmental status of the South East Arm (SEA) of Lake Malawi, hence placing both the resources and livelihoods on a precarious course. SEA which supports over 40,000 households is considered as Malawi's major fishing ground is currently under threat. The area has a relatively high population density of 60 people per km^2, most of whom are trading off their natural resources through unsustainable utilization due to poverty. Focus group discussions with community resource users and consultations with key stakeholders from SEA hot spot of Monkey Bay, Makawa, Namalaka, and Makanjira areas that was carried out between January – June 2012 reveals that deforestation for wood energy, human settlement, subsistence farming that is heavily dependent on fertilizers and pesticides under farm input subsidy program are the major culprits to environmental degradation in the area. This was reinforced by extensive literature reviews. Enormous volumes of soil and chemicals into the lake have lead to high levels of nutrient load thus compromising on aquatic biodiversity. Study findings also corroborated with statistics on dwindling fish catches as spawning sites continue to be lost. Aquatic plants like azolla and water hyacinth are proliferating. Unstable rainfall patterns have been observed in the study area evident by dry out of what used to be annual flowing streams hence poor crop production. There are no wide spread climate change coping mechanisms as the majority are exerting undue pressure on fish and forest resources for short term livelihood support. Communities are capitalizing on weak government enforcement capacity to engage destructive fishing gears and encroach into Lake Malawi National Park and other gazzeted forests. Careless dumping of wastes from tourism activities and human settlements along the Mangochi - Monkey bay stretch, continue to impact negatively on the environment. Institutions are deemed to be working in isolation on environmental management disregarding how interlinked the issues are. With such identified shortfalls, this paper recommends for stakeholder collaboration in the implementation of broad based sustainable environmental management programs and formulation of coherent climate change compliant livelihood strategies for the communities. As all is not lost, fears are rife that livelihoods mostly through the fishery might collapse if no immediate redress is done.

Keywords: Livelihoods, sustainable natural resources, biodiversity, fish resources.

Socio-Economy and Adaptation

Abstracts

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NORWEGIAN EMBASSY

IMPACTS OF CLIMATE CHANGE TO THE MALAWIAN ECONOMY AND CONSEQUENCES FOR THE LIVELIHOOD OF SMALL-HOLDING FARMERS

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This presentation suggests how down-scaled projections based on Global Climate Models models can be used to estimate the impacts of climate change on macroeconomic indicators to a country, and how changes in the economic aggregates for a country can provide useful information for studies of adaptation and vulnerability to climate change in local communities with small-holding farmers. By use of a global general equilibrium model that integrates impacts of climate change, we estimate the overall economic consequences of switching from a high-emission scenario (RCP8.5) to a low-emission scenario (RCP4.5) to African economies south of Sahara. Being based on a standard description of economic activities, these estimates apply, in principle, only to market based economic activities. Consequently, the results give insufficient indications of implications to the welfare of the population in general, and to small-holding farmers in particular. In order to address the vulnerability of small-holding farmers in Malawi, we extend the description of the agricultural sector of the economy by linking the production to the distribution of farm sizes. Further imposing a minimum constraint on the consumption of food by household, the economic impacts of climate change projected by the global model can be derived for the different farm sizes. This prepares the ground for analyses of adaptation and vulnerabilities in the light of the opportunities various households have for providing food by subsistence farming, for trading products in markets and for attaining extra income by alternative employment. We show how different the changes in macroeconomic indicators resulting from climate change may affect the livelihood for various households depending on the size of the farm.

Keywords: GCMs, climate change, macroeconomic indicators, adaptation, Malawi.

SOCIO-ECONOMIC IMPACTS OF FLOODS AND DROUGHTS IN THE MIDDLE ZAMBEZI RIVER BASIN

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The major issues affecting communities' livelihood in the middle Zambezi River Basin are related to recurrent floods and droughts. Floods are due to seasonal rainfall which occurs at the peak of the rainfall season and destroy crops. As for droughts, the frequency of dry-spells of 20 days on average has increased. Some of these areas are occupied by human settlements, floods and droughts which became more frequent in recent years, have led to adverse impacts on their livelihoods. A case study was drawn from Mbire district in Zimbabwe, which is one the low lying areas within the Middle Zambezi River Basin. The study analyses the impacts of weather extreme events and coping mechanisms which households apply to counter them. Data collection was done using semi-structured interviews, focus group discussions and semi-structured questionnaires. To substantiate qualitative data, secondary data including crop production and precipitation were collected from Mbire district authority and Zimbabwe Meteorological Office respectively. The impacts of floods and droughts in the district, notably in some wards such as Kanyemba are the reduction of crop production, food shortages, reduction of agriculture derived income and death of livestock.

Households have responded to these impacts through a number of coping mechanisms including disposal of assets, labour migration, floodplain cultivation, stream bank cultivation and fishing using lines. Initiatives on setting up irrigation schemes have been tried but these have failed due to water course agreements in Zambezi Basin. However, such coping mechanisms are short term and some of them are in conflict with the laws or agreement of the country. There is a need to address the issues in the holistic manner, integrating policy makers, local communities and other stakeholders in the region, for shift in focus from food aid to long-term mitigation and adaptation measures such as drought-resistant crop varieties, early warning system, irrigation schemes development and providing off-farm employment opportunities, so that the impact of floods and droughts can be minimised.

Keywords: Coping mechanisms, droughts, floods.

DANGEROUS SILENCES: A FEMINIST CRITIQUE OF MALAWI'S NAPA

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That Malawian women hold the worst end of the stick when Malawi suffers adverse climatic changes, is an issue that scholars resoundingly converge on (Njewa 2005, Harrigan 2005). However, a critical analysis of the 2006 Malawi National Adaptation programmes of Action (NAPA), a self identified 'key devise in facilitating urgent and immediate adaptation needs of vulnerable communities' (2006, ix), evidences a document that suffers from an acute malnutrition when it comes to engaging and mainstreaming gender as a main organising principle in most Malawian communities (Kabwila 2006, 2010). This paper interrogates NAPA's adaptation strategies from a feminist perspective, arguing that the NAPA glosses over gender and women and is silent on the patriarchal communal power relations that construct and reproduce women's vulnerability to adverse climatic changes in Malawi (Tizifa 1994, Chirwa 2003). This patriarchy is the engine that has to be engaged if adaptation strategies are to reach many women and do so with sustenance. If one considers women's positionality in most Malawian communities and the impact this has on them when Malawi suffers adverse climate changes, it becomes imperative that a key climate adaptation devise like the NAPA, cannot afford to limit itself to the laundry list, role call (*kuchongetsa*) approach to gender and women. It has to transcend that and clearly identify gender and women in the majority of the 'fifteen urgent and immediate priority needs for adaptation' (2006, ix). Being silent or glossing over gender power relations (Alber 2009) negatively impacts the credibility of the NAPA's adaptation and mitigation strategies as the latter, become products of an eclipsing of the very people worst hit by adverse climate changes. Failure to engage gender and women sustainably cripples efforts to fruitfully define the source of women's vulnerability. This tends to homogenise and pathologies Malawian women. Taking off from an analysis of the representation of gender and women in the NAPA, the paper employs Lucius Banda's popular song *Zakukhosi* (*Survivor* 2006) to underline the position of women in Malawi and the importance of engaging the power relations that produce their positionality, when designing climate adaptation intervention devices like the NAPA.

Keywords: NAPA, climate change, gender and women, Malawi.

RE-THINKING IRRIGATION WATER QUALITY MONITORING AS A TOOL FOR CLIMATE CHANGE ADAPTATION IN MALAWI

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Climatic change and resultant alterations on availability and quality of irrigation water are a threat to socio-economic development and agricultural production in Malawi. Use of saline water poses a risk of salt accumulation in the root zone and consequent damage to crop production and soil fertility. Concerns of effects of climate change on water quality have often been neglected over concerns of availability and quantity in irrigation projects in Malawi. In this study, irrigation water quality monitoring was done in Mpherembe and Mtwalo areas in Mzimba district, northern Malawi, in order to locate usable irrigation water resources, plan for and assess possible adaptations to changing climate. Irrigation water samples (68) were collected from shallow wells and boreholes in dry and wet seasons from 2009-2012 and analysed for pH, major ions, total dissolved solids (TDS), total alkalinity and electrical conductivity (EC), using standard methods. The United States Salinity and Wilcox diagrams were used to classify and evaluate the groundwater in terms of its suitability for irrigation. The levels of EC, a measure of level of mineralisation, ranged from 50-3,160 µS/cm in July, 2009 to 750-3,800 in July, 2012. The results suggested the effect of evapo-concentration process, which resulted into the salt water intrusion. A significant number of usable irrigation water sources were observed to changing to more saline waters as only 14.7 % belonged to very salinity type (EC > 3,160 µS/cm) and unsuitable for irrigation in July, 2009 compared to 25.4 % very high salinity water type in July, 2012. Although the % Na^+ and SAR were found to be consistently <60% and <10, respectively, the high salinity waters are generally undesirable for irrigation. Although saline water is already used in agriculture in the studied area, its use without suitable soil-crop-irrigation management poses high risks of land degradation through the development of salinity, sodicity, ion-specific toxicity, and nutrient imbalance in irrigated soils. These reduce crop productivity and limit crop choice in the studied area. There is need to re-think monitoring of irrigation water quality in order to adapt to future changes to climate change in the agriculture sector in Malawi.

Keywords: Water quality, climate change, salinity, irrigation.

USE OF INDIGENOUS KNOWLEDGE IN DETECTING WEATHER AND CLIMATE CHANGE: CASE OF NDINDI COMMUNITIES IN SALIMA DISTRICT, MALAWI

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Within the framework of climate change studies, people rely predominantly on their local or indigenous knowledge, unique to their culture. The present study was conducted to determine different ways in which indigenous knowledge is used in determining climate change in Malawi. Specifically the objectives were a) to quantify different ways of indigenous knowledge that people use in Salima district to detect climate change and b) to determine commonly used indigenous ways of forecasting weather in the district. Household interviews were conducted using questionnaires to collect information on demographic characteristics vis-à-vis gender and age, indigenous early warning indicators, use of early warning information and ways of passing of indigenous information to young generations. A total of 88 respondents were interviewed. SPSS and Microsoft Excel were used to analyze the data. Occurrence of frequent droughts, change in rainfall patterns and long dry spell were mentioned as the major indicators of climate change. Further, the results revealed that leaf setting; flowering; and fruiting of some plants such as *Mangifera indica*, and the behaviour of some animals (Ducks) and insects (Ants); appearance of clouds; shape and change in colour of the moon are the common indigenous ways of forecasting weather among Mphunga and Ndindi communities. Therefore it was recommended that there is need for simplified information on the science and issues of climate change to build on the already existing indigenous knowledge systems. In addition, greater awareness campaigns among local communities especially the youths, policy makers on the use of indigenous knowledge in forecasting weather is called for since adaptation to climate change is effective at community level if people have proper understanding of what they are doing and its cost and benefits. Validation of indigenous knowledge on its use with scientific methods is also required. In view of this, training of community members to understand forecasts and sharing of local forecasting information and partnership is necessary.

Keywords: Indigenous knowledge, climate change, Salima, Malawi, climate forecasting.

IMPACT OF WASTE DISPOSAL SITES TO CLIMATE CHANGE AND SOCIAL-ECONOMIC STATUS OF LIVELIHOODS SURROUNDING THEM: A CASE OF SADIKI AND MSOGOJA VILLAGES IN BLANTYRE DISTRICT

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A study was carried out at 'Kachere ntaya', one of the waste disposal sites in Blantyre, Malawi. The main objective was to assess the impact of waste disposal sites on climate change and socio-economic status of people surrounding it. The semi-structured questionnaire was used to collect data. Statistical Package for Social Scientists (SPSS) was used to analyze data.

The study found out that wastes are cleared off through burning, and yet they are not separated into solid and liquid wastes during disposal in the localities; and yet this produces a lot of greenhouse gases like methane and carbon dioxide which increase the effects of climate change. Besides the ntaya are peoples fields and a river 'namangunda' which has silted due to spill-offs from the disposal site and yet it is a source of water for a scheme just 7km away. The main items that are scavenged on at the disposal site are used plastic papers and plastic bottles that are sold to companies for recycling; soya bean husks that used to feed livestock such as pigs; and food items like raw chickens, nsima and chips that are eaten either on the spot or in the scavengers homes or sold to people surrounding who get about K200/ day to improve their livelihoods. 60% of scavengers at Kachere Ntaya come from Msogoja village, whilst 29% and 11% come from Sadiki village and Kachere trading centre respectively.

From the study, it can be recommended that emphasis be made on top options waste management hierarchy to localities inorder to reduce greenhouse gas emissions, creating awareness on the health hazards of scavenging and using the food items from the waste disposal sites and study to be conducted to find out if the surrounding fields and the water that is used at the affected irrigation scheme are not contaminated.

Keywords: Waste disposal site, climate, socio-economic status, scavenger.

Working Group Reports

Theme 1: Climate and Water Resources

The theme covered a wide range of presentations on climate and water resources. Some centered on climate model simulations and others were climate and land use impact assessments on hydrological processes.

1. **Who are the users of our information?**
    (a) The information is in this case physical variables and indicators related to hydroclimatology (e.g. precipitation, temperature, drought indices, river discharge).
    (b) The users are water managers, national disaster preparedness agencies, impact modelers, various sectors like the agricultural sector (subsistence farmers, irrigation needs), forestry, fisheries, navigation and industry (including hydropower), ecologists, policy makers and the public.
2. **What are their needs and expectations?**
    (a) Provide projections for the near future.
    (b) Less technical communication of scientific results, which can be facilitated through:
        (i) Training of the scientific staff.
        (ii) Introduce a "middle man" (e.g. communication expert with a base in science) to assist in "demystifying" the science.
    (c) Expect scientists to provide more clear results than currently can be given, e.g. spatial and temporal scales (regional vs. local scales, mean vs. extremes values).
    (d) Ensure sufficient meeting places between scientists and users.
    (e) Invest time in the dissemination of science results to the users as a continuous process as science is always progressing.
3. **What are the most important findings in support of this?**
    (a) Capacity constraints.
    (b) Need to distinguish between global change (e.g. land use change, water withdrawals) and climate change as the adaptation processes are different.

(c) Need for more data (new stations as well as continuous long time series) and raise awareness of all those involved.

(d) Society needs to adapt to higher variability in climate and hydrology (water resources, extremes, etc.).

(e) Need for success adaptation stories to be shared for up scaling and inclusion into policies.

(f) Need to integrate climate change adaptation into the development process to create robust and less vulnerable societies.

4. Which are the research gaps?

(a) Need to link perceptions of change to scientific proof of change.

(b) More studies on the detection of changes and trends using standard techniques.

(c) More regional climate model simulations to support ensemble modeling.

(d) Extensive naturalized as well as human impact model runs.

(e) Analyse how changes in land use (e.g. deforestation) have impacted regional and local climate as well as the water balance.

(f) Climate change impacts studies on groundwater (quality and quantity).

(g) Quantitative assessment of the uncertainty in model simulations.

(h) Global change impacts on large water bodies (e.g. Lake Tanganyika, Lake Kariba, Lake Malawi, Lake Chilwa etc).

(i) Research on how to communicate scientific results to a wider audience.

5. What recommendations can we give for focus of future research?

(a) Local ownership to problem statement, e.g. NUFU Water Sciences project provides a model of research network collaboration, design and implementation (involving all partners) and fellowships. In the future it is essential to include follow ups of PhD candidates in their home organisations (e.g. Post Doctorals).

(b) Facilitate capacity building at all levels, i.e. scientific, technical and administrative staff.

(c) Gender awareness at all levels, through project formulation, involvement of female researchers and leadership, and representation of female students (work towards an increase in the recruitment base of female students).

(d) Commitment to home institutions by trainees.

(e) Integrating natural and social sciences.

(f) Online discussion forum.

Theme2: Agriculture and Food Security

Eight presentations were made on the theme: Agriculture and Food Security particularly on crops, livestock and fisheries. Field data from a wide range of countries in sub-Saharan Africa including Malawi and Tanzania were presented.

1. Who are the users of our information and what are their needs and expectations?

Information on agriculture and food security that was presented is relevant to a wide range of users especially:

(a) Policy and decision need this information to make policies and decisions on agriculture production and food security at national, regional and local levels.
(b) Academics and researchers need such information to enhance knowledge, validate theories and disseminate information to various groups.
(c) Professionals and technical officers in the agriculture, environment and natural resources management sector would use this information to make decisions on technologies, practices and approaches to be developed and disseminated.
(d) Farmers need to know what measures to take to improve agricultural productivity and attain food security in light of changing climate.
(e) Health experts need such information to deal with agricultural and food security related deficiencies.
(f) Development partners would be interested in understanding agriculture and food security trends to prioritize areas for development cooperation.
(g) Economists would like to understand economic drivers and pressures and agriculture is the hub of socio-economic development in sub Saharan Africa.
(h) The media seek this information to inform the public about advances in approaches, technologies and practices that could be adopted by various users.

2. Most Important Findings in Support of this

(a) Climate change in terms of increased temperature and more frequent droughts and floods were reported, and all over such anomalies tended to affect agricultural productivity negatively.

(b) Crop production is affected in various ways. Small-scale farmers have limited capacity to adapt and are often unable to cope with situations with less than normal rainfall during the growing season or dry spells during sensitive stages of crop growth. Excessive rainfall can be destructive in crop production. Floods wash away crops resulting in poor yields. Some of the studies found that the change in rainfall and temperature patterns brought increased problems of pests and diseases in crop production.

(c) Livestock are affected negatively by the warmer climate because of impact on digestibility of grazed vegetation and added heat load on the animals. Changed seasonal patterns of rainfall affect the balance between the productive period when herded animals grow and the dry periods when they lose weight. Pastoral people are particularly vulnerable to climate change.

(d) Changed precipitation has resulted in lake recession and negative consequences for fisheries and environment in Malawi. Lake Chilwa, which is one of the most productive lakes in Malawi, is receding leading to decline in fish population and loss of livelihoods for fish-dependent communities.

(e) Agriculture dependent communities are coping differently to climate variability and climate change in different areas. However, some of the coping strategies are unsustainable, increasing long term vulnerability of such communities.

(f) Farmers' knowledge and adaptive capacities are valuable and important resources.

(g) Identification and dissemination of Best practices is essential

(h) The consequences for crops, livestock and fisheries may affect men and women differently. All of this point to participatory approaches, involvement of farmers – men and women - in research for adaptation to climate change.

(i) Use of drought tolerant crops is useful to adapt to climate change. However, caution should be taken when introducing new varieties to ensure that they do not cause problems in the areas where they are introduced.

3. Research Gaps and Recommendations

1.1 Research Gaps

(a) Most of the research on agriculture and food security for the sub Saharan African region does not utilise climate related quantitative data that would link observed changes to climate change.

(b) Research on developing climate resilience in agricultural production is low (e.g.. less research undertaken to develop and propagate drought tolerant varieties). Lack of local capacity in terms of breeding and supply of adapted seeds was mentioned.

1.2 Recommendations

(a) Generate and utilise more quantitative data in research to validate results.

(b) Develop novel solutions on resistance (quality of crops, cultivation technologies that enhance resilience to climate change (Needs of drought tolerant crops and varieties were highlighted).
(c) Improve the application of research on the ground (create the linkages between the generation of the knowledge and the infiltration of the knowledge on the ground). Participatory research (engaging the farmers) could assist in this.

Theme 3: Socio-Economics & Adaptation

1. Who are the users and what are their expectations?

(a) National policy makers: Expectations depend on who they address, and are sometimes flavored by what they would like to hear. But information needed for policy making include:

(i) Description of challenges: To the economy, and to the livelihood of people

(ii) Information on barriers, why they represent hindrances towards adaptation and what they can do to remove/lower them

(iii) Ideas to and implications of policy initiatives both on peoples well-being and on broader socioeconomic consequences

(b) Local governments: Expects:

(i) Impacts of climate projections in region

(ii) Lessons from other places

(iii) Clarification of roles and responsibilities

(c) Agents in business and public services and individuals whose activities are affected by climatic changes:

(i) What will happen?

(ii) What can they do?

2. The most important findings in support of the user needs

(a) Users – as defined above – have different objectives, and for that reason, the aim of actions and policies may appear to be in conflict.

(b) People's perceptions of changes correspond reasonably well with statistical observations, but the value indigenous knowledge declines as formerly unobserved climatic events emerge

(c) People use a broad set of coping strategies that cover initiation of alternative production methods, utilization of alternative income opportunities and migration over shorter or longer periods - and in some cases permanently

(d) Gender matters: Women's room for flexibility and options for choosing coping strategies and thereby adapting to climate change is limited considerably for cultural reasons.

(e) A better understanding of which role indigenous knowledge plays for how people perceive and prepare for weather anomalies may help in predicting upcoming extreme events and to make seasonal weather forecasts. It will, moreover, improve communication and preparedness among people on the ground.

(f) Environmental impacts of climatic changes as well as climate effects of environmental degradation needs to be integrated in the development of local climate policy. There is a need to better understand behavior and responses among people to implement appropriate management plans. Lack of management may have severe environmental impacts. There are strong indications that this is the case in waste management, but there is little knowledge.

(g) There is a huge potential for improving the preparedness to climate change by strengthening north-south partnerships.

3. Main research gaps and recommendations for future research

(a) Find means to combine scientific knowledge with indigenous knowledge systems, in order to draw more extensively on knowledge generated by local people, to enhance the relevance of scientific knowledge to the local people and to facilitate communication between experts and users.

(b) More integration and holistic approaches: E.g. further improve the understanding of environmental consequences of climatic changes and climate consequences of environmental degradations.

(c) Develop analytical tools for integration different user perspectives.

(d) Clarification of roles and responsibilities among users of different categories, and coordination of decisions and strategies depending on:

  (i) Measures, instruments and actions available to each category.

  (ii) Information of relevance to each category.

Appendices

Appendix 1: Workshop Programme

Socioeconomic Consequences of Climate Change in Sub-equatorial Africa (SoCoCA)

SCHEDULE FOR THE SoCoCA DISSEMINATION WORKSHOP

25-27 SEPTEMBER 2012 AT SUNBIRD CAPITAL HOTEL, LILONGWE

THEME: "CLIMATE CHANGE IN SUB-SAHARAN AFRICA AND IMPACTS ON AGRICULTURE AND ECONOMIC DEVELOPMENT"

Directors of Ceremony: Professor John Saka

Day & Date	Time	Activity	Responsibility	Remarks/ Comments
Monday, 24 September 2012	Afternoon	Arrival of Participants from outside Lilongwe/ Registration	SoCoCA Committee	Loading of Presentations
DAY 1 **Tuesday, 25 September 2012**	08.00 – 08.30	Registration	PCO Secretariat/Protocol	
	8.30-9.30	Welcome Remarks	SoCoCa Coordinator	
		Welcome Remarks	Principal, Bunda College	
		Remarks by the Vice Chancellor	Vice Chancellor of UNIMA	
		Remarks by the Royal Norwegian Embassy (RNE)	Royal Norwegian Ambassador	
		Remarks by the Acting Director of Environment Affairs Department	Acting Director of Environment Affairs Department	
	09.30 – 09.45	**Official Opening Remarks by The Minister of Environment and Climate Change – Catherine Gotani Hara (MP)**		
	09.45 – 10.15	GROUP PHOTO & HEALTH BREAK		
	10.15 – 12.00	**SESSION 2: INTRODUCTORY PRESENTATIONS**	**Chairperson**: Prof. Lena Tallaksen	
		Overview of SoCoCA Project	Prof. Frode Stordal	
		Lessons from NUFU Project	Prof. John Saka	
	12.00 – 12.45	**Discussion and Comments**		
	12.45 – 14.00	**LUNCH BREAK**		
	14.00 – 15.30	**SESSION 3: Climate and water resources**	**Chairperson:** Director of Climate Change & MET Services	

		Flood frequency analysis under the changing climate in the Upper Kafue River Basin, Southern Africa: A large Scale Hydrological Model Application	Cosmo Ngongondo	
	15.30 – 15.45	Dynamical downscaling of rainfall and temperature over Southern Africa using RegCM4.	Diallo Ismaila	
		Droughts under climate change	Lena Tallaksen	
		Climate change and impacts on the hydrology of the Congo basin	Raphael Tshimanga	
		HEALTH BREAK		
	15.45 – 17.25	**SESSION 3: Climate and water resources cont'd.**	**Chairperson:** Director of Climate Change & MET Services	
	15.45 – 17.25	Modeling water table depth and drainage discharge dynamics in arid conditions	Mphatso Malota	
		Assessing runoff changes in major catchments in Swaziland due to climate change	Roy Vilane	
	17.25 – 17.30	Changes in extreme precipitation	Frode Stordal	
		Discussion and Comments		
		Day One Closing Remarks	**Director of Ceremonies**	

END OF DAY 1

Appendix 1: Workshop Programme (continued)

Directors of Ceremony: Dr. Cosmo Ngongondo

Day & Date	Time	Activity	Responsibility	Remarks/ Comments
DAY 2	08.00 – 08.30	Registration	SoCoCA Committee	
DAY 2 **Wednesday, 26 September 2012**	08.30 – 09.00	Recap of Day 1	Rapporteurs: Raphael Tshimanga & Jacinta Nyaika	
	09.00 – 10.15	**SESSION 3: Climate and water resources cont'd.**	**Chairperson: Director EAD**	
		Hydrological modeling climate change in Southern Africa	Lu Li	
		Fodder security and climate change	Trygve Berg	
		A critical review of community forestry in Zomba, Malawi, as a climate change mitigation measure: Is it worth the money and effort?	Gerald Meke	
	10.15 – 10.30	**HEALTH BREAK**		
	10.30 – 11.30	**Discussion on Climate and water resources**		
	11.30 – 12.30	**SESSION 4: Agriculture and Food Security**	**Chairperson:** Dr John Kazembe	
		Agricultural production vulnerability in the context of climate variability in Central Tanzania	Brown Gwambene	
		Integrating climate change adaptation in agriculture and natural resource management in Malawi	Weston Mwase	
		Declining value of indigenous knowledge in weather climate and forecasts: challenges of agricultural adaptation to climate variability in Mpasu and Mphampha, Chikhwawa, Malawi.	Mirriam Joshua	
	12.30 – 13.30	**LUNCH BREAK**		

DAY 2 **Wednesday, 26 September 2012 (Continued)**	13.30 – 15.00	**SESSION 4: Agriculture and Food Security cont'd.**	**Chairperson:** Dr John Kazembe	**Remarks/Comments**
		Impact of climate change on agriculture prod, food security and nutrition in Malawi	Wells Kumwenda	
		Food and Agriculture polices in Malawi	Benson Phiri	
		Climate change and variability in Lake Chilwa basin: Implications for food security	Welton Phalira	
		Improvement of environment degradation on the fishery and communities livelihoods: A case study	Andrew Saukani	
	15.00 -15.30	**Discussions on Agriculture and Food Security**		
	15.30 – 15.50	**HEALTH BREAK**		
	15.50 – 16.50	**SESSION 5: Socio – Economy and Adaptation**	**Chairperson:** Dr. Roy Vilane	
		Modeling of socio economy in relation to climate change	Asbjørn Aaheim	
		Socioeconomic impacts of floods and droughts in the middle Zambezi river basin.	Pierre Kabuya	
		Dangerous silences: A feminist critique of Malawi's NAPA	Jessie Kabwira-Kapasula	
	16.50 – 17.20	**Discussions on Socio – Economy and Adaptation**		
	17.20 – 17.30	**DAY TWO CLOSING REMARKS**	**Cosmo Ngongondo**	
	19.00 – 22.00	**Cocktail & Reception**	**SoCoCA Committee**	

END OF DAY 2

Appendix 1: Workshop Programme (continued)

Directors of Ceremony: Moses Limuwa

Day & Date	Time	Activity	Responsibility	Remarks/
DAY 3 **Thursday, 27 September 2012**	08.00 – 08.30	Recap of Day 2	Rapporteurs: Jessie Kabwila & Welton Phalira	
	08.30 – 10.00	**SESSION 5: Socio – Economy and Adaptation Cont'd.**	**Chairperson:** Diallo Ismaila	
		Climatic vulnerability and the role of indigenous soil and water conservation	Amon Kabuli	
		Re-thinking irrigation water quality monitoring as a tool for adaptation in Malawi	Elijah Wanda	
		Use of indigenous knowledge in detecting weather and climate change: A case study	Khumbolaynie Mandambwe	
		Imp of waste disposal sites to climate change and socio-economic status of surrounding livelihoods	Jacinta Nyaika	
	10.00 – 10.30	**HEALTH BREAK**		
	10.30 - 11.00	**Discussions on Socio – Economy and Adaptation**		
	11.00 – 13.00	**SESSION 6: Workshop Summary and Closing**	**Chairperson:** Prof. Frode Stordal	
		Summary on Climate and water resources	Rapporteurs (Lena Tallaksen & Cosmo Ngongondo)	
		Summary on Agriculture and Food Security	Rapporteurs (Trygve Berg & Welton Phalira)	
		Summary of Socio-Economy and Adaptation	Rapporteurs (Asbjørn Aaheim & Jessie Kabwira – Kapasula)	
		General Discussions and Way Forward		
	13.00 – 13.15	Workshop Statement	SoCoCA Committee	
		Closing Of Workshop	Acting Director of Environment Affairs Department, Malawi	
	13.15 –	**LUNCH BREAK & DEPARTURES**		

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