Building African Capacity for Conserving Biodiversity in a Changing Climate

Final Report

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Building African Capacity for Conserving Biodiversity in a Changing Climate in the Albertine Rift Region

Final Report 2009

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Report Prepared by: Jyoti S. Kulkarni

Cover design by: Lauren Gibbons

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The International START Secretariat, 2000 Florida Avenue, NW, Washington, DC 20009, USA

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Hassan Virji, START
Pius Yanda, IRA, University of Dar es Salaam
Jyoti Kulkarni, START

Table of Contents

List of Figures

List of Tables

List of Boxes

EXECUTIVE SUMMARY

An advanced education and training program on biodiversity conservation and climate change was implemented at the University of Dar es Salaam, Tanzania, targeted at building the capacity of early- to mid-career conservation professionals from the Albertine Rift region. This MacArthur foundation-funded effort was jointly implemented by the International START Secretariat, Washington DC and the Institute of Resource Assessment (IRA), University of Dar es Salaam. The project duration was approximately one year, from January 2007 through December 2008. A total of twenty conservation professionals from the Albertine Rift countries of Congo, Burundi, Rwanda, Uganda and Tanzania were engaged in this enterprise.

This capacity building effort was undertaken in recognition of the enormous challenge posed by climate change to ecosystems and biodiversity and the urgent need to develop response strategies to effectively address these risks and sustain the flow of goods and services derived from natural systems. Recent studies suggest that the African continent is among the most vulnerable to the impacts of climate variability and change (IPCC, 2007). The Albertine Rift region, an important biodiversity hotspot, is particularly under the increasing influence of multiple stressors including human induced landscape changes (Plumptre et al, 2007). This region is characterized by several unique ecosystems and habitats and is home to numerous species of flora and fauna, many of them endemic to the region (Plumptre et al, 2007; Plumptre et al, 2003). At the same time projections of climate change impacts in Africa due to rising temperatures and increased rainfall variability suggest a likely loss or alteration of natural habitats and negative impacts on the rich plant and animal biodiversity (Boko et al, 2007). Adaptation options, to date, for the protection of ecosystems and biodiversity are unfortunately very few since this is still an emerging area for research and investigation. Natural resource management techniques that can help to increase the resilience of ecosystems are likely to be particularly useful.

These concerns outlined above highlight the urgent need for targeted capacity building in the Albertine Rift region. This education and training project therefore served as a step in this direction and took cognizance of the critical importance of local ownership of conservation strategies, local participation in evaluating and prioritizing risks and response options, the highly context specific nature of adaptive responses and the need for a continuous process of learning at the local level in the assessment of risks and conservation strategies with a changing climate. In doing so it supported the MacArthur Foundation's goals of adapting place-based conservation to changing risks from a changing climate and contributed towards narrowing the existing capacity gap in the Albertine Rift region.

The primary components of this project were a baseline assessment of existing scientific and research capacity in the Albertine Rift region, and the design and implementation of Masters level courses on biodiversity conservation and climate change. Participants also took part in an externship/practicum training activity as a follow-up to the coursework that enabled the development of hands-on skills in applying lessons from the classroom to the field.

Goals and Objectives

The overall goal of the project was to establish an education and training program for early- to mid-career conservation researchers and practitioners in Africa on aspects of biodiversity conservation in a changing climate. The specific objectives were to:

1. Examine the current status of regional research on conservation, and assess the potential need for capacity building related to adapting biodiversity conservation to climate change.
2. Develop a curriculum for masters-level courses in climate change and biodiversity conservation that would serve the needs of conservation communities in the Albertine Rift region.
3. Educate and train a select number of early to mid-career conservation researchers and practitioners during the project period to enable them to make substantive contributions to the challenge of climate change and biodiversity conservation.
4. Establish climate change and biodiversity conservation as a recognized focal area within the curriculum of the Masters of Science program in Natural Resource Assessment and Management (NARAM) at the University of Dar es Salaam.

Major accomplishments

In terms of the successes, the key achievement of the project clearly lay in the successfully executed training and capacity building of 20 African conservation professionals from the Albertine Rift region in developing and understanding climate change related challenges to ecosystems and biodiversity and learning to address such challenges. This one-of-a-kind endeavor that combined learning about ecosystems, biodiversity and conservation with climate change has drawn the attention of several other education and conservation institutions in Africa and abroad. A summary of some of the significant performance milestones from the project and planned or anticipated future activities is included in the table below.

Project achievements

Task	**Accomplishments**
Baseline Assessment	➢ A review of key literature and an examination of current policies and programs was undertaken. ➢ 14 departments from 8 Albertine Rift institutions were consulted. ➢ The assessment identified significant gaps in capacity and knowledge about the combined risks of climatic and non-climatic stressors to ecosystems and biodiversity. ➢ Very few conservation initiatives accounting for climate related risks were currently found to exist. ➢ A scoping report highlighting findings from the assessment and identifying key research and training needs is available at: http://www.start.org/Program/Biodiv.html
Curriculum Development	➢ 2 intensive Master's level courses for conservation professionals entitled, *Climate Change Risks to Ecosystems and Biodiversity* and *Conserving Biodiversity in a Changing Climate* were designed. ➢ Several existing programs that addressed biodiversity and climate change topics were examined in the process. ➢ More than 40 academic experts were consulted during the course design process and their feedback incorporated into the final product. ➢ A strong interest in the program was displayed by the African conservation community with more than 200 applications and special requests for consideration from as far as Jordan. ➢ Several academic institutions in the Albertine Rift countries have expressed interest in offering the courses developed.
Program Implementation	➢ 20 conservation professionals from the Albertine Rift region were selected to undertake the program, under the guidance of expert faculty from within and outside Africa.

Task	Accomplishments
	➢ Training was offered in theoretical coursework, case study exercises and field visits supplemented by an externship project. ➢ Participants accorded a consistently high rating to the program in terms of overall quality and applicability of contents, materials and activities to their conservation work. ➢ Participants agreed that the program had made a significant contribution to their capacity in understanding climate change risks to biodiversity and ability to adapt conservation strategies to address such risks. ➢ Participants expect to see significant benefits to their conservation careers.
Participant externships	➢ 17 participant externships were successfully executed at various Albertine Rift locations under the guidance of local mentors. 3 externships are currently in progress. ➢ A range of climatic and non-climatic stressors were examined from the perspective of adapting conservation strategies and sustaining ecosystem goods and services ➢ Externship research projects with scientifically significant outcomes will be considered for possible journal publication ➢ The overall externship experience was well received by participants and supervisors in terms of building skills, providing valuable research experience and reinforcing networking among institutions and individuals working on biodiversity conservation and climate change in the region.
Future plans	➢ Efforts are currently underway to formally incorporate the two courses into the University of Dar es Salaam's MSc. NARAM program. ➢ Options are being explored to offer the intensive training summer program on a continuing basis at the University of Dar es Salaam. ➢ Options are being explored to expand the effort in the form of distance learning modules and implementation in other Albertine Rift and African institutions. This is based on the high demand for participation as well as participant recommendations for an expansion of the program to reach larger numbers of conservation professionals. ➢ Opportunities to engage policy and decision makers in future endeavours will be examined. ➢ Achievements from the current effort will be widely disseminated in the form of brochures highlighting project achievements and compact discs containing educational material from the project such as curriculum, power point lectures and participant research information. ➢ Efforts are underway to update the project website at START to serve as a one-stop knowledge resource about the activity, its participants and its achievements and to facilitate networking of conservation professionals.

In addition to the targeted achievements outlined above, the project also resulted in important ancillary benefits thus making added contributions to the greater endeavor of capacity building to enable adaptation to climate change impacts and sustain the flow of goods and services critical to human survival in the following ways:

- The development, organization and implementation of the project has also resulted in the building of capacity among the faculty and staff at IRA to design and execute such an activity thus resulting in an "training of trainers" output.
- The bringing together of individuals engaged in conservation efforts in various different capacities ranging from course organizers, faculty and participants has resulted in a network of informed professionals who can work across borders towards a common goal. Such a network can make important contributions to other planned and ongoing efforts

such as for example the MacArthur foundation funded *Ecosystems and Livelihoods Adaptation Network (ELAN)* and the *Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)* to inform the second round of the *Millennium Assessment* project.

Nonetheless, the project also experienced some challenges as evidenced from the feedback from participants and externship supervisors. Most of the concerns were targeted at the externship component of the education and training program and primarily include:

- Short duration of the education program and externship activity,
- Limited research grant amount and need for a more efficient grant disbursement
- Lack of travel support for supervisors to visit participants in field locations
- Lack of access to modeling tools and software
- Need for improved communication between IRA, externship host institutions and participants

Participants and supervisors felt that these challenges limited the scope of the externship research and affected the quality of outcomes in some instances. While the length of the education program and externship had purposely been designed as short training activities with an estimated equivalent funding support to enable participants to take time away from their professional engagements, these concerns will be closely scrutinized in terms of incorporating improvements in future capacity building programs of this nature. Efforts will also be made to facilitate better program and grant management, better supervision and guidance to participants and better communication between the various institutions and individuals engaged in the program. Particular attention will be paid to individual participants to ensure that they are able to effectively apply learning from the classroom in their field research

The intention is to build upon the successes and challenges of this learning experience and pave the way for its expansion to other institutions in the Albertine Rift region and beyond. This is particularly important given the significant interest in participation from conservation professionals during the program application phase. Efforts are also underway to offer the courses as distance learning modules to reach a greater number of individuals and institutions. Future initiatives will also seek to engage policy-makers and other relevant stakeholders to further develop and grow the network of individuals and institutions engaged in the conservation of ecosystems and biodiversity, particularly from a climate change perspective.

Participants group with faculty at the University of Dar es Salaam

1 INTRODUCTION

The John D. and Catherine T. MacArthur Foundation funded project, *Building African Capacity for Conserving Biodiversity in a Changing Climate*, was designed with the primary objective of building the capacity of early- to mid-career conservation professionals from the Albertine Rift region of Africa to more effectively address changing risks to biodiversity from a changing climate. The main components of this effort included a Baseline Assessment of existing capacity and capacity needs in the region and the development and implementation of an education and training program in biodiversity conservation and climate change for conservation practitioners and graduate students from the Albertine Rift countries of Congo, Burundi, Rwanda, Uganda and Tanzania. The project was executed over a period of two years during January 1, 2007 and December 31, 2008 and implemented jointly by the International START Secretariat, Washington DC and the Institute of Resource Assessment (IRA), University of Dar es Salaam.

This capacity building endeavor took cognizance of the enormous challenge posed by climate change to the earth's natural heritage and the urgent need for response strategies to effectively address these risks to sustain the flow of critical goods and services derived from natural systems. While naturally occurring climatic changes have been historically transforming ecosystems, the current accelerated rate of human induced climate change will likely exceed their resilience and alter ecosystems boundaries and species distribution at a relatively much faster pace. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) states with high confidence that the recent warming observed is having significant impacts on terrestrial biological systems resulting in changes in ecosystem locations and boundaries and their species composition (Fischlin and Midgley, 2007). In addition, synergistic interactions of climate change with other human and natural stressors pose new threats for ecoregions bringing on the possibility of impacts that are not yet fully understood (Fischlin and Midgley, 2007; Millennium Ecosystem Assessment, 2005).

Recent studies suggest that the African continent is among the most vulnerable to the impacts of climate variability and change. This continent already experiences significant variability in rainfall with millions of people suffering from the effects of floods, droughts and their associated health, livelihood and overall quality of life implications on a regular basis (Boko et al, 2007). Added to this, the IPCC AR4 projects an overall warming trend for Africa over this century that is "very likely" to be larger than the global annual mean warming (Christensen et al, 2007). Rainfall projections suggest drier conditions in the sub-tropical regions and wetter conditions in the tropics. Almost all sectors of the African economy are expected to be at risk from the negative impacts of such climatic changes resulting in the loss of food security and livelihoods for millions of people (Boko et al, 2007). Detectable changes have already been noted in African ecosystems, which are important sources of biodiversity and are significant contributors to human well-being. These changes can largely be attributed to climatic influences and their interactions with anthropogenic stressors such as hunting, deforestation, over harvesting of particular species and forest fires (Boko et al, 2007). Future climate trends indicate further alterations in the structure and function of African ecosystems and have significant impacts on species diversity (Boko et al, 2007).

The Albertine Rift region of Africa is particularly important from this perspective since it is a vital "biodiversity hotspot" that is home to numerous species of flora and fauna, several of them endemic to the region. It is characterized by many unique ecosystems and habitats and is reported to be under the increasing influence of multiple stressors including human induced landscape changes (Plumptre et al, 2007; Plumptre et al, 2003). The rich plant and animal biodiversity of the

Albertine Rift therefore faces considerable risks from the projected changes in the climate in Africa due to rising temperatures and increasing rainfall variability that are expected to cause a loss or alteration of natural habitats (Boko et al, 2007).

Unfortunately adaptation options for the protection of ecosystems and biodiversity to date are quite few as this is still an emerging area for research and investigation. Many of the currently used conservation strategies have been developed and implemented in a relatively static climate (Lovejoy, 2005) and underscore the need for new and/or modified strategies to address changing climatic risks and their interactions with other natural and anthropogenic stressors (Da Fonseca et al., 2005; Hannah and Hansen, 2005; Hannah and Salm, 2005; Lovejoy, 2005; van Jaarsveld et al., 2003; and von Maltitz et al., 2008). Natural resource management techniques that can help to increase ecosystem resilience will be particularly useful. This necessitates regular monitoring of climatic and ecological changes as well as the dynamics of other stressors in order to determine effective response strategies that can help to better protect ecosystems and ensure greater species survival (Fischlin and Midgley, 2007).

Key to the adaptation of conservation is the capacity building of conservation professionals to equip them with the knowledge and tools necessary to effectively develop approaches to address climate related risks to ecosystems and biodiversity. Current scientific and technical capacity in Africa is inadequate and not systematically targeted to address such concerns. This project attempted to narrow this gap by engaging conservation researchers and practitioners from the Albertine Rift region in an education and training program implemented for the communication of climate risk information and involving them in collaborative efforts to determine and assess appropriate conservation strategies. In doing so it underscored the critical importance of local ownership of conservation strategies, local participation in evaluating and prioritizing risks and response options, the highly context specific nature of adaptive responses and the need for a continuous process of learning at the local level in the assessment of risks and conservation strategies with a changing climate.

1.1 Goals and Objectives

The overall goal of the project was to establish a sustainable program to educate and train early to mid-career conservation researchers and practitioners in Africa for conserving biodiversity in a changing climate. At the same time the success of this effort would contribute to the critical need for greater human capacity to understand and respond to climate change threats. The specific objectives to be accomplished were:

1. Examine the current status of research, applications of research to conservation, capacity, and capacity building in Africa that are related to adapting biodiversity conservation to climate change;
2. Develop a curriculum for masters-level courses in climate change and biodiversity conservation that serve the needs of conservation communities in the Albertine Rift and other regions of Africa;
3. Educate and train a select number of early to mid-career conservation researchers and practitioners during the project period to enable them to make substantive contributions to the problem of adapting biodiversity conservation to a changing climate; and
4. Establish climate change and biodiversity conservation as a recognized focal area within the curriculum of the Masters of Science program in Natural Resource Assessment and Management (NARAM) at the University of Dar-es-Salaam.

1.2 Project Activities

Project activities designed to meet the goals and objectives listed above include:

1. Baseline Assessment of the current status of scientific research and individual and institutional capacity for biodiversity conservation under a changing climate particularly in the Albertine Rift region
2. Facilitation of the education and training program
    - Curriculum development for Master's level Climate Change and Biodiversity Conservation courses
    - Organization and implementation of intensive training courses at the University of Dar-es-Salaam
    - Integration of courses into University of Dar es Salaam's MSc. NARAM curriculum
3. Monitoring, evaluation and reporting of project performance

1.3 Role of partner organizations

START's primary role was the overall management and oversight of the project, assistance with performance, monitoring of performance and reporting to the MacArthur foundation. Some of the specific activities that START staff engaged in include assistance with the preparation of the baseline assessment report and its distribution; offering advice on curriculum content and conducting expert consultations; assistance with advertising the program; providing advice on selection of participants; assistance with the implementation of training courses and participation in the same; providing advice on the implementation of externships; helping with the development of participant and faculty evaluations; and meeting reporting requirements of the MacArthur Foundation. START is currently exploring opportunities to sustain and grow this capacity building effort.

IRA's primary role was in the implementation of the training courses and the externship program. IRA also contributed to the baseline assessment activity in terms of literature search, regional consultations and drafting sections of the report. IRA played a key role in the design and implementation of the training program including curriculum development, selection of faculty and students, implementation of courses, execution of externships and participant evaluations with assistance from START. IRA is currently engaged in discussions with senior personnel from the University of Dar es Salaam to integrate this educational program as a permanent component of its MSc NARAM program. It is also investigating options to offer the courses online as distance learning modules to widen their reach to larger numbers of conservation professionals.

The subsequent chapters of this report document in detail the achievements, findings and challenges pertinent to this effort, particularly in relevance to the specific goals and objectives of the project.

2 BASELINE ASSESSMENT

A baseline assessment was undertaken to learn about the present status of scientific research and policy in the Albertine Rift Region related to biodiversity conservation and climate change; gauge institutional and individual capacity to apply available resources to adapt conservation practices to climate change risks; identify unmet research needs and the current gap in coping capacity; and assess capability to meet these needs and narrow the capacity gap. Key elements of the Baseline Assessment included:

a. A limited literature review and assessment of existing conservation policy and initiatives
b. Consultations with key research, education and conservation institutions in the Albertine Rift region

The findings and outputs from this activity informed the development and design of the education and training components of this project. A brief overview of the baseline assessment effort and its findings is presented below. The detailed Baseline Assessment report is available in Appendix 1.

2.1 Literature Review

The literature review assimilated up-to-date available information on climate change and biodiversity conservation in Africa and the Albertine Rift region and helped identify critical knowledge gaps in the understanding of these issues. The effort entailed a limited review and documentation of key available literature on the vulnerability of African biodiversity to climate change impacts and the current status of ecosystems and biodiversity conservation programs in Africa and the Albertine Rift Region. Leading scientific and policy related publications on the subject were referenced e.g. the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), research papers from prominent scientific journals, authoritative books, key conference proceedings, as well as government policy documents. Existing conservation initiatives as well as community strategies for adaptation to climate change in the Albertine Rift Region were also examined as a part of this effort. Though this exercise was by no means a comprehensive examination of the vast literary resources available on the subject it did attempt to capture and present the latest important information and generate a useful overview that could inform the next steps in this project.

A brief description of key literature on biodiversity in Africa and the Albertine Rift region and the vulnerability of African biodiversity to climate change impacts is presented below. An assessment of the current status of conservation programs in the Albertine Rift region is also included. For a detailed account please see Appendix 1.

2.1.1 Biodiversity in Africa and the Albertine Rift Region

Africa is a biodiversity rich continent, occupying about one-fifth of the global land surface and home to about one-fifth of all known species of plants, mammals, and birds in the world, as well as one-sixth of amphibians and reptiles (Siegfried, 1989). It houses several major bio-diversity hotspots in the eastern, western, central and southern portions of the continent (Desanker and Magadza, 2001). This rich variety of endemic flora and fauna is an important source of goods and services and supports both formal and informal economic sectors (von Maltitz and Scholes, 2008). Only a fraction of the African land surface, however, is designated as formal conservation areas and much of its biodiversity occurs outside these protected spaces. Increasing human pressures on the landscape due to the extension of agriculture and destruction of forests therefore raises important concerns about the sustainability of this biodiversity under a changing climate (Desanker and Magadza, 2001).

Of the several biodiversity hotspots in Africa, the Albertine Rift region in the eastern portion of the continent is among the most important. It stretches from the northern end of Lake Albert to the southern end of Lake Tanganyika (Figure 1) and covers countries that border the western arm of the Great Rift Valley, namely, Burundi, Democratic Republic of Congo, Rwanda, Tanzania and Uganda. It contains the Rift Valley lakes of Tanganyika, Kivu, Edward, and Albert.

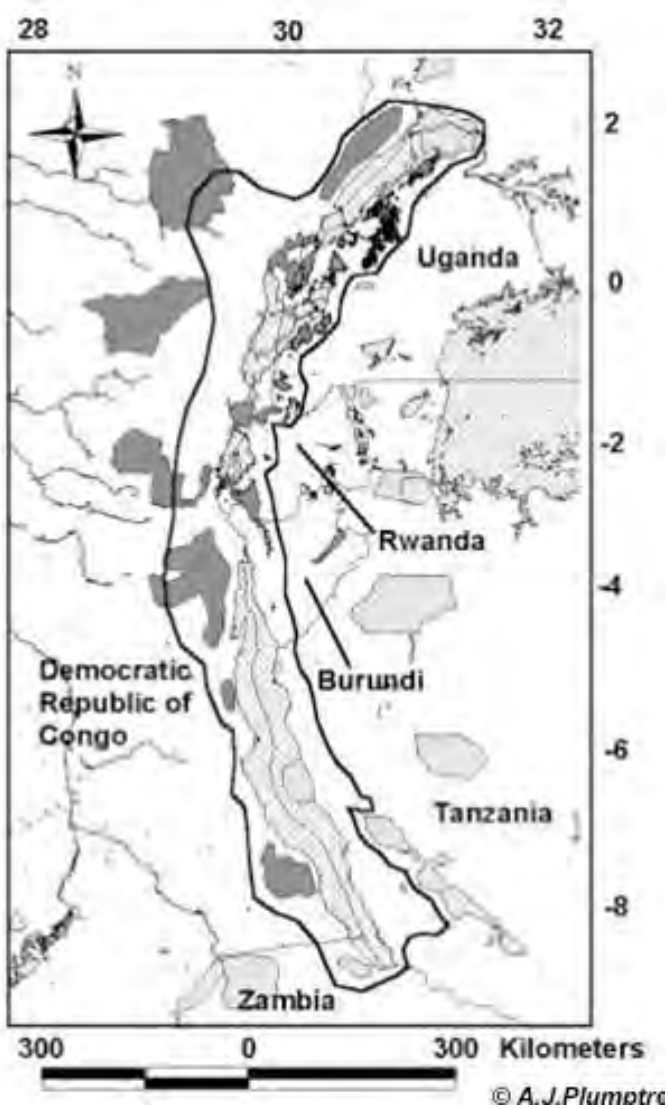

Figure 1: The boundary of the Albertine Rift
(Source: Plumptre et al, 2003)

The Albertine rift region has unique ecosystems characterized by some of the highest mountains in Africa, including the Virunga Mountains, Mitumba Mountains, and Rwenzori Range. It has a high diversity of habitats, which include glaciers; lava rock and volcanic hot springs; alpine vegetation (including giant forms of plants that occur at lower altitudes such as giant Lobelias and Senecios), montane forest, savanna, low land forests and woodlands; and papyrus swamps and high altitude swamps. The rift system is known for its richness in biodiversity, including many species of fauna and flora that thrive in these habitats. It is very rich in vertebrate species and is home to more than half of continental Africa's birds and nearly 40% of its mammals, including gorilla and elephants (Plumptre et al, 2003). It has more endemic species of mammals, birds and

amphibians than other regions of Africa. The Albertine Rift region is not only important for its biological diversity but also for the ecological processes and services that it sustains. For example, the Rwenzori Mountains form one of the largest and most important catchment areas in Uganda and a substantial source of water for the White Nile River (Plumptre et al, 2003). However, like many parts of the world, the ecosystems and biodiversity of the Albertine Rift region has been adversely impacted and threatened by various factors, including climate variability and change as well as human-induced landscape changes.

Figure 2: Snapshots of African biodiversity

2.1.2 Projected impacts of climate change on African biodiversity

According to recent studies, climate change is likely to affect most of Africa's natural resources and a range of potential impacts on terrestrial and aquatic ecosystems have been indicated (Leemans and Eickhout, 2004; Boko *et al.*, 2007). Climate change impacts such as rising temperatures and declining rainfall in combination with other stresses could result in the shifting of ecological zones, loss of flora and fauna and an overall reduction in ecological productivity in Africa (Boko et al, 2007).

Loss or alterations of terrestrial habitats due to climate change will likely impact animal biodiversity concentrated in the savannas and tropical forests though there are few detailed studies on this subject and those that exist do not demonstrate the potential extent of its impact. The recent IPCC report notes the possibility of losses of 10-20% in African mammalian species by 2080 even under the scenario of unlimited migration (Boko et al, 2007). The vast herds of migratory ungulates such as rhinos, swine, and elephants among others in east and southern Africa remain a distinguishing ecological characteristic of the continent. A major migratory system is located in the Serengeti area of Tanzania and the Masai-Mara region of Kenya. Reduced large-mammal migratory systems persist in the Kalahari (Botswana, South Africa, and Namibia) and Etosha (Namibia) areas of southern Africa. Typical migrations involve regular movement between dry-season and wet-season grazing areas, and are therefore climate sensitive. Other animals such as the African antelope species are also expected to experience range alterations due to climate change (Hulme, 1996). This has significant implications on the ability of this species to adapt given that Africa is home to more than 90 percent of the 80 species of Antelopes found worldwide (Macdonald, 1987).

Among the African bird species, about one-fifth migrate on a seasonal basis within Africa and an additional one-tenth migrate annually between Africa and the rest of the world (Hockey, 2000). If climatic conditions or specific habitat conditions at either end of these migratory routes change beyond the tolerance of the species involved, significant losses of bird biodiversity could result (Desanker and Magadza, 2001). Although these species have some capacity to alter their destinations, this could be hindered by the alteration of habitat due to human land use (Fischlin and Midgley, 2007).

African biodiversity is also defined by the concentration of species in several unique native environments such as the Cape Floral Kingdom (fynbos) at the southern tip of Africa with more than 7,300 plant species (Gibbs, 1987) and the adjacent Succulent Karoo biome with an additional 4,000 species (Cowling *et al*., 1998). These two floral biodiversity hot spots occur in the winter rainfall regions and the distribution and survival of species in these environments would likely be threatened by a shift in rainfall seasonality (von Maltitz and Scholes, 2008). Among the other African floral biodiversity rich areas vulnerable to global warming are Madagascar, the mountains of Cameroon and the Afromontane habitats stretching from Ethiopia to South Africa at altitudes of about 2,000 meters and above (Mace *et al*., 1998). Montane centres of biodiversity are particularly threatened by increases in temperature because many contain isolated plant populations with no possibility of migration. Significant changes have already been noted in mountain ecosystems, likely due to complex climate-land interactions that may continue under future changes in climate. By 2020, for example, indications are that the ice cap on Mt. Kilimanjaro could disappear for the first time in 11,000 years (Thompson *et al*., 2002, Boko et al, 2007).

Other ecosystem types such as mangroves and coral reefs, the main coastal ecosystems in Africa, will also likely be affected by climate change (Boko *et al*., 2007) placing at risk several endangered species including manatees, marine turtles and migratory birds. The proliferation of algae and dinoflagellates during these warming events could also increase the number of people affected by their toxins (such as that of *Ciguatera*) due to the consumption of marine food sources. In the long term, these impacts will have negative effects on fisheries, food security and tourism besides the reduction of marine biodiversity (Boko et al, 2007).

Some important statistics regarding projected impacts on biodiversity in Africa, as noted by different research initiatives on this subject are noted below:

- Projected losses of between 51 and 61% of *Fynbos and succulent Karoo biomes* by 2050 (Midgley et al., 2002).
- *Critically endangered taxa* (e.g. Proteaceae) losses in the low-lying coastal areas of Africa will increase, and up to 2% of the 227 taxa will become extinct (Bomhard et al., 2005).
- Kruger Park study estimates that about 66% of species of Nyala and Zebra have already been lost (Dixon et al., 2003).
- Projected losses of over 50% for some Southern African bird species (Nama-Karoo area; attributed to restriction of movements) by 2050 (Simmons et al., 2004).
- Carbon isotope data in Lake Tanganyika show aquatic species losses of about 20%, with a 30% decrease in fish yields. It is estimated that climate change may further reduce lake productivity (O'Reilly et al., 2003)
- Complex impacts on grasslands including the intensification of fire in southern Africa (Boko et al, 2007).

2.1.3 Conservation strategies in the Albertine Rift Region

In the Albertine Rift countries several policies and programs are geared towards the conservation of ecosystems and biodiversity and derive from national and international initiatives. A key example is Tanzania's National Biodiversity Strategy and Action Plan (NBSAP), an initiative derived from the 1992 Convention on Biological Diversity (CBD) that is aimed at the protection of threatened species and habitats and the restoration of biological systems across aquatic, terrestrial and agricultural habitats and addresses several cross-cutting issues across the realms of policy, regulation, planning, conservation, monitoring and evaluation and capacity building. Tanzania is also party to several international conventions such as the CBD, the Convention on

International Trade in Endangered Species of Wild Fauna and Flora, the UN Convention to Combat Desertification and the Convention on the Conservation of Migratory Species among others besides the several national and local policies and strategies that are directly and indirectly relevant to biodiversity conservation such as those related to forestry, fisheries, wildlife, water resources, land-use, agriculture and poverty reduction. Besides Tanzania, Rwanda also has several national policies that are aimed at the protection of forests, aquatic areas, agro-biodiversity and protected areas and involves various state, parastatal and private institutions in the conservation and use of biological resources.

There are also several conservation initiatives in the Albertine Rift region that are aimed at a specific objective and implemented by national, international, government as well as non-governmental organizations. Many of these initiatives are concentrated in the Congo Basin and target aspects of biodiversity conservation in direct and indirect ways. Examples include:

- The Albertine Rift Program: protects many, but not all, biodiversity rich sites under national parks, wildlife reserves or forest reserves.
- The Bonobo Conservation Initiative: Aimed at the conservation of Bonobos in the Condo Basin
- The Nile Transboundary Environmental Action Project (NTEAP): Targeted at the environmentally sustainable development of the Nile Basin and enable equitable utilization of water resources
- The Congo Basin Forest Partnership (CBFP): Promotes sustainable management of Congo Basin forest ecosystems and wildlife
- The Lake Tanganyika Biodiversity Program (LTBP): Aimed at the sustainable management and conservation of biodiversity in lake Tanganyika
- The Bush Meat Crisis Task Force: Dedicated to the conservation of wildlife threatened by illegal hunting
- The Mountain Gorilla Conservation Fund: Dedicated to saving gorillas from extinction
- The Okapi Conservation Project / Okapi Wildlife Reserve: Protects okapi and several other species in this rainforest reserve
- The Uganda Food Security (UFSI): An integrated rural development program that includes rehabilitation of degraded lands
- The Gombe National Park: Established for the conservation of Chimpanzees
- The Malagarasi-Moyovosi Wetland project: Aimed at the sustainable and integrated management of this Ramsar site

[A more detailed description of these initiatives can be found in the Baseline Assessment Report in Appendix 1].

This significant number of initiatives indicates an active interest in the conservation of this region at the international, regional and national levels. It must be kept in mind that most of these have been designed on the basis of a more static climate system and their effectiveness varies even under current circumstances due to several organizational, management or design related factors. However they can nonetheless provide a basis for the development of the next generation of strategies

2.2 Regional Consultations

Consultations were undertaken with key research and training institutions in the Albertine Rift region countries of Burundi, Rwanda, Tanzania and Uganda to evaluate the status of their programs in the areas of biodiversity conservation and climate change. Consultations could not be

undertaken in the Democratic Republic of Congo, also in the Albertine Rift region, due to the unstable political situation there and information for this country was instead obtained from available literature. The focus of the consultations was on seeking information on institutional programs addressing biodiversity conservation and climate change, their teaching and research curricula, the applicability of the information they generate to actual conservation practices on the ground, as well as unmet needs in the areas of knowledge, research and training. The key institutions consulted, including higher education institutions, research institutes and non-governmental organizations are:

- Relevant departments at Makerere University, Uganda
- Relevant departments at Mbarara University, Uganda
- Relevant departments at the University of Burundi, Burundi
- Tanzania Wildlife Research Institute, Tanzania
- Tanzania National Parks, Tanzania
- College of African Wildlife Management, Tanzania
- The Nile Basin Discourse Forum, Rwanda
- Rwanda Environmental Conservation Organization

A complete list of institutions and their program descriptions can be found in the 'Baseline Assessment Report' in Appendix 1.

2.2.1 Outcomes

Some of the key observations about the status of biodiversity conservation and climate change related programs and initiatives that came emerged from the regional consultations include:

- Awareness of the separate concepts of "biodiversity" and "climate change" was relatively good though knowledge about the linkages between the two was poor. Research and academic institutions have so far been engaged in research and training on biodiversity and climate change as separate topics with little integration between the two.
- Extremely few studies have been undertaken so far, at any of the consulted institutions, to document the relationships between ecosystems and climate change. Some changes in the distribution and population of species have been noted though data available to support these observations is very little.
- Awareness regarding the risks to ecosystems and biodiversity due to climate change therefore varied greatly. Professionals from universities and research institutions were relatively better informed but even among this category, the early and mid-career professionals were poorly informed about climate related risks and about climate predictions for Africa or the Albertine Rift region.
- Most interviewed individuals reported having observed ecosystem changes over the last couple of decades along with a decrease in biodiversity in the region. This change was largely attributed to human activities stemming from the dependence on natural resources for livelihoods. The magnitude and significance of the changes were however uncertain.
- Further losses in biodiversity were expected in the absence of any intervention measures to enhance conservation.
- A need for additional academic, research, information and awareness building programs about climate change and implications for biodiversity was identified. Academic institutions identified the lack of funding as a key constraint in instituting programs of this nature.

- Some awareness building programs initiated by Government Ministries, non-governmental organizations and academic institutions do exist although their effectiveness is unknown.

2.3 Key Capacity Building Needs Identified by the Baseline Assessment

The knowledge obtained from the review of literature and existing initiatives and the regional consultations together highlighted significant knowledge gaps in the understanding of the risks of climate change to biodiversity in the Albertine Rift region. While the implications of human stresses on natural resources for ecosystem and biodiversity conservation are relatively better known, the linkages with climate change impacts are poorly understood and developed. As a result several national and local policies and measures directly and indirectly target the protection of biodiversity and natural resources but they do not account for the risks due to climate change. Even in the academic and research field, institutional programs specifically targeted towards understanding the implications of climate change risks to ecosystems and biodiversity are almost non-existent. This absence of a knowledge base at the institutional level directly translates into a lack of information and data on the risks of climate change to ecosystems and biodiversity and results in a capacity deficiency among conservation practitioners to address these issues.

Institutions consulted in the process of this baseline assessment specifically identified key areas where advanced research and training were necessary. These are briefly listed in the boxes below.

Box 1: Unmet research needs

- Climate prediction and modelling at the regional scale to better understand impacts and vulnerability
- Relationship between climate change and changes in biodiversity, including the dynamics of flora and fauna
- Community perceptions of climate change and biodiversity loss and current strategies, if any, to deal with such risks.
- Strategies for communities engagement in sustainable management of natural resources and biodiversity conservation
- Alternate sources of energy to replace fuel wood and alternatives to medicinal plants.

Box 2: Unmet training needs

- Climate change science, modelling tools, policy and adaptation and mitigation strategies
- Scientific, technical and policy related concepts of ecosystems, biodiversity and conservation
- Knowledge of interactions between climate change and biodiversity and the role of human stressors
- Understanding of multidisciplinary aspects of ecosystems management, biodiversity conservation and climatic and non-climatic stressors
- Resource economics - to evaluate the costs and benefits of actions that positively or negatively impact ecosystems and biodiversity

The lessons learnt, the gaps in capacity identified and the research and training needs highlighted by the Baseline Assessment exercise served as a valuable resource in informing the next phase of the project i.e. designing and implementing the education and training program for conservation professionals from the Albertine Rift region.

3 ORGANIZATION AND IMPLEMENTATION OF THE EDUCATION AND TRAINING PROGRAM

Organization and implementation of the education and training component of the Albertine Rift capacity building program included the following key components:

1. Curriculum development for master's level Climate Change and Biodiversity Conservation courses
2. Organization and implementation of intensive training courses at the University of Dar-es-Salaam
3. Integration of courses into University of Dar es Salaam's MSc. NARAM curriculum

3.1 Curriculum Development

Developing curriculum for master's level courses that would adequately equip participants with the knowledge and tools to effectively address climate change risks to ecosystems and biodiversity proved to be an interesting and challenging assignment. A reference research on existing curricula offered by other academic programs, globally, in the areas of biodiversity conservation and climate change, yielded very few graduate level courses that addressed these issues together, a finding also highlighted by the Baseline Assessment exercise for Africa and the Albertine Rift region. The curriculum design effort therefore drew from several academic programs that offered courses in biodiversity conservation and/or climate change, referenced recent literature that addressed impacts of climate change on ecosystems and biodiversity and consulted with more than 40 experts from higher education and research institutions, government and non-governmental organizations and independent consultancies. A list of institutional programs and experts consulted is available in Appendices 2 and 3, respectively.

This effort culminated in a set of two Masters level courses with Course I focusing on the risks from climate change to ecosystems and biodiversity and Course II exploring strategies for conserving biodiversity in a changing climate. The courses were designed as three-week intensive sessions and a brief description of the course content is provided below.

3.1.1 Course 1: Climate change risks to ecosystems and biodiversity

The primary objective of this course was to enable participants to develop a sound understanding of climate change risks to ecosystems and biodiversity and their implications for ecosystem goods and services. Contents include instruction in theory, key methods and tools as well as case study exercises. Course I is organized as a set of 6 key modules, and sub-modules as listed below:

1. Biodiversity in a Changing Climate: Framing the Issues
2. The Climate System: Processes, Variability and Change
   2.1. The Climate System and Greenhouse Effect
   2.2. Climate Change in the Past
   2.3. Climate Change Projections for the Future
3. Vulnerability and Adaptation to Climate Change
4. Ecosystems, Biodiversity and Climate Change
   4.1. Ecosystem Concepts and Processes
   4.2. Ecosystem Goods and Services
   4.3. Mechanisms by Which Climate Change Affects Ecosystems
   4.4. Climate Change Impacts on Ecosystems in the Distant and Recent Past
   4.5. Biomes and Biodiversity of Africa and the Albertine Rift
5. Future Impacts of Climate Change on Ecosystems and Biodiversity

5.1. Methods for Modeling Climate Change Impacts
5.2. Methods for Social Assessment of Ecosystem Changes
5.3. Assessments of Future Impacts

6. Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift

3.1.2 Course 2: Conserving biodiversity in a changing climate

The aim of this course was to enable participants to examine current biodiversity conservation strategies for their effectiveness in address climatic and non-climatic risks and stressors and to learn to develop new and/or modified strategies to address these risks where necessary. Once again instruction was provided in methods and tools that could be used in such assessments and in the development of new/modified conservation strategies. Like Course I, key components once again include, theory, methods and tools and case study exercises. Course 2 is organized as set of 5 key modules, as listed below:

1. Need for protecting ecosystems and conserving biodiversity
2. Current biodiversity conservation strategies and their effectiveness
   2.1 Traditional approaches to biodiversity conservation
   2.2 Effectiveness of traditional approaches against various stressors
3. Extent and status of managed and natural systems in the Albertine rift
4. Protecting ecosystems and conserving biodiversity under a changing climate in the Albertine Rift region
   4.1 Approaches to designing conservation responses that address climate change risks
   4.2 Designing landscapes
   4.3 Management of protected areas
   4.4 Protecting the matrix areas
   4.5 Community inclusive approaches
   4.7 Monitoring the effectiveness of adaptive strategies
5. Case Study: Designing conservation strategies for addressing climate impacts in the Albertine Rift region

A detailed curriculum for the courses, including recommended readings is available with this report as Appendix 4.

3.2 Program Organization

As a precursor to actual program implementation this activity included the logistics of advertizing the program, inviting applications, selection of participants and faculty, organizing course materials and timetable design.

3.2.1 Application to the program

Applications to the program were invited in early 2008 from African early to mid-career professionals and graduate students, with priority given to applications from the Albertine Rift countries. The program announcement was widely circulated via email listservs and posts on the websites of START, IRA, the Pan-African START Secretariat (PASS), housed within IRA and affiliated organizations. Applicants had the option of applying for either or both courses. Applicants were requested to submit along with the completed application form, two Professional Reference forms, an Institutional Support form, a Statement of Current Activities and Future Plans, a Preliminary Proposal for an externship, Official University Transcripts and Curriculum Vitae. The deadline for completed applications was 29 February 2008. The criteria for the review of applications included the following:

- Level of education and relevant experience and training
- Level of competence in the applicant's field(s) and intellectual abilities
- Academic/Professional interests in areas related to and general familiarity with the topics of climate change and biodiversity conservation
- Future professional plans, commitment to work in the Albertine Rift region and potential for future leadership
- Preliminary proposal for externship/practicum training/small research project
- English language speaking and writing skills (the courses will be conducted in English; all application materials must be submitted in English)

A tremendous expression of interest in the program was observed with more than 200 applications from all over Africa, a majority of them from the Albertine Rift countries, and special requests for consideration from the Royal Society for Conservation and Nature in Jordan.. Within the Albertine Rift region, a majority of applications was from Tanzania and Uganda possibly due to a language barrier for the French speaking countries in the region. The applicant pool also saw a greater number of male applicants versus females. A distribution of overall program applicants by country and also by gender for the Albertine Rift region is available in Appendix 5.

Based on the review process and keeping within program capacity limits, 20 early- to mid-career professionals working in areas related to biodiversity conservation and natural resources management in the Albertine Rift region were selected, with all 20 having applied to participate in both courses. Care was taken to maintain, as far as possible, a fair representation of countries and institutions and a gender balance.

Country	**Number of Participants**
Tanzania	6
Uganda	6
Rwanda	2
Burundi	2
Democratic Republic of Congo	4

Table 1: Participant distribution by country

Table 1 indicates the participant distribution by country and a more detailed list of selected program participants is available in Appendix 6 (include photos, short bios, contact information and externship research blurb)

3.2.2 Selection of faculty

Faculty for the program was sourced from the broad range of academic expertise available within IRA and the University of Dar es Salaam. This was supplemented by expert faculty invited from other institutions within and outside Africa including the Sokoine University of Agriculture, Tanzania; University of Rwanda; University of York, UK; and the Potsdam Institute for Climate Impact Research, Germany. For a complete list of faculty and their institutional affiliations please see Appendix 7 of this report.

3.2.3 Course materials

Arrangements were made to provide participants with course materials and readings recommended in the curriculum. These were drawn from key scientific publications including

authoritative books on the subject such as *Climate Change and Biodiversity* (Lovejoy and Hannah, 2005) and *Managing Protected Areas* (Lockwood, Worboys and Kothari, 2006); reports of the Intergovernmental Panel on Climate Change (IPCC); the Millennium Ecosystem Assessment (2005); scientific journal papers; and web resources. The list of required and recommended course readings are listed in the curriculum in Appendix 4 of this report.

3.2.4 Timetable

Each course was designed as a three-week intensive session with Course 1 scheduled during 1 July – 15 July 2008 and Course 2 scheduled during 28 July – 15 August 2008. A field trip to a few select protected areas and migratory corridors in Tanzania was scheduled during the one-week recess between the two courses. Besides curriculum based lecture sessions, the timetable also accommodated faculty guidance sessions particularly for case study design, externship proposal preparation and report writing. For the detailed program timetable please see Appendix 8 of this report.

3.2.5 Other logistics

These included participant accommodation, financial support for local travel and subsistence and arrangement for the field visits, all of which was organized by IRA. IRA also organized visiting faculty travel and accommodation arrangements

3.3 Program Implementation

Courses were executed at the University of Dar es Salaam campus and the program commenced on 1 July 2008 with a formal orientation for participants. The Vice Chancellor of the University of Dar es Salaam, Professor Mukandala was the invited guest of honor at this event and several senior faculty of the University were in attendance. The commencement also received local television and media coverage in Tanzania.

Figure 3: Vice Chancellor of the University of Dar es Salaam, Prof. Mukandala addressing the orientation event; also seen are Profs. Yanda, Maboko and Kangalawe

Courses were based on various different formats such as lectures, seminars, group discussions, hands on training in select methods and tools, field visits, guided projects and seminar presentations. Key outcomes from this component are briefly listed below.

3.3.1 Course sessions

Course sessions were generally noted to be highly interactive, with participants taking a keen interest in applying the learning to their individual conservation experiences on the ground and actively engaging in seminars, discussions and presentations. This lead to a significant cross sharing of information and experiences and enhanced the education process.

Figure 4: Course participants engaged in a modeling and tools session

Figure 5: Participants and faculty at the University of Dar es Salaam

3.3.2 Case studies

Case studies were an important component in Course I, particularly since this exercise enabled participants to use knowledge from the course modules to design topics that addressed a range of stressors experienced in their individual countries and localities. In addition participants also relied on available scientific literature and personal experiences as practitioners to explore the interactions between climatic and non-climatic stressors and their influence on the vulnerability

of human and natural systems. Some of the key cross-cutting challenges that emerged from individual case study explorations of climatic and non-climatic stressors in different Albertine Rift locations include:

- Temperature increases: An increasing temperature trend was noted by almost all case study presentations and reported impacts include decreased aquatic ecosystem productivity in Lake Tanganyika leading to declines in fish catch; melting of ice caps on the Rwenzori mountains causing a shift in the course of the Semliki river; a shift in the range of the three horned chameleon in Uganda; and the increasing susceptibility of Chimpanzees e.g. in the Bwindi Impenetrable National Park (BINP) due to changes in habitat and reduced availability of food resources.
- Deforestation: This was attributed largely to the increased demand for resources due to population increases (e.g. cleared Gishwati forest in Rwanda), poor farming techniques, increasing fuel wood collection as well as from the creation of refugee camps and civil war impacts (e.g. Gishwati, Nyungwe and Akagera Protected areas in Rwanda and Ruwenzori Mountains in Uganda)
- Drought: Drought not only causes hardships for humans but also causes increased suffering and mortality among animals, resulting in a decimation of numbers. Serious impacts of drought have been noted in Bugesera Protected Area in Rwanda, Akagera National Park in Burundi, Katavi ecosystem in Tanzania and Rusizi plains and other wetlands in Burundi. Massive deaths of hippos have been reported in Katavi National Park in years of extreme drought.
- Wildfires: Persistent and extreme drought conditions are also conducive to wildfires, destroying forests with serious impacts on flora and fauna, species composition, habitats and ecosystem integrity e.g. the Lake Mburo fire in Uganda in 1999.
- Flooding: Flooding was particularly a cause for concern during the El-Nino event of 1997/98 as a result of which many plant and animal species were impacted e.g. destruction of habitats of the Puku antelope along Lake Rukwa shores in Tanzania.
- Outbreaks of disease and parasites: Changing climatic conditions can often create conditions that are conducive to the spread of disease and parasites among animal populations e.g. the simultaneous spread of canine distemper viruses and the tick borne blood parasite, Babesia in the Serengeti National Park in 1994. Even though this park is outside the Albertine Rift, it serves an important example of how abnormal and extreme climatic conditions e.g. severe drought followed by heavy rainfall can create perfect conditions for the two diseases to converge and thrive.
- Overgrazing: Limited park areas with little scope for expansion can in some cases result in overgrazing by large mammals e.g. in the Akagera National park in Rwanda. The lack of adequate grazing resources can serve as added stressors in a changing climate.
- Exotic and invasive species: Changing climatic conditions and the human traffic in protected areas are important reasons behind the spread of exotic and invasive species that compete with local flora and fauna for resources e.g. the spread of *Eicchornia crassipes and Sericostachys scandens* reported in the Rwanda case study.
- Poaching: Poaching continues to be a serious problem in all parks of the Albertine Rift and is further facilitated by the droughts and wildfires, which push animals closer to communities in search of water resources or as they seek to escape fire, respectively. Seeking community cooperation becomes particularly important here.
- Erosion: Poor farming practices outside park boundaries, particularly in upstream locations cause siltation and soil erosion in downstream lakes e.g. Lake Kivu in the Democratic Republic of Congo and Lake Tanganyika in Tanzania where increased siltation has been implicated as one of the causative factors in the loss of lake fauna.
- Blockage of migratory corridors: Habitat destruction and defragmentation of connective

corridors between protected areas due to human settlements and activities have disrupted migratory routes, particularly for large mammals in many Albertine Rift countries.

- Industrial activities: Some protected areas are endowed with rich mineral deposits resulting in mining activities and encroachment into park boundaries e.g. in Nyungwe National Park in Rwanda.

Overall, participants exhibited a good depth of understanding about key local issues in their home regions and this helped the group as a whole to get a sense of the range of vulnerabilities that arise from the juxtaposition of climate related impacts on existing pressures. Participant case studies stressed upon the need for strategies for adaptation of conversation that addressed climatic and non-climatic stressors and took into account ecosystem goods and services derived by human communities. The lack of adequate baseline data to measure ecosystem and biodiversity changes was cited as an important constraint. In addition, the absence of climate change related policies and conflicts between policies related to conservation and land-use / business interests were considered to be significant challenges.

Figure 6: Case study presentations in progress

A list of participant case study titles is available in Appendix 6.

3.3.3 Designing response strategies

This activity in Course II served as a follow-up to the case study exercise from Course I and engaged participants, working in country teams, to design response strategies to address climate change concerns to conservation in the Albertine Rift countries. Some country teams focused on particular ecosystems within this region e.g. Massito-Ugala Ecosystem, Tanzania and Bwindi Impenetrable National Park (BINP), Uganda, while those from Burundi, Rwanda and Democratic Republic of Congo examined strategy options at the country level. A range of climatic and non-climatic stressors, management concerns and local community needs were examined to explore integrated response options that sought to address these issues. Some of the key elements of suggested management strategies that addressed protected areas as well the matrix included:

- Awareness building and education of conservation practitioners and stakeholders
- Engaging and empowering local communities in conservation planning and natural resources management
- Seeking and promoting alternative livelihood options for communities that depend on natural resources
- Examining alternative energy sources to firewood

- Seeking sustainable tourism options
- Examining options to address the impacts of climatic stresses, particularly droughts
- Engaging local/regional scientific experts to better inform decision-making
- Promoting cross-boundary cooperation
- Better law enforcement to discourage hunting and poaching activities
- Seeking innovative ideas for fundraising to support implementation of improved and more integrated conservation programs

3.3.4 Field Trip

A field trip component was incorporated into the program during the one-week recess between the two courses (21 July – 27 July, 2008), with the primary objective of providing participants a first hand experience of some of the issues and risks to ecosystems and biodiversity that were addressed in the coursework. While logistics of distance and resource constraints prevented travel to locations within the Albertine Rift, key locations of conservation significance nearer to the University of Dar es Salaam were visited. These included:

- Protected areas: The Arusha National Park, the Lake Manyara National Park, the Tarangire National Park and the Ngorongoro Conservation Area - a World Heritage Site and Biosphere reserve, that supports multiple land-uses mainly pastoralism, conservation and tourism were visited. Particular emphasis was laid on engaging participants in understanding the specific roles of these areas from a conservation and ecosystems goods and services perspective, known climatic and non-climatic stressors and noted changes, existing conservation strategies and policies and primary challenges to conservation. Where possible, park ecologists, managers, researchers and other expert personnel were invited to address the group on these issues at the local level.
- The Jangwani migratory corridor: This is an important connective landscape for migratory animals, particularly elephants, and also supports a thriving human community and associated infrastructure and economic activities including agriculture, animal rearing, local businesses and tourism related services.
- The Olduvai and Makuyuni archeological sites: These visits served to inform participants about the role of paleo-climatic information in contributing to our understanding of the impacts and vulnerability from current climate stressors.

The format of learning was once again interactive and participants were encouraged to pay particular attention to the role of visited areas in terms of biodiversity conservation and provision of goods and services; influences of climatic and non-climatic stressors; types and roles of stakeholders; and most importantly similarities and differences with the Albertine Rift region. The key observation that came out of the field trip was land degradation and defragmentation of the landscape, resource competitions between humans and wildlife, and illegal activities such as hunting and poaching are currently the most important concerns faced by park managers. Climate related concerns are not at the forefront at the moment though the El Nino/La Nina event of 1997/98 was reported to have had important impacts.

Participants actively contributed to the discussions, particularly by drawing comparisons with the status of conservation areas in their home countries in the Albertine Rift. Reports prepared by participants based on their assessment of the field visit experience highlighted several commonalities in the issues and challenges and evaluated them from the perspective of climate change impacts. Recommendations for a suite of strategies to address such challenges were made and briefly include:

- Building awareness among conservation professionals, policy and decision makers and local communities
- Assessing and enhancing existing capacity of conservation professionals to address climatic and non-climatic threats
- Developing conservation plans that are customized to the unique situation and requirements of each specific protected area
- Encouraging participatory involvement of local communities in conservation efforts and benefits sharing opportunities to provide them a sense of ownership
- Discouraging immigration to communities adjacent to protected areas to reduce pressures on scarce resources
- Seeking strategies to prevent encroachment of wildlife corridors
- Inviting conservation experts to provide advice on any plans of new economic development in protected area localities
- Imparting protected area status to additional biodiversity rich areas to serve as a migratory refuge for species
- Supporting additional data collection and research on past and current climate and other critical parameters in the region to clearly assess threats
- Developing forecasting techniques and early warning systems, particularly for extreme weather events
- Promoting regional collaboration to integrate strategies in Albertine Rift countries

A more detailed report on the field trip is available in Appendix 9.

Figure 7: Park ecologist addressing the group (left) and interactive discussions (right)

3.3.5 Externships

Following successful completion of the training courses, participants were engaged in executing externship projects at conservation locations of their choice within their home country in the Albertine Rift region to obtain practical experience in applying the knowledge and skills gained in the classroom to on-the-ground conservation challenges. The externship duration was 2 months and participants were awarded stipends of $2000 each to execute this activity. Host institutions provided mentorship and support to the participants in executing the externship research.

All participants developed a research proposal for their choice of externship activity with assistance from the program faculty as well as supervisors at their externship host institutions. Proposed research topics addressed a range of stressors on natural ecosystems and biodiversity at selected locations, particularly from the perspective of climate change impacts (Box 3). A brief

description of participant externship research activities is available in Appendix 6.

Box 3: Participants' externship research topics

1. Observation of water characteristics and aquatic biota at Pangani River delta, Tanzania.*
2. Climate variability and extremes: Implications for the management of biodiversity in Katavi-Rukwa Ecosystem
3. Assessment of the impacts of climate variability on biodiversity conservation and livelihoods in the Lake Manyara Sub basin, Tanzania
4. Effect of climate change on stinging bee's behaviour (*Apis milifera)* and honey production: A case of Arumeru District, Tanzania
5. The impact of climate change on the phenology of chimpanzee (*pantroglodytes*) tree food species in Gombe National Park, Western Tanzania
6. Effect of climate change and non-climatic variability on butterflies of Njiro Forest, Tanzania
7. Decomposition rate of fish pond organic fertilizers in changing climate, Uganda#
8. Structural changes of *Neuboutina macrocalyx* tree in a changing microclimate around Mubwindi Swamp, Bwindi Impenetrable National Park, Uganda
9. Assessment of the existing legal framework in relation to biodiversity conservation in a changing climate in Uganda
10. Climate variability and waterbird diversity at Lutembe wetland Uganda*
11. Climate change impacts and environmental risk assessment in Rwenzori mountains ecosystem in Uganda*
12. A Baseline study of the vegetation cover of the Mabira Forest Reserve Uganda, in the existing climatic conditions.#
13. Recent changes in vegetation structure of the Ngezi Swamp in the face of climate change: Case of Volcanoes Biosphere Reserve and National Park, Rwanda
14. Evaluating the impact of climatic parameters on *Ericaceous* species of Nyungwe National Park, Rwanda
15. Effect of climate change and variability on socio-economic activities in Burundi: Implications for biodiversity conservation#
16. Climate change and the Ruvubu National Park, Burundi
17. Impact of climate change on the Biogeochemistry of Lake Kivu, Western Basin (Kalehe), Democratic Republic of Congo
18. Altitudinal distribution of small mammals in relation to climate change: The case of *Muridae* family in Kabwe Kandongwe station, Democratic Republic of Congo
19. Impact of climate change on the parasitology of *Gorilla graueri* in Tayna Gorilla Reserve, Democratic Republic of Congo
20. Climate change impacts on aquatic biodiversity conservation in an urban ecosystem: Case study of the *Itchyo* biodiversity of pool malebo in Congo River, Democratic Republic of Congo

* Pending externship report
# Externship report under revision

The output of this activity was one research report per externship project. Most participants have turned in a well-detailed documentation of their research and findings although the limited two-month duration of the activity was in many cases insufficient to draw significant conclusions from a climate impacts perspective, except where long-term data was readily available. This may not often be the case since the correlation between climate change and biodiversity conservation in the Albertine Rift is a relatively new area of research. Despite these constraints, some participants were able to report scientifically significant findings from their research efforts and these could be considered for possible journal publications.

The original timeline for the completion of all externships was December 2008. Unfortunately some participants, particularly those from Congo and Uganda, experienced delays in executing their externship research due to unanticipated banking delays in transferring externship grant funds. As a result externship reports from 2 Ugandan participants are at this time still pending and communication with them at their field research sites has proved somewhat problematic. Besides, an externship report is also awaited from 1 Tanzanian participant. Externship supervisors have also expressed some reservations about the quality of 3 submitted reports, 2 from Uganda and 1 from Burundi respectively, and these participants are currently revising their work.

3.3.6 Participant assessment

Courses: Evaluation of participant performance in the courses was based on faculty assessment of performance in terms of written reports, seminar presentations, case studies, proposals, class-room participation and externship performance. The initial plan was to grade participants in accordance with University of Dar es Salaam grading system. However, given the participatory and interactive nature of the course and its primary objective of building capacity, it was determined that a more generalized Pass / Fail grading system would be more appropriate.

Figure 8: Certificate awarding ceremony

Performance varied from participant to participant based on inherent knowledge levels, background, as well as pre-existing barriers such as language. Overall, all participants displayed great enthusiasm and made good effort to earn the Pass grade for all individual assignments and presentations. At the conclusion of the courses, the University of Dar es Salaam awarded all participants with a certificate for successful program completion.

Externships: Evaluation of participant performance in their externship project activities was based on feedback from mentors and the assessment of participant research reports submitted to IRA. As noted above, externship research reports have so far been received from 17 of the 20 program participants with efforts currently on to encourage the remaining 3 to turn in their documented findings. Of the 17 reports submitted, most received an overall good assessment while 3 participants have been requested to incorporate some suggested revisions. Some participants performed significantly better than others and documented scientifically important findings that could possibly be considered for journal publication. Commonly experienced issues with participant research included limited data to support conclusive analysis; lack of a statistically significant correlation between climatic factors and impacts on biodiversity; inability to account for non-climatic stressors in a few cases; and inability to draw clear linkages with climate change. Once again the limited duration of the research activity and constraints such as the limited availability of pre-existing data must be borne in mind besides the fact that this kind of research was a first time experience for many participants. The important objective here was capacity building and efforts must be made to continue to network with participants in the long-term to sustain and build upon this capacity and ensure a continuous exchange of information and knowledge.

3.4 Integration of Courses into the MSc. NARAM Curriculum

The Institute of Resource Assessment is currently engaged in discussions with senior personnel from the University of Dar es Salaam to integrate this educational program as a permanent component of its MSc NARAM program. This is currently an ongoing effort and updates on its success will be communicated to the MacArthur foundation and in START/IRA website announcements.

In addition, IRA is also exploring options to offer the courses online as distance learning modules in collaboration with the University of Dar es Salaam's Center for Virtual Learning (CVL). CVL will offer technical support in uploading, making accessible, managing and maintaining the courses in its Learning Management System. IRA faculty will work with CVL to organize and format course material to ensure compatibility with an online learning format. Training resources in accessing the Learning Management System will be provided to course facilitators and students via IRA and CVL staff as well as facilitator guidebooks. IRA and CVL will together hold responsibility for ensuring quality control and effective management of the online program.

4 PROJECT MONITORING AND EVALUATION

Evaluation of project performance was conducted at three levels:

1. Participant evaluation of the educational program at the University of Dar es Salaam
2. Participant and supervisor evaluation of externships
3. Assessment of overall project performance

4.1 Evaluation of the Educational Program at the University of Dar es Salaam

This exercise was conducted at the conclusion of the education and training program at the University of Dar es Salaam campus. A questionnaire-based feedback was invited from the participants to seek their perceptions about the overall design, implementation and organization of the education program, availability and quality of professional guidance, and potential for contribution to their professional growth. The questionnaire was designed as a combination of numeric and open-ended questions that could effectively capture participant perceptions. A sample survey questionnaire is included in Appendix 10 of this report.

An analysis of participant responses revealed that the overall assessment of the program was "good" with a few participants rating it as "excellent" (Figure 4). No participant rated the program "average" or "bad".

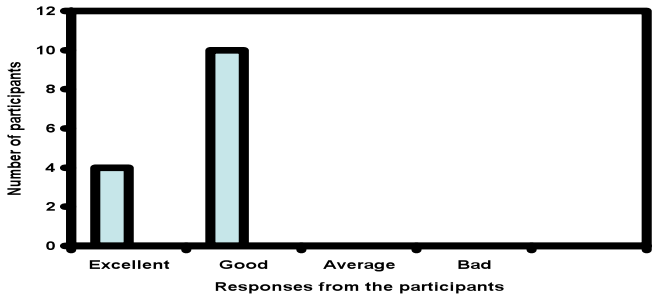

Figure 9: Overall assessment of the program

More than 90% of the participants agreed that the program had achieved its objective of equipping participants with climate change related knowledge and skills that could be applied to their ongoing conservation work (Figure 5) and a majority of participants "strongly agreed" that they expected to incorporate this learning in their day-to-day conservation related activities (Figure 6). In fact, participants, who were lecturers or instructors in educational institutions, expressed a strong interest in introducing the same courses offered at the University of Dar es Salaam to students at their home institutions. If such an expansion of the program could be affected for a larger number of Albertine rift educational institutions, this could have significant benefits in terms of broadening the reach of this educational effort to increasingly larger numbers of conservation professionals in the region. It could also facilitate the development of a network of institutions and individuals making important contributions towards the adaptation of vulnerable ecosystems and biodiversity to climate change impacts.

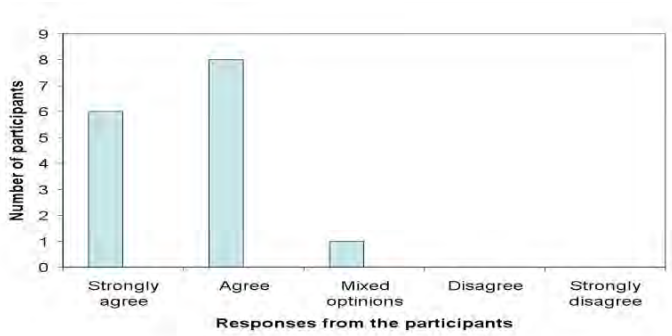

Figure 10: Achievement of program objectives

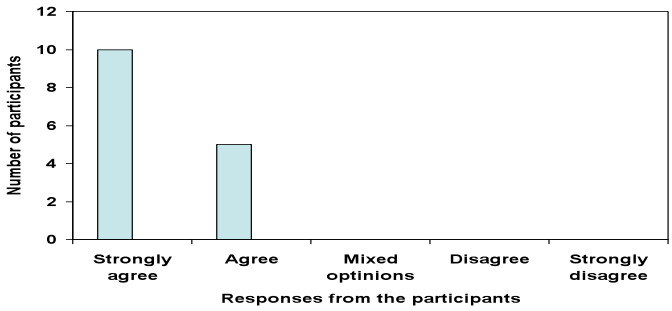

Figure 11: Participants' expectation to incorporate knowledge from the program in their conservation activities

In addition, the program consistently received a high rating through all categories including course contents, quality of instruction and guidance, faculty expertise and program design and organization. Most importantly participants "strongly agreed" that:

a) The program made a significant contribution to their knowledge base;
b) The program challenged them to think in new ways; and
c) The program would benefit their future career goals

Major strengths of the program identified by participants include:

- Unique nature of the program in linking climate change and biodiversity conservation issues
- Diverse group of participants
- Diverse group of highly competent lecturers
- Participatory and interactive teaching methods
- Good management and organization
- Attention to participant inputs

Thus, overall, participants expressed great satisfaction with the education component at the University of Sa res Salaam. Among the concerns that were raised, most were directed at the relatively short duration of the courses though it is important to note here that each course was purposely designed as an intensive three-week activity keeping in mind that conservation professionals may not be able to afford a lengthy period of time away from work. A few participants also expressed concerns about the logistical arrangements of local transportation and this feedback is extremely useful for program organizers to consider for future endeavors of this nature, particularly since this activity was also a new experience for them. Participant recommendations for improvements include:

- A larger program with more detailed coursework, more intensive training in tools and methods and a longer field study program component
- Access to modeling software and additional computer equipment for participant use
- Increase the reach of the program to a larger group of conservation professionals in the Albertine Rift region and Africa, keeping in mind that many may not have the capacity to afford the trip to the University of Dar es Salaam
- Explore options for offering the program in French for Francophone participants
- Engage policy-makers and other stakeholders (for example via capacity building workshops) to build connections between practitioners and decision-makers and allow for an exchange of ideas between the different categories of stakeholders
- Organize a follow-up meeting / workshop for course participants

Participants unanimously agreed that they would "highly recommend" the program to other conservation professionals. In addition, they also expressed a keen interest in developing and maintaining a network of course participants and faculty in order that collaborative opportunities could be explored.

A detailed evaluation of participant responses to the questionnaire is available in Appendix 11.

4.2 Evaluation of the Externship Component

The evaluation of externships was designed along the same lines as the course evaluation above using a questionnaire based approach to seek feedback on experience from both participant and mentor groups. Participant opinion was sought on various aspects such as externship organization and management, applicability of coursework in implementing the research, quality and level of supervision and benefits/impacts of research outputs. Feedback from supervisors was requested on participants' capacity and ability to conduct the research and sought their impression of the externship component in general. The intention behind seeking supervisor feedback on participant capacity and performance was not to judge individual participants but to instead assess the effectiveness of the education component held at the University of Dar es Salaam in adequately equipping them to conduct field research. Sample evaluation forms for participants and mentors are included in Appendix 12 and a detailed analysis of participant responses is available in Appendix 13.

4.2.1 Participant evaluations

On an average, a majority of the participants who responded to the survey agreed that the overall learning experience offered by the externship research activity was good (Figure 12). There was also general consensus that the experience provided an added value to the knowledge obtained from the education component and would benefit their ongoing work on biodiversity conservation (Figure 13).

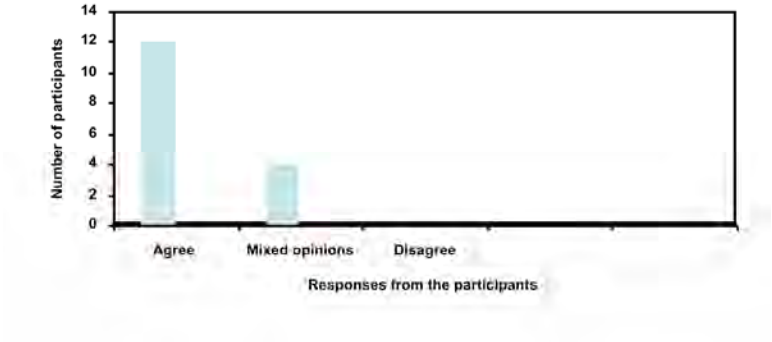

Figure 12: Overall learning experience

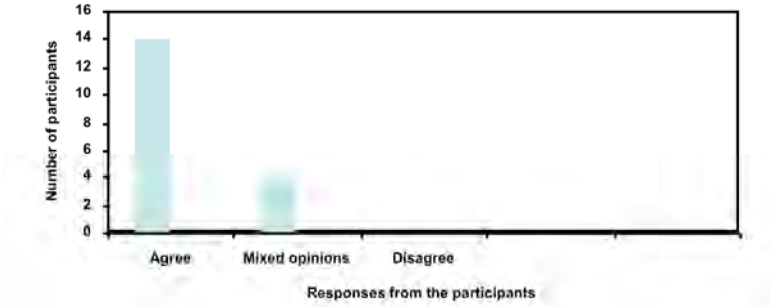

Figure 13: Value-added from the experience and benefit to conservation work

However, in this case, a greater variability in the level of satisfaction was noted as compared to the participant feedback to the education component in the previous section. While participants largely responded positively to most questionnaire categories, some also registered "mixed opinion" or "disagreed" or were "unsatisfied" (see Appendix 13). Participant opinions were divided about the externship duration where 8 of the 16 survey respondents found the duration adequate for accomplishing research objectives, 4 registered mixed opinions while another 4 disagreed (Figure 14).

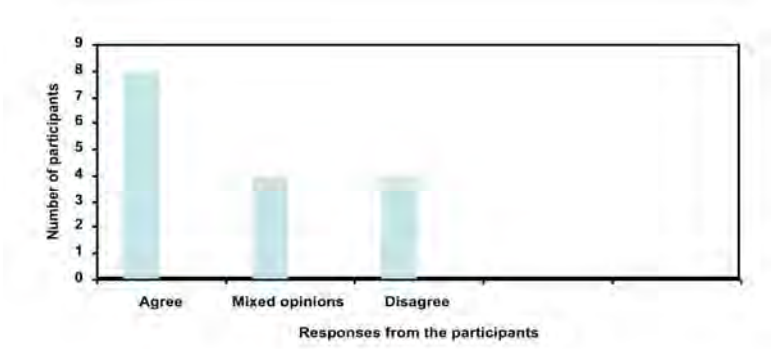

Figure 14: Duration of the externship research

It must be noted that the duration of the externship research was fixed at approximately 2 months for all participants based on limitations of time and budget. The intention here was not to engage

participants in an extensive research activity but rather, to have them execute short field projects that could give them practical experience in using knowledge from the coursework and enhance their understanding of adapting conservation strategies to a changing climate.

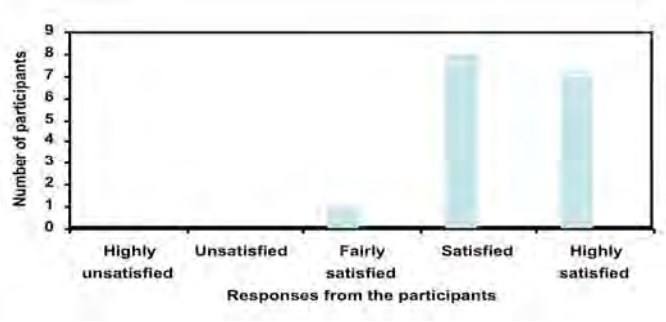

Figure 15: Overall grant management

With respect to overall grant management, most participants were satisfied to highly satisfied (Figure 15). Grant related concerns largely stemmed from the following:

- The grant amount was fixed as US $2000 per participant and it is likely that proposed project activities of the 3 participants whose responses ranged from "unsatisfied" to "fairly satisfied" (see Appendix 13) demanded resources beyond the scope of this budget. START/IRA will make efforts to investigate the issues here and will ensure greater oversight of the proposal writing process in future to ensure a better match between proposed activities and available funds.
- Grant disbursements followed START's standard practice of routing funds through externship host institutions instead of direct cash payments, as preferred by participants. The institutional routing however, created bureaucratic delays in funds delivery for some participants, particularly those from the Democratic Republic of Congo and Uganda. It also subsequently delayed their project commencement and reporting schedule and thus generated some discontent. While cash payments to individuals is unlikely to be a feasible solution given the need to maintain accountability and transparency, START will certainly use this experience as an important lesson to examine options to improve delivery of funds in future endeavors.

Nonetheless, in terms of the project impact, survey respondents predominantly agreed that:

- The externship experience along with the education program had made them significantly knowledgeable on the subject of climate change and biodiversity conservation.
- Their externship research outputs could prove useful for field applications of biodiversity conservation and conservation policy in the region.
- The externship activity had helped establish linkages with other institutions and researchers.

Most participants also expressed interest in a continued engagement with their respective externship research activities, particularly by exploring opportunities to weave them into Master's or Doctoral study programs within or outside the region. However, funding to pursue such an option remains an important barrier. Participants also expressed a desire to join a regional network of practitioners that works towards addressing climate change and biodiversity conservation issues and to assist with any future ecosystem goods and services assessment efforts. In addition, participants expected to contribute towards informing other conservation

practitioners, raising awareness about biodiversity conservation and climate change and providing inputs to national mitigation and adaptation plans.

The main strengths of the externship activity as perceived by the participants include:

- Provided valuable research experience in linking climate change and biodiversity conservation-related issues.
- Enabled the testing of some theoretical concepts on ground.
- Built capacity on better managing biodiversity under changing climatic risks.

The main weaknesses identified by the participants include:

- Insufficient funds for conducting the externship research activity.
- Insufficient time allocated for conducting the externship research activity.
- Lack of access to modeling tools and software for analyzing climate change impacts on various ecosystems components as a part of the research activity.

Based on this assessment, participants offered the following suggestions for future improvements in the program:

- A change in the grant payment delivery method to avoid transmission delays, particularly in the case of Uganda and the Democratic Republic of Congo.
- Need to allocate externship funds in proportion to actual tasks to be conducted in the field
- Enable access to modeling tools and other software for analysis of climate change - biodiversity issues (this need was also expressed in the evaluation of the education component and will be examined).
- Need to encourage participants to make thorough reconnaissance surveys in their field research location to enable them to develop appropriate data collection tools. This would also help to minimize the length of time spent in the field.

4.2.2 Supervisor evaluations

Externship supervisor opinions provided another important perspective into the strengths and weaknesses of the externship program. A detailed analysis is provided in Appendix 13. The overall assessment was largely positive with rankings ranging from good to excellent and responses almost evenly distributed between these categories. Only 2 of the 18 supervisors who responded to the survey rated the performance satisfactory (see Figure 16).

A similarly favorable response trend was noted for questionnaire categories assessing participants' performance, skills, attitude and quality of work. A majority of supervisors agreed that participants displayed adequate background knowledge of their proposed research and methodology. Most agreed that participants were capable of applying this knowledge and of working independently.

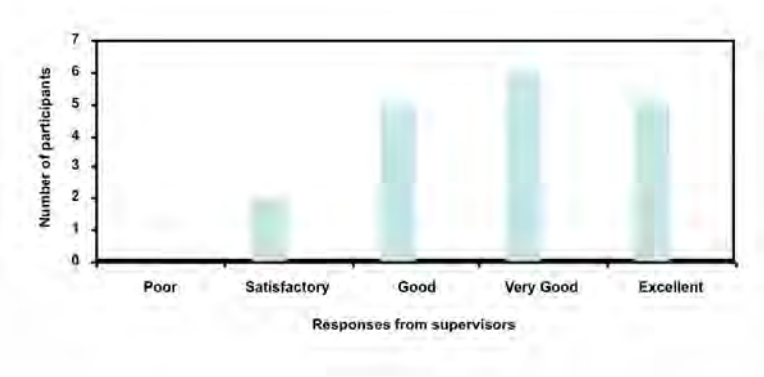

Figure 16: Overall externship performance

A few supervisors however expressed concern about the ability of participants to apply their knowledge and adequately account for climatic and non-climatic stressors and stakeholder roles in their practical research. A small number of supervisor ratings also ranged from satisfactory to poor for the assessment categories of reporting punctuality, communication with supervisors and quality of reports (Figures 17 and 18).

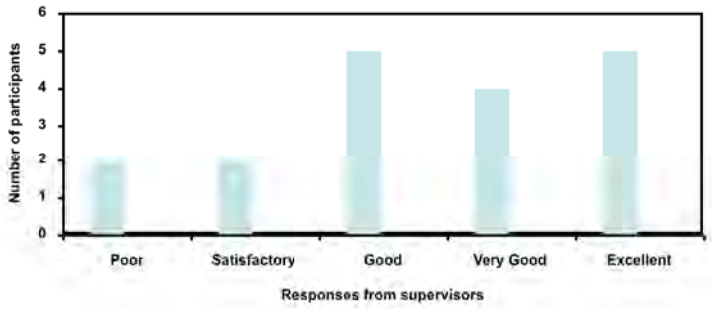

Figure 17: Communication with supervisors

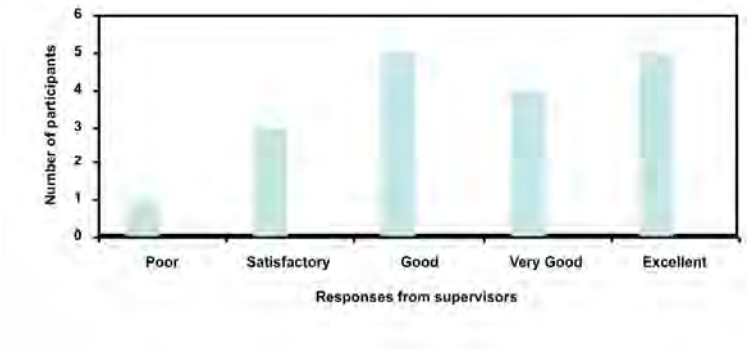

Figure 18: Quality of externship reports

Supervisors acknowledged that the presence of participants in remote field locations posed communication issues and in turn reflected upon the level of supervision and quality of research outputs. They recommended that future efforts of this nature could examine the possibility of

budgeting supervisor travel to participant field research locations to ensure better results. Supervisors also expressed concern over the short length of the research period, low level of funding and in combination with the constraints of distance-supervision, approximately 50% of the survey respondents registered mixed opinions or disagreed that the participant research outputs had the potential to influence policy in the region.

However, despite some of the drawbacks noted above the overall consensus was that the externship research had significant value-added benefits to the host institutions. Strengths of the activity as noted by the supervisors include:

- It reinforces the networking in the region by generating important linkages with other institutions and individuals engaged in biodiversity conservation and climate change work.
- Enables capacity-building in addressing climate change and biodiversity conservation by taking into consideration multiple stressors and the roles of various stakeholders.
- It benefits both supervisors and the participants by bringing in new knowledge and research skills
- The financial support offered to participants served to facilitate this capacity enhancement.
- Participants received good guidance in developing his/her research project and in report writing.
- Participants' had the flexibility to select their own research topics of interest.

Weaknesses of the externship activity noted by the supervisor group are:

- The short research period was insufficient for adequate data collection and proper statistical analyses to ensure better results.
- The lack of a travel allowance for supervisors to facilitate visits to participant field research location affected the level of supervision and limited activities that could have been undertaken.
- Linkages between IRA/PASS, participants and the externship host institutions were inconsistent.

Supervisor suggestions for future improvements to the externship activity and to the overall education and training program include:

- Establishing stronger linkages between PASS/IRA and externship host institutions.
- Allocating additional funds for externship research activities.
- Support for participants to conduct long-term research with plots for monitoring changes over time.
- Creating and maintaining a formal network of climate change and biodiversity conservation experts to enable the exchange of knowledge about biodiversity conservation and climate change in the region.
- Implementing repeated training programs to generate a critical number of climate change-biodiversity conservation experts in the region.
- Encouraging PASS/IRA to establish a permanent program on climate change and biodiversity conservation in the region.
- Implementing national workshops to generate awareness and build capacity on managing biodiversity in a changing climate (communication strategy).
- Encouraging other universities in the region to establish similar courses, possibly as an outcome of the national workshops.

4.3 Assessment of Overall Project Performance

While the feedback from the participants and supervisors described above provided an important perspective on the strengths and weaknesses of this first order effort, the assessment of its overall performance also benefits from the experience that came from designing and implementing the education and training program and the outputs that it generated.

In terms of the successes, the key achievement of the project clearly lies in the successfully executed training and capacity building of 20 African conservation professionals from the Albertine Rift region in developing and understanding climate change related challenges to ecosystems and biodiversity and learning to address such challenges. This one-of-a-kind endeavor that combined learning about ecosystems, biodiversity and conservation with climate change has drawn the attention of several other education and conservation institutions in Africa and abroad. The curriculum developed for the purpose of this education and training program will not only be instituted within the University of Dar es Salaam curriculum but will also be available for adoption by other academic institutions implementing similar programs and as online learning modules. Other outputs such as the Baseline Assessment Report and as well as this Final Project Report throw light on the unique characteristics of this region, current capacity in addressing climate related challenges and the experiential learning that came from implementing a capacity building program of this nature. Besides, the engagement of key experts in the major stages of the project, particularly in terms of guidance in curriculum development and course instruction, has lent credibility to the effort and ensured quality of the products.

A summary of some of the significant performance milestones from the project and planned or anticipated future activities is included in Table 2 below.

Task	**Accomplishments**
Baseline Assessment	➢ A review of key literature and an examination of current policies and programs was undertaken. ➢ 14 departments from 8 Albertine Rift institutions were consulted. ➢ The assessment identified significant gaps in capacity and knowledge about the combined risks of climatic and non-climatic stressors to ecosystems and biodiversity. ➢ Very few conservation initiatives accounting for climate related risks were currently found to exist. ➢ A scoping report highlighting findings from the assessment and identifying key research and training needs is available at: http://www.start.org/Program/Biodiv.html.
Curriculum Development	➢ 2 intensive Master's level courses for conservation professionals entitled, *Climate Change Risks to Ecosystems and Biodiversity* and *Conserving Biodiversity in a Changing Climate* were designed. ➢ Several existing programs that addressed biodiversity and climate change topics were examined in the process. ➢ More than 40 academic experts were consulted during the design and their feedback incorporated into the final product. ➢ A strong interest in the program was displayed by the African conservation community with more than 200 applications and special requests for consideration from as far as Jordan. ➢ Several academic institutions in the Albertine Rift countries have expressed interest in offering the courses developed.
Program Implementation	➢ 20 conservation professionals from the Albertine Rift region were selected to undertake the program, under the guidance of expert faculty from within and outside Africa.

Task	Accomplishments
	➢ Training was offered in theoretical coursework, case study exercises and field visits supplemented by an externship project. ➢ Participants accorded a consistently high rating to the program in terms of overall quality and applicability of contents, materials and activities to their conservation work. ➢ Participants agreed that the program had made a significant contribution to their capacity in understanding climate change risks to biodiversity and ability to adapt conservation strategies to address such risks. ➢ Participants expect to see significant benefits to their conservation careers.
Participant externships	➢ 17 participant externships were successfully executed at various Albertine Rift locations under the guidance of local mentors. 3 externships are currently in progress. ➢ A range of climatic and non-climatic stressors were examined from the perspective of adapting conservation strategies and sustaining ecosystem goods and services. ➢ Externship research projects with scientifically significant outcomes will be considered for possible journal publication. ➢ The overall externship experience was well received by participants and supervisors in terms of building skills, providing valuable research experience and reinforcing networking among institutions and individuals working on biodiversity conservation and climate change in the region.
Future plans	➢ Efforts are currently underway to formally incorporate the two courses into the University of Dar es Salaam's MSc. NARAM program. ➢ Options are being explored to offer the intensive training summer program on a continuing basis at the University of Dar es Salaam. ➢ Options are being explored to expand the effort in the form of distance learning modules and implementation in other Albertine Rift and African institutions. This is based on the high demand for participation as well as participant recommendations for an expansion of the program to reach larger numbers of conservation professionals. ➢ Opportunities to engage policy and decision makers in future endeavours will be examined. ➢ Achievements from the current effort will be widely disseminated in the form of brochures highlighting project achievements and compact discs containing educational material from the project such as curriculum, power point lectures and participant research information. ➢ Efforts are underway to update the project website at START to serve as a one-stop knowledge resource about the activity, its participants and its achievements and facilitate networking of conservation professionals.

Table 2: Project performance milestones

In addition to the targeted achievements outlined above the project also resulted in important ancillary benefits thus making added contributions to the greater endeavor of capacity building to enable adaptation to climate change impacts and sustain the flow of goods and services critical to human survival in the following ways:

- The development, organization and implementation of the project has also resulted in the building of capacity among the faculty and staff at IRA to design and execute such an activity thus resulting in an "training of trainers" output.
- The bringing together of individuals engaged in conservation efforts in various different capacities ranging from course organizers, faculty and participants has resulted in a

network of informed professionals that can work across borders towards a common goal. Such a network can make important contributions to other planned and ongoing efforts such as for example the MacArthur foundation funded *Ecosystems and Livelihoods Adaptation Network (ELAN)* and the *Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)* to inform the second round of the *Millennium Assessment* project.

Nonetheless the program also offered some important challenges as have been highlighted in the participant and supervisor evaluations. While the education component of the capacity building program overwhelmingly received highly positive feedback from participants, the externship component did experience a few hurdles. Participants and supervisors primary expressed their concern over:

- Short duration of the education program and externship activity,
- Limited research grant amount and need for a more efficient grant disbursement
- Lack of travel support for supervisors to visit participants in field locations
- Lack of access to modeling tools and software
- Need for improved communication between IRA, externship host institutions and participants

They felt that these challenges limited the scope of the research that could be undertaken and affected the quality of outcomes in some instances. While the length of the education program and externship had purposely been designed as short training activities with an estimated equivalent funding support to enable participants to take time away from their professional engagements, these concerns will be closely scrutinized in terms of incorporating improvements in future capacity building programs of this nature. Efforts will also be made to facilitate better grant management, better supervision and guidance to participants and better communication between the various institutions and individuals engaged in the program. Particular attention will be paid to individual participants to ensure that they are able to effectively apply learning from the classroom in their field research, especially in accounting for climatic and non-climatic stressors on biodiversity.

It is hoped that this learning experience can be fed back into further improving the capacity building program design and management and will pave the way for its expansion to other institutions in the Albertine Rift region and beyond. A summary of lessons learnt and next steps is offered in the following chapter.

5 LESSONS LEARNT AND NEXT STEPS

The experiences that emerged from organizing and implementing this kind of a unique capacity building project for conservation professionals as well as the feedback from participants generated several important lessons that can serve to inform future endeavors of this nature. These are briefly highlighted below.

- The most important lesson that came out of this activity was need to sustain the effort in the longer term at the University of Dar es Salaam and expand its reach to other regions in the Albertine Rift and beyond. This was highlighted by the large numbers of applications to the educational program but also from participant feedback about the need to increase access, particularly for the many participants in Africa who made not be able to afford international travel.
- Exploring options to offer the courses as distance learning modules to reach a greater number of individuals and institutions is another way of expanding access. Efforts to facilitate this at the University of Dar es Salaam are currently underway, though subject to the availability of funds. Several considerations will be necessary when offering modules online. Some of these include the need to ensure the applicability of contents for a broader population across the developing world and the possibility of offering the modules in different languages, particularly given the participant feedback about language barrier for Francophone applicants
- Exploring ways in which existing modules can be improved and updated to better address the needs of conservation professionals is also important. This might include continually updating the information to incorporate new scientific knowledge; exploring options to include a more intensive training on tools, methods and software; and providing participants increased access to computing equipment, software and tools, as indicated by participants in the evaluation feedback.
- Exploring options to better improve the externship experience and its outputs on the basis of participant and supervisor feedback. As discussed in the previous chapter, this would include: examining possibilities of enabling a longer duration externship research; improving overall grant management; exploring options to offer larger grant amounts or to allocate grant amounts equivalent to the scope of proposed research; offering better guidance to participants in limiting the scope of their research activity within the available time and funds; offering funding support for supervisor travel to participant research field locations; effectively advising participants and assisting them to apply learning from the classroom in the field; exploring possibilities for enabling access to modeling tools and software; and improving communication between the various institutions and individuals engaged in the effort.
- There is also a need to explore ways in which research findings from participants' externship activities can be used to inform and improve the contents of the program modules.
- Exploring options to engage participants in organizing and enabling stakeholder workshops in Albertine Rift countries to build awareness and inform key stakeholders, particularly decision-makers
- Exploring options for also developing education and awareness building programs for undergraduate students and the general public
- Developing a climate change and biodiversity conservation communication strategy for the region and beyond.
- Maintaining communication among the network of individuals and institutions developed under this program. This would also help to obtain feedback from participants in terms of the long-term benefits of the course to their careers and work on conservation.

- Exploring ways in which this network of individuals and institutions can be sustained and grown to enable the initiation and implementation of future efforts for the adaptation of ecosystems and biodiversity to climate related risks. This would also include developing linkages with other organizations and institutions that may be undertaking efforts in this direction.
- Exploring options to bring visibility to the accomplishments and outputs of this initial effort. Besides updates on START and IRA websites, START plans to develop a brief brochure highlighting the achievements of the program for wider circulation. Another option under planning is the development of compact discs with course curriculum, power point lessons and description of participant research as a package for wider circulation of among biodiversity and conservation professionals, thus enhancing the capacity building effort.

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APPENDIX 1 – BASELINE ASSESSMENT REPORT

GLOBAL CHANGE STYSTEM ANALYSIS RESEARCH AND TRAINING

Building African Capacity for Conserving Biodiversity in a Changing Climate in the Albertine Region

Baseline Assessment Report

By

The Institute of Resource Assessment (IRA)

and

The Pan-African START Secretariat (PASS)

University of Dar es Salaam, Tanzania

July, 2007

Albertine Rift map on cover courtesy of A.J. Plumptre 2003

Table of Contents

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1 Introduction

Climate change poses an enormous challenge for the global community as it strives to ensure that the earth's natural heritage is conserved and sustained over time. While naturally occurring climatic changes have been historically transforming ecosystems, the current accelerated rate of human induced climate change will likely exceed their resilience and alter ecosystems boundaries and their species distribution at a relatively much rapid pace. The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) states with high confidence that the recent warming observed is having significant impacts on terrestrial biological systems resulting in changes in ecosystem locations and boundaries and their species composition (Fischlin and Midgley, 2007). In addition, the synergistic interactions of climate change with other human and natural stressors pose added threats for ecoregions and are likely to result in ecosystem changes that are not yet fully understood (Fischlin and Midgley, 2007; Millennium Ecosystem Assessment, 2005a).

Recent studies suggest that the African continent is among the most vulnerable to the impacts of climate variability and change (IPCC, 2007b). An overall warming trend is projected for Africa over this century and this warming is "very likely" to be larger than the global annual mean warming according to the IPCC's Fourth Assessment report (Christensen et al, 2007). Rainfall projections suggest drier conditions in the sub-tropical regions and wetter conditions in the tropics. Almost all sectors of the African economy are expected to be at risk from the negative impacts of such climatic changes resulting in the loss of food security and livelihoods for millions of people (Boko et al, 2007). Detectable changes have already been noted in African ecosystems, which are important sources of biodiversity and are significant contributors to human well-being. These changes can largely be attributed to climatic influences and their interactions with human driven impacts such as hunting, deforestation, over harvesting of particular species and forest fires (Boko et al, 2007). Future climate trends are expected to further result in changes in the structure and function of African ecosystems and have significant impacts on species diversity (Boko et al, 2007).

Adaptation options for the protection of ecosystems and their biodiversity are unfortunately not extensive since this is still an area under investigation. Many of the currently used conservation strategies have been developed and implemented in a relatively static climate (Lovejoy, 2005) and these will need to be adapted to respond to future impacts on ecosystems and biodiversity from changes in climate and their interactions with other natural and anthropogenic stressors in order to remain effective (Da Fonseca et al., 2005; Hannah and Hansen, 2005; Hannah and Salm, 2005; Lovejoy, 2005; van Jaarsveld et al., 2003; and von Maltitz et al., 2006). Natural resource management techniques that can help to increase the resilience of ecosystems will be especially useful. This necessitates regular monitoring of climatic and ecological changes as well as the dynamics of other stressors in order to determine effective response strategies that can help to better protect ecosystems and ensures greater species survival (Fischlin and Midgley, 2007).

In response to the challenges of adapting ecosystem conservation strategies to the impacts of future climate change, the Institute of Resource Assessment (IRA) of the University of Dar es Salaam, in collaboration with the International START Secretariat, and with funding from the MacArthur Foundation, is executing a project in Africa entitled "Building African Capacity for Conserving Biodiversity in a Changing Climate". The focus of this project is on the biodiversity rich Albertine Rift region in eastern Africa, a biodiversity hotspot and home to several endemic species of flora and fauna. The objective is to build and sustain scientific and technical capacity in these countries by educating and training early to mid-career conservation researchers and

practitioners in Africa for conserving biodiversity in a changing climate. As a first step, this involves the evaluation of the current status of knowledge, existing conservation strategies and the present capacity of ecosystems to adapt. This will be followed by the communication of risk information to conservation practitioners and stakeholders through masters-level courses at the University of Dar es Salaam and the engagement of research, practitioner and stakeholder communities in collaborative efforts to design, test and implement appropriate conservation strategies. The near term goal is to establish climate change and biodiversity conservation as a part of the curriculum of the Masters of Science program in Natural Resource Assessment at the University of Dar es Salaam. In the longer term, we intend to facilitate other universities in the region to incorporate climate change and biodiversity conservation into their curricula.

This report is the first step in this capacity building process and presents the findings of a baseline assessment of existing information related to biodiversity conservation and climate change in Africa and specifically in the Albertine Rift countries of Africa. It includes an examination of climate change and biodiversity in Africa as well as of the existing capacity and current status of research and training programmes in the Albertine Rift countries. A detailed description of this assessment is provided in the sections that follow.

2 Methodological Approaches

The baseline assessment was performed primarily through a literature review and consultations with key research, education and conservation institutions in the Albertine Rift region. This information was then synthesized in the form of a baseline assessment that presented an overview of the current status of biodiversity and climate change in Africa and the main areas of current research and training in Africa, particularly in the Albertine Rift Region, that are closely related to biodiversity conservation in a changing climate.

2.1 Literature Review

Literature search entailed review and documentation of information pertaining to climate change impacts on and vulnerability of African biodiversity and the current status of biodiversity research and conservation education and training programmes in Africa and the Albertine Rift Region. We also examined existing conservation initiatives as well as community strategies for adaptation to climate change in the Albertine Rift Region. This helped to assimilate up-to-date available information and as well as identify knowledge gaps in the understanding of climate change and biodiversity conservation in Africa particularly in the Albertine Rift region. Though this literature review is by no means a comprehensive examination of the vast literary resources available on this subject it does attempt to present up to date key information and generate a useful overview that can inform the next steps in this project.

2.2 Consultations with Key Institutions

Consultations were undertaken with various training and research institutions in the Albertine region (see Appendix 1, next) to capture relevant information about their programs and activities in the area of climate change and biodiversity conservation. Consultations were undertaken in Burundi, Rwanda, Tanzania and Uganda. The team could not travel to the Democratic Republic of Congo (DRC) due the unstable political situation that prevailed there during the period of the consultations. However, much of the information from DRC was obtained from the literature. A

checklist of issues was prepared to focus on the following aspects: what institutions and researchers are involved in these issues, where and how is this research being applied to adapt conservation practices, what are the unmet research and training needs that are important in conserving biodiversity, what is the current research and training capacity in Africa to meet these needs, what are the critical gaps in capacity, and what mechanisms currently exist to fill these gaps.

3 An Overview of Current and Future Climate Change

The term climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 1996; 2007a). It is largely attributed to changes in atmospheric concentrations of greenhouse gases and aerosols, in solar radiation and in land surface properties. Since pre-industrial times a marked increase has been noted in the atmospheric concentrations of greenhouse gases such as carbon dioxide, methane and nitrous oxide primarily due to human activities such as fossil fuel burning, land-use change and agricultural activities. This is resulting in an alteration of the energy balance of the climate system and manifesting as increases in temperature, changes in rainfall patterns, and more frequent and severe extreme events among other effects (IPCC, 2007a).

According to latest observations reported by the IPCC (2007a), the lower atmosphere is warming up faster than anticipated and an increase in global surface temperature of about 0.76°C has been noted between the 1850-1899 and the 2001-2005 periods. A warming of 0.2°C is projected for the next two decades at a rate of about 0.1°C per decade based on the results of various climate modelling studies. Trends in precipitation over the 1900-2005 period show a increase in the eastern parts of North and South America, northern Europe and northern and central Asia and a decrease in the Sahel, the Mediterranean, southern Africa and southern Asia. Future precipitation projections suggest a high likelihood of increases in the higher latitudes and decreases in sub-tropical regions. An increase in the frequency and intensity of extreme events has also been noted since the last century. Overall it is projected that the increasing concentration of greenhouse gases would result in several changes in the global climate system over the course of the 21st century that are expected to be larger than those observed over the 20th century (IPCC, 2007a). This has significant implications for the survival of natural systems, many of which are already being affected by the temperature increases (IPCC, 2007b).

Changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems in many parts of the world (IPCC, 2007b; MaCarthy *et al.*, 2001). The Millennium Ecosystem Assessment (2005b, p.10) suggests that, at a global level, the impacts of anthropogenic climate change could likely be the "dominant driver of biodiversity loss and changes in ecosystem services". Some of the observed impacts include shrinkage of glaciers; lengthening of mid to high-latitude growing seasons; pole-ward and altitudinal shifts of plant and animal ranges; declines of some plant and animal populations; earlier flowering of trees; and emergence of insect pests. Moreover, the vulnerability of natural systems and human populations to climate change differs substantially across regions and across populations in the world. Even within regions, impacts of climate change and variability, and adaptive capacity vary (IPCC, 2007b; McCarthy *et al.,* 2001).

Developing countries are the worst hit by the adverse impacts of climate change and it is projected that they will continue to suffer disproportionately in the future (IPCC, 2001; IPCC, 2007b). In these countries existing stresses that arise from current climate hazards, poverty, lack of adequate access to resources, food insecurity, trends in economic globalization, conflict and

incidence of diseases such as HIV/AIDS further aggravate vulnerability and affect capacity to adapt (IPCC, 2007b).

3.1 Climate Change Impacts on Africa

Africa is one of the most vulnerable regions in the world to climate change mainly due to poverty, lack of awareness, lack of access to knowledge and a high dependence on rain-fed agriculture. About 70% of people in Africa live by agriculture while 40% of all exports are of agriculture produce (WRI, 1996; Mugabe *et al*., 2000; McCarthy *et al*., 2001; IPCC 2001; WWF, 2002). The historical climate record for Africa shows increased warming rates since the 1960s with a warming of approximately 0.7°C over most of the continent noted during the twentieth century. A decrease in rainfall over large portions of the Sahel (the semiarid region south of the Sahara) and an increase in rainfall in east and central Africa has also been observed (Low, 2005 & WWF, 2002). This is already impacting critical sectors such as water resources, food production, human health and biodiversity and resulting in increased desertification trends across the continent (IPCC, 2007b; McCarthy *et al.,* 2001).

In terms of future projections, the drier sub-tropical regions are likely to warm more than the moist tropics. Modelling results for the 2080-2099 period suggest a median temperature increase between 3°C–4°C for the West African, East African, South African and Saharan regions of the continent over the 1980-1999 baseline period using the multi-model dataset for the IPCC A1B scenario from it's Special Report on Emissions Scenarios (SRES). This increase is about 1.5 times the modelled increase in the global mean temperature. Overall, warming across the continent will likely range from 0.2°C per decade (low scenario) to more than 0.5°C per decade (high scenario) (Hulme *et al*., 2001).

Modelled projections of annual precipitation trends for the 2080-2099 period and over the same 1980-1999 baseline suggest drier conditions for the sub-tropics and wetter conditions for the tropics. Specifically, about a 6% decrease in annual rainfall is expected for the Mediterranean and northern Saharan regions; a decrease is also expected in the South African winter rainfall; while East Africa is likely to see about a 7% increase in annual rainfall. There is still uncertainty regarding future rainfall patterns for the Sahel, the Guinean Coast and southern Sahara (IPCC, 2007a).

The impacts of these future climatic conditions are likely to interact with and exacerbate existing developmental challenges related to poverty; deficiencies in governance; weak institutions; lack of access to capital, markets and technology; diseases such as HIV/AIDS and lack of access to adequate health services; ecosystem degradation; natural and man-made disasters; and conflicts. Agricultural yields are projected to decrease as much as 50% by 2010 for some African countries and net revenues from crop production could fall by as much as 90% by 2100, with small scale farmers likely to be the most at risk (Boko et al, 2007). Water stress is also expected to increase, affecting about 75-250 million people in 2020 and increasing to 350-600 million people by 2050 (Boko et al, 2007). Sea-level rise is expected to increase flooding and affect the health of coastal populations and could cost at least 5-10% of the African GDP (Boko et al, 2007). Impacts on ecosystems have already been observed to progress at a rate much higher than anticipated and it is expected that by the 2080s, there will likely be a 5-8% increase in the proportion of arid and semi-arid lands and about 25-40% of mammal species in national parks in sub-Saharan Africa will likely be endangered (Boko et al, 2007). The highest degree of habitat losses are likely to occur in warm mixed forests and savannas, both of which support a large and growing human population (Sala, 2005). Human health in Africa is also likely to be impacted by the increased

incidences of insect borne diseases such as malaria and dengue fever and other infectious diseases such as meningitis and cholera. Overall, present capacity to address existing impacts stemming from climatic and non-climatic stressors is unfortunately low and current strategies may be insufficient to address future challenges (Boko et al, 2007).

4 Climate Change Impact on Biodiversity

Many species around the world are now affected by the combined impacts of natural climate variability and anthropogenic climate change and their interactions with other human stressors such as the encroachment, fragmentation and destruction of natural habitats. Species typically respond to climatic stressors by migrating and shifting their ranges to areas with more favourable conditions. This has already been noted in the case of birds, marine life forms, butterflies and insects in response to the changes in climate that have already taken place, particular to the increase in temperature (Hanahn et al, 2005). Besides, many range-restricted species, chiefly polar and mountaintop species, show severe range contractions and have been the first groups among which entire species extinctions have been noted due to the recent changes in climate (Parmesan, 2006). It has also been observed that, tropical coral reefs and amphibians have been the most negatively affected. The differential responses of species to warming have also been reported to have disrupted predator-prey and plant-insect relationships (Parmesan, 2006).

The observations of range shifts in parallel with climate change have been largely reported from northern European countries, where observational records for many birds, butterflies, herbs and trees date back to the mid 1700s (Parmesan, 2006). Since the early twentieth century, researchers from these areas have documented the sensitivity of insects to spring and summer temperatures; these includes studies by Uvarov (1931), Ford (1945); Dennis, (1993), Bale *et al*., (2002) who described the northward range shifts of several butterflies in England. These studies related the shifts to the summer warming trend that began around 1915. In general, most of the research conducted so far includes impacts of single extreme weather events; experimental studies of physiological tolerances; snapshot correlations between climatic variables and species' distributions; and correlations between climatic trends and changes in distribution, phenologies, genetics and behaviours of wild plants and animals (Parmesan, 2006).

However, successful range shifts by species to areas with more favourable climatic conditions may be hampered by anthropogenic influences such as habitat destruction, land degradation and the disruption of migratory corridors due to human development. The interaction of climate change impacts with these and other stressors such as alien invasive species, pollution and over hunting, is likely to greatly reduce species resilience and impact the probability of their survival under further changes in climate (Hannah et al, 2005). Such ecosystem disruptions also negatively impact human populations dependent upon natural resources for their sustenance and livelihoods by affecting the availability of ecosystem goods and services, a fact of life in Africa and especially the Albertine Rift countries (Fischlin and Midgley, 2007; IPCC, 2007b; Lovejoy and Hannah, 2005; Leary et al., 2005; McCarthy et al., 2001; Millennium Ecosystem Assessment, 2005a; and von Maltitz and Scholes, 2006).

According to the IPCC (2007b) findings, any increase in global average temperature above the range of 1.5-2.5°C is likely to result in significant alterations in the structure, function and geographical ranges of ecosystems thus negatively influencing species distribution and survival. In most cases ecosystem responses to climate change and increased atmospheric CO_2 concentrations are expected to be non-linear in nature and the surpassing of some critical threshold values are likely to induce sudden transitions in state. Terrestrial ecosystems are also

likely to initially experience increased growth from CO_2 fertilization effects but these benefits are projected to be soon overshadowed by the negative impacts of increased temperature by the end of the 21st century. Overall a very high possibility of irreversible losses of biodiversity as a result of such changes in climate are projected with many terrestrial, freshwater and marine species being placed at an much greater risk of extinction than before (Fischlin et al, 2007).

4.1 Climate Change Impacts on Biodiversity in Africa including the Albertine rift Region

Africa is a biodiversity rich continent, occupying about one-fifth of the global land surface and home to about one-fifth of all known species of plants, mammals, and birds in the world, as well as one-sixth of amphibians and reptiles (Siegfried, 1989). It houses several major bio-diversity hotspots in the eastern, western, central and southern portions of the continent (Desanker and Magadza, 2001). This rich variety of endemic flora and fauna is an important source of goods and services and supports both formal and informal economic sectors (von Maltitz and Scholes, 2007). Only a fraction of the African land surface, however, is designated as formal conservation areas and much of its biodiversity occurs outside these protected areas. Increasing human pressures on the landscape due to the extension of agriculture and destruction of forests therefore raises important concerns about the sustainability of this biodiversity under a changing climate (Desanker and Magadza, 2001).

Of the several biodiversity hotspots in Africa, the Albertine Rift region in the eastern portion of the continent is among the most important. It stretches from the northern end of Lake Albert to the southern end of Lake Tanganyika (Figure 1) and covers countries that border the western arm of the Great Rift Valley, namely, Burundi, Democratic Republic of Congo, Rwanda, Tanzania and Uganda. It contains the Rift Valley lakes of Tanganyika, Kivu, Edward, and Albert.

The Albertine rift region has many unique ecosystems and some of the highest mountains in Africa, including the Virunga Mountains, Mitumba Mountains, and Rwenzori Range. It has a high diversity of habitats, which include glaciers; lava rock and volcanic hot springs; alpine vegetation (including giant forms of plants that occur at lower altitudes such as giant Lobelias and Senecios), montane forest, savanna, low land forests and woodlands; and papyrus swamps and high altitude swamps. The rift system is known for its richness in biodiversity, including many species of fauna and flora that thrive in these habitats. It is very rich in vertebrate species and is home to more than half of continental Africa's birds and nearly 40% of its mammals, including gorilla and elephants (Plumptre et al, 2003). It has more endemic species of mammals, birds and amphibians than other regions of Africa. The Albertine Rift region is not only important for its biological diversity but also for the ecological processes and services that it sustains. For example, the Rwenzori Mountains form one of the largest and most important catchment areas in Uganda and a substantial source of water for the White Nile River (Plumptre et al, 2003). However, like many parts of the world, the ecosystems and biodiversity of the Albertine Rift region has been adversely impacted and threatened by various factors, including climate variability and change as well as human-induced landscape changes.

According to recent studies, climate change is likely to affect most of Africa's natural resources and a range of potential impacts on terrestrial and aquatic ecosystems have been indicated (Leemans and Eickhout, 2004; Boko *et al*., 2007). Climate change impacts such as rising temperatures and declining rainfall in combination with other stresses could result in the shifting of ecological zones, loss of flora and fauna and an overall reduction in ecological productivity in Africa (Boko et al, 2007).

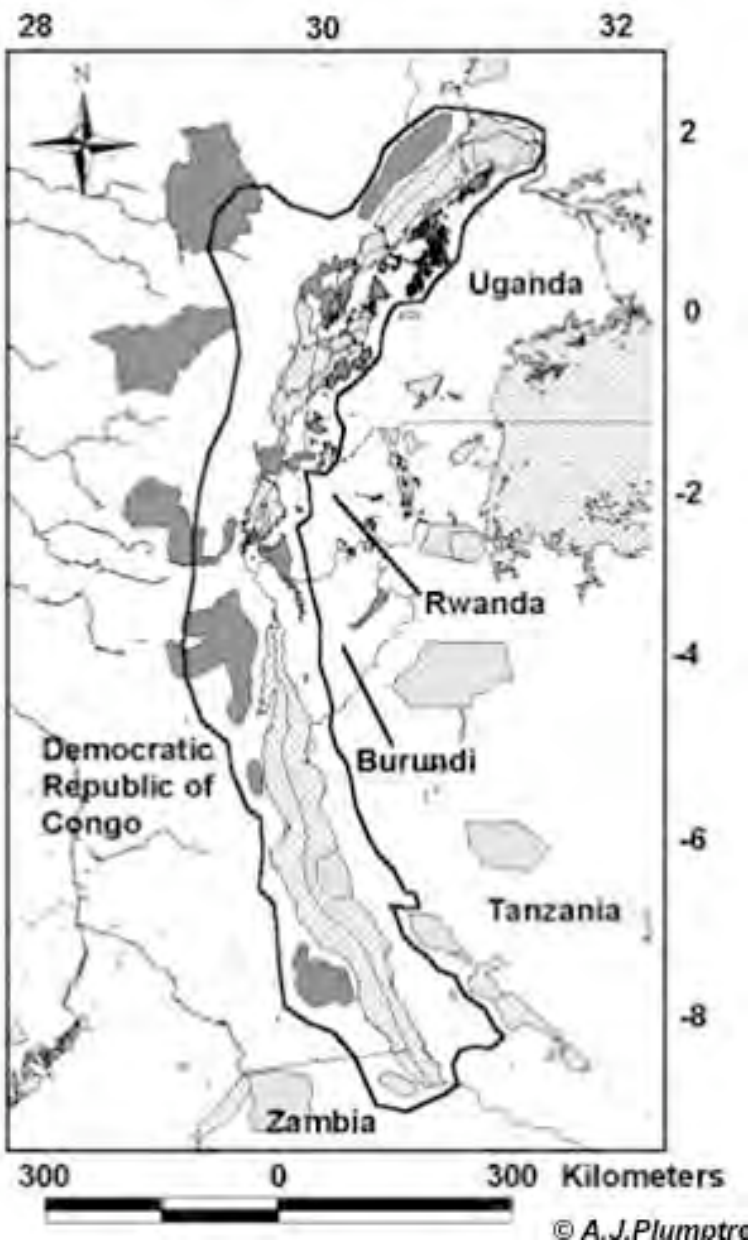

Figure 1: The boundary of the Albertine Rift

(Source: Plumptre et al, 2003)

Loss or alterations of terrestrial habitats due to climate change will likely impact animal biodiversity concentrated in the savannas and tropical forests though there are few detailed studies on this subject and those that exist do not demonstrate the potential extent of its impact. The recent IPCC report notes the possibility of losses of 10-20% in African mammalian species by 2080 even under the scenario of unlimited migration (Boko et al, 2007). The vast herds of migratory ungulates such as rhinos, swine, and elephants among others in east and southern Africa remain a distinguishing ecological characteristic of the continent. A major migratory system is located in the Serengeti area of Tanzania and the Masai-Mara region of Kenya. Reduced large-mammal migratory systems persist in the Kalahari (Botswana, South Africa, and

Namibia) and Etosha (Namibia) areas of southern Africa. Typical migrations involve regular movement between dry-season and wet-season grazing areas, and are therefore climate sensitive. Other animals such as the African antelope species are also expected to experience range alterations due to climate change (Hulme, 1996). This has significant implications on the ability of this species to adapt given that Africa is home to more than 90 percent of the 80 species of Antelopes found worldwide (Macdonald, 1987).

Among the African bird species, about one-fifth migrate on a seasonal basis within Africa and an additional one-tenth migrate annually between Africa and the rest of the world (Hockey, 2000). For example the waterfowl spends the austral summer in southern Africa and winter in central Africa while palearctic migrants spend the austral summer in areas such as Langebaan lagoon, near Cape Town, and the boreal summer in the wetlands of Siberia. Any change in climatic or specific habitat conditions at either end of these migratory routes beyond the tolerance of the species involved, could result in significant losses of bird biodiversity (Desanker and Magadza, 2001). Although these species have some capacity to alter their destinations, this could be hindered by the alteration of habitat due to human land use (Fischlin and Midgley, 2007).

African biodiversity is also defined by the concentration of species in several unique native environments such as the Cape Floral Kingdom (fynbos) at the southern tip of Africa with more than 7,300 plant species, 68 percent of which are unique to the area (Gibbs, 1987), and the adjacent Succulent Karoo biome with an additional 4,000 species of which 2,500 are native (Cowling *et al*., 1998). These two floral biodiversity hot spots occur in the winter rainfall regions and the distribution and survival of species in these environments would likely be threatened by a shift in rainfall seasonality (von Maltitz and Scholes, 2008). Other important floral regions affected by global warming include Madagascar, the mountains of Cameroon, and the island-like Afromontane habitats that stretch from Ethiopia to South Africa at altitudes above about 2,000 meters (Mace *et al*., 1998). Montane centres of biodiversity are particularly at risk from temperature increases because many contain isolated plant populations with no possibility of migration (Desanker and Magadza, 2001).

Significant changes have also been noted in mountain ecosystems, which are likely to some extent linked to complex climate-land interactions and which may continue under future changes in climate. By 2020, for example, indications are that the ice cap on Mt. Kilimanjaro could disappear for the first time in 11,000 years (Thompson *et al*., 2002). In addition, other ecosystem types such as mangroves and coral reefs, the main coastal ecosystems in Africa, will also likely be affected by climate change (Boko *et al*., 2007). Endangered species associated with these ecosystems, including manatees and marine turtles, could be at risk, along with migratory birds. Mangroves could also colonise coastal lagoons because of sea-level rise. Additionally climate-change-induced ocean warming could result in the destruction of coral reefs, as exemplified by the extensive coral bleaching event that followed the 1997/1998 extreme El Niño and resulted in a greater than 50% mortality of corals in some regions (Lough, 2000; Muhando, 2001; Obura, 2001; Spalding 2001). The proliferation of algae and dinoflagellates during these warming events could also increase the number of people affected by their toxins (such as that of *Ciguatera*) due to the consumption of marine food sources. In the long term, these impacts will have negative effects on fisheries, food security and tourism besides the reduction of marine biodiversity (Boko et al, 2007). Sea-level rise due to climate change could cause inundation of salt marshes and in combination with reductions in river runoff could result in changes in estuaries in South Africa (Clark, 2006).

Some important statistics regarding projected impacts on biodiversity in Africa, as noted by different research initiatives on this subject are noted below:

- Projected losses of between 51 and 61% of *Fynbos and succulent Karoo biomes* by 2050 (Midgley et al., 2002).
- *Critically endangered taxa* (e.g. Proteaceae) losses in the low-lying coastal areas of Africa will increase, and up to 2% of the 227 taxa will become extinct (Bomhard et al., 2005).
- Kruger Park study estimates that about 66% of species of Nyala and Zebra have already been lost (Dixon et al., 2003).
- Projected losses of over 50% for some Southern African bird species (Nama-Karoo area; attributed to restriction of movements) by 2050 (Simmons et al., 2004).
- Carbon isotope data in Lake Tanganyika show aquatic species losses of about 20%, with a 30% decrease in fish yields. It is estimated that climate change may further reduce lake productivity (O'Reilly et al., 2003)
- Complex impacts on grasslands including the intensification of fire in southern Africa.

5 Strategies for Biodiversity Conservation under Climate Change

Traditional biodiversity conservation strategies have been designed under the assumption of a relatively static environment; an idea that is now challenged by the influence of the rapid rate of climate change on ecosystem boundaries and species distribution, already threatened by the impacts of human stressors. As a result existing conservation strategies now need to be revised in order to respond to the challenges posed by a changing climate and its synergistic interactions with a multitude of other human stressors, which is expected to result in ecosystem range shifts and species migrations. The management of natural areas must therefore account for such natural transitions (Hannah et al, 2005).

According to Lovejoy (2005) two of the biggest threats to biodiversity under climate change are habitat loss and invasive alien species. Habitat loss is likely to pose a significant barrier in the ability of species to track a changing climate while invasive species such as, for example, various types of weeds, may thrive in environments that are no longer hospitable to their original inhabitants. Therefore, though the traditional methods and tools of conservation would still hold true, they would nonetheless need to the modified where necessary to provide for the flexibility species will need in tracking changing climates. Importantly, such strategies will need to include the addition of new protected areas to allow for range shifts and the maintenance of connectivity between habitats to enable successful species migrations (Lovejoy, 2005; Hannah et al, 2005). In addition, from the human perspective, such strategies will also need to ensure sustainability in the provision of ecosystem goods and services and the maintenance of subsistence livelihoods and indigenous populations (Fischlin and Midgley, 2007).

Some of the important considerations for successfully adapting biodiversity conservation strategies to the combined impacts of climate change and other human and non-human stressors are briefly discussed below:

i) Developing an improved understanding of future climate conditions and dispersal biology under these conditions: This calls for significant research investments in regional climate modelling studies as well as in the monitoring of ecosystem responses to climatic and non-climatic stressors. Several new tools and modelling programs to map future climate change and its impacts on biodiversity are now available such as statistical downscaling, CLIMEX, GARP, genetic algorithms, artificial neural networks, etc. to name a few. Besides, models that can help to determine the range shift of species can help to guide the selection of areas that will need to be conserved or protected.

ii) Protection of the matrix: One of the most important considerations in conservation planning under climate change is likely to be the protection of the matrix, within which protected areas are located. The matrix is in most instances subject to a variety of land uses and often consists of highly fragmented landscapes. This would greatly limit successful species migration outside of the boundaries of protected areas in order to track a changing climate and thus move to more compatible ecoregions (Lovejoy, 2005; von Maltitz et al, 2008). Protection of the matrix is particularly critical in the case of Africa, given that the majority of its biodiversity exists outside of formal conservation areas (Desanker and Magadza, 2001). Some strategies for matrix protection include the creation of buffer zones around existing protected areas and the creation of linear corridors linking patches of protected areas (von Maltitz et al, 2008).

iii) Restoration of degraded habitat and prevention of incompatible land use practices: This is to primarily help reduce the impacts of non-climatic stressors on ecosystems and allow for successful range shifts and species migrations.

iv) Design dynamic landscape conservation plans: The objective is to allow for flexibility in the various types of land-uses in order to allow for successful species migrations either into or through a variety of landscapes in response to changing climatic conditions. This might necessitate assistance from government and non-government entities either in designating future target areas for species migrations as protected areas or in ensuring compatibility between current human activities in such target areas and the existence and survival of migratory species. The IUCN categories of protected areas are particularly relevant here i.e. categories I and II are designated as formal protected areas like nature reserves and national parks while categories III to VI include a variety of less formally protected areas that are governed by zoning regulations and allow for the conservation and protection of biological features while enabling human activity (Gustavo et al, 2005)

v) Biodiversity conservation targets: A relatively new concept is that of landscape level biodiversity, which targets the protection of biodiversity at all levels i.e. genetic, species and ecosystem. In terms of temporal targets, planning for both short-term and long-term timeframes to account for changes in climate at the scales of decades to centuries is considered important.

vi) Flexibility of responses: Given the existing uncertainty regarding future impacts, management responses need to be flexible enough in order that they can either be augmented or reversed as necessary. This is especially important when there is uncertainty regarding certain changes that might either be due to temporary climate variability or a longer term trend.

vii) Networks: Networks between scientists, policymakers and practitioners can allow for the effective communication and coordination and ensure successful adaptation of conservation strategies. In protecting matrix areas, sectoral and spatial coordination will be especially important, as will be the participation of local stakeholders (von Maltitz et al, 2008). Also collaboration and cooperation across regional and national boundaries will be critical.

viii) Capacity building: Last but not the least, adequate scientific, economical and political capacity would be necessary in order to successfully out into action the above strategies. This is particular true of for developing countries where institutions are often weak and there is a lack of financial resources to enable successful conservation planning.

(Adapted from Hannah and Hansen, 2005; Gustavo et al, 2005; Hannah and Salm, 2005 with inputs from Lovejoy, 2005; Desanker and Magadza, 2001; and von Maltitz et al, 2008)

6 Existing Conservation Initiatives in the Albertine Rift Region

Based on the above understanding of planning needs for successfully adapting biodiversity conservation to climate change impacts, this section examines the current biodiversity conservation initiatives in the Albertine Rift, in order that an understanding about existing policies and programs can be developed. The several policies and programmes geared towards biodiversity conservation in the Albertine Rift countries are derived from both national and international initiatives. One such international program is the Biodiversity Action Plan (BAP), which was derived from the 1992 Convention on Biological Diversity (CBD). It is an internationally recognized program addressing threatened species and habitats and is designed to protect and restore biological systems. Tanzania, is a participant in this program and is in the final stages of preparing the National Biodiversity Strategy and Action Plan (NBSAP) for subsequent approval by the Tanzanian Government. Aquatic biodiversity, terrestrial biodiversity and agro-biodiversity are the key elements of the NBSAP and activities under these sectors are integrated under this program (URT, 2006). Crosscutting issues covered by the NBSAP include:

- Policy, regulatory issues and international co-operation.
- Planning and co-ordination.
- Ecosystem and species conservation and sustainable utilization.
- Biodiversity monitoring and evaluation.
- Capacity building (personnel, facilities, and financial capacities).

In addition, Tanzania is a Party to the following biodiversity-related Conventions:

- Convention on Biological Diversity (ratified by Tanzania in March 1996);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (ratified by Tanzania in November 1979);
- Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region and related Protocols (Ratified by Tanzania in March 1996);
- U.N. Convention to Combat Desertification in those Countries Experiencing Drought and/or Desertification, Particularly in Africa, (Ratified by Tanzania in April, 1997);
- Convention on the Conservation of Migratory Species of Wild Animals (Ratified by Tanzania in April, 1999); and
- U.N. Framework Convention on Climate Change, (Ratified by Tanzania in March 1996)

Major national level policies and strategies in Tanzania that are considered relevant to the environment and biodiversity in the Albertine Region include: The National Wildlife Policy (1998); The National Forestry Policy (1998); Forest Act (2002); The Fisheries Sector Policy and Strategy Statement (1998); The Water Policy (2002); The Wildlife Policy (1998) and Wildlife Conservation Act No. 12 (1974); The Land Policy, the Village Land Act (1999), and the Land Act (1999); The Poverty Reduction Strategy Paper (2000) and National Strategy for Growth and Reduction of Poverty (NSGRP) (URT, 2005); The National Agriculture and Livestock Policy (1997) and the Agricultural Sector Development Strategy (2001). All these policies complement each other and aim for the sustainable management of natural resources including biodiversity. In addition, Tanzania has a number of programmes, projects and activities geared towards implementing these policies, most of which are administered at national or district levels.

Likewise in Rwanda, major policy and strategic thrust for the protection of biodiversity exists for certain aspects of biodiversity such as forests, aquatic areas, agro-biodiversity (agriculture, animal

breeding and fisheries) and Protected Areas. Various state, parastatal and private institutions are involved in the conservation and use of biological resources on the basis of existing policy documents and legal texts which are unfortunately in most cases not well organized, not comprehensive enough and mostly outdated. Among these policies are the Forestry Policy, the Wetland Management Policy, Agricultural and Stock breeding policy, Settlement Policy and Protected Areas Policy.

Besides these policies and programs, there also exist several other biodiversity conservation initiatives within the Albertine countries that are more specifically targeted towards a particular objective and are initiated and implemented by national and international government as well as non-government organizations. Some of these initiatives are not specifically targeted at an aspect of biodiversity conservation but do still have positive influences on biodiversity through cross-cutting linkages. Most of these programmes are concentrated in the Congo Basin, which covers the largest area in the region (Africa Conservation Foundation, undated). Examples of such initiatives include:

i. Albertine Rift Programme: Under the Albertine Rift Program, many sites in the Albertine Rift Region are protected as National Parks, Wildlife Reserves or Forest Reserves. However, several other sites important for conservation and in need of legal protection, especially under the scenario of climate change - mainly in the Democratic Republic of Congo, are not covered under this program.

ii. The Bonobo Conservation Initiative: This is a non-profit organization based in Washington, D.C. whose mission is to promote conservation of the Bonobo Ape and its tropical forest habitat in the Congo Basin. The Initiative is working to increase global awareness of Bonobos and their habitat, build partnerships with the Congolese people, and raise funds for supporting conservation and educational activities. It is also working to bring together an international network of scientists, conservation groups, zoos, government and non-governmental organizations, and other concerned parties to work together effectively for the protection of this rare species of great ape.

iii. Nile Transboundary Environmental Action Project (NTEAP): The NTEAP is the largest project in the Shared Vision Program of the Nile Basin Society. It provides a strategic framework for environmentally sustainable development of the Nile River Basin and supports basin wide environmental action and stakeholder cooperation to address transboundary issues in the context of the Nile Basin Initiative (NBI) Strategic Action Program. The long-term goal of the Shared Vision Program is to create the enabling environment for the Nile riparian communities to realize their vision of "achieving sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources."

iv. The Congo Basin Forest Partnership (CBFP): The CBFP is an association of 29 governmental and non-governmental organizations that works to improve communication and coordination among its member organizations vis-à-vis their projects, programs, and policies. The CBFP is aimed at promoting sustainable management of Congo Basin Forest ecosystems and wildlife and improve the lives of people living in the region. CBFP aims to increase awareness of the programs being funded and implemented by its member organizations, enhance the efficiency of these programs and relevant coordination processes, and identify and eliminate gaps and overlaps in programs and funding.

v. The Lake Tanganyika Biodiversity Program (LTBP): The LTBP is a UNDP/GEF funded project aimed at helping the riparian countries to produce an effective and sustainable system for managing and conserving the biodiversity of Lake Tanganyika into the foreseeable future. The project is implemented by various institutions from Burundi, Democratic Republic of Congo, Tanzania and Zambia, with advice from international agencies, including UNDP and GEF.

vi. The Bush Meat Crisis Task Force (BCTF): This is a consortium of conservation organizations and professionals working throughout Africa and dedicated to the conservation of wildlife populations threatened by illegal commercial hunting for sale as meat. The BCTF was founded in 1999 and operates under the direction of an elected Steering Committee and is funded by Supporting and Contributing Members. BCTF's primary goals are to: (a) work with the general members of the BCTF to focus attention on the bush meat crisis in Africa; (b) establish an information database and mechanisms for information sharing regarding the bush meat issue; and (c) facilitate engagement of African partners and stakeholders in addressing the bush meat issue. Although the task force does not specifically mention biodiversity conservation, the fact that they deal with bush meat may have a direct/indirect influence on managing wild animal biodiversity.

vii. Mountain Gorilla Conservation Fund (MGCF): The MGCF is undertaking several projects to achieve the goal of saving gorillas from extinction. It is dedicated to ensuring the future of the Mountain Gorillas of Rwanda, Uganda and the Democratic Republic of the Congo. By providing a partnership in business, wildlife conservation and community development, MGCF addresses the single biggest challenge facing preservation of these animals today i.e. the destruction of habitats due to human development pressures in these countries.

viii. Okapi Conservation Project/Okapi Wildlife Reserve: Okapi Wildlife Reserve was given official protected status, creating a reserve covering 8,500 square miles of the Ituri rainforest, one of the most biologically diverse places on earth. The Reserve harbours okapi and many other rainforest species including chimpanzees, elephants, hornbills and 13 species of monkeys. Found only in the Congo, the Okapi (*Okapia johnstoni*) is a shy and reclusive forest dweller and is the only living relative of the giraffe.

ix. Uganda Food Security Initiative (UFSI): Africare-Uganda's UFSI program is working in a densely populated, very poor, and very hilly region where people currently farm small plots of degraded land and conditions of extreme poverty and environmental deterioration are endemic. The initiative is succeeding in its integrated rural development program through the introduction of tree species with good ecological and commercial properties, new crops, nutrition and health education, health care, child growth monitoring and management of disease. Other initiatives address better and more efficient stoves, fuel wood use, natural fertilizers, land management practices, and sustainable and environmentally sensitive road construction in this densely populated but almost inaccessible area, so villagers can sell produce and get to medical care and schools.

x. Gombe National Park: Gombe National Park is located on the eastern shore of Lake Tanganyika, 15km north of the town of Kigoma in Tanzania. It was established in 1968 and the Gombe Stream Research Centre was founded in 1967. Tanzania hosts the largest population of wild chimpanzee in the world in its Mahale Mountains, Rubondo Islands, and Gombe National Parks. Of these, the chimpanzee population in Gombe National Park has been studied the longest. Survival of this population, however, is now highly

threatened partly due to recurring disease outbreaks probably contributed by climatic variations/changes. Various diseases have been reported and measures are being instituted to control the situation, including stringent regulations for tourists (Malengenya & Lyaruu, Undated).

xi. Malagarasi – Moyovosi Wetland: Water is one of the key resources in the Malagarasi-Muyovosi ecosystem, which supports the entire biodiversity in the area, including human beings, fish, wildlife and other aquatic animals. In view of the ecological importance of the Malagarasi-Muyovozi wetland ecosystem, this area was designated as the first Ramsar Site in Tanzania. Therefore, the Government of Tanzania, through the Wildlife Division of the Ministry of Natural Resources and Tourism, and with the assistance from DANIDA, has been implementing a project for Sustainable and Integrated Management of the Malagarasi-Muyovozi Ramsar Site (SIMMORS, 2000). It has also strived to ensure that the wise use principle of resources is applied to all wetlands through the designation of Ramsar Sites (Ngatunga & Mung'ong'o, 2004; Yanda *et al*., 2001; URT, 2001).

The Malagarasi-Muyovozi wetland ecosystem provides an important dry season refuge and feeding area for migratory wild animals including many water-birds and large mammal species. It also supports a number of vulnerable or endangered species. For example, it is one of the few areas in Tanzania where the antelope species *Tragelaphus spekei* (Sitatunga) lives. *Loxodonta africana* (elephants) and *Crocodylus cataphractus* are also found in small numbers. Other large fauna associated with this wetland include *Hippopotamus amphibius*, *Syncerus caffer*, *Redunca* sp., *Damaliscus korrigum, Equus burchelli, Kobus defassa* and *Panthera leo* and the crocodile *Crocodylus niloticus* (SIMMORS, 2000; URT, 2001).

Most birds are reported to be residents exhibiting restricted movements. There are however some long-distance migrants, which usually come to the wetlands during summer and return to the north at the end of winter. Some known winter migrant species include the white pelican. The African spoonbill and Madagascar bee-eater are intra African Migrants (Yanda *et al.*, 2001). Further, studies have shown that, there are more than 20,000 water birds utilizing the area. The site regularly supports more than 1% of the population of several water bird species including Shoebill (*Balaeniceps rex*) (10-20%), Wattled Crane (*Grus carunculatus*), (5-10%), *Ardea goliath* (1-2%), and *Egretta alba* (2%), (SIMMORS, 2000;URT, 2001). Other bird species include the Saddle-billed Stork (*Ephippiorhynchus senegalensis*), Great Egret (*Casmerodius albus*), Great Snipe *(Gallinago media*), White-winged Tern (*Chlidonias leucopterus*), Coppery-tailed Coucal (*Centropus cupreicaudus*), Kurrichane Thrush (*Turdus libonyana*), White-headed Black-chat (*Myrmecocichla arnoti*), Miombo Rock-thrush (*Monticola angolensis*), Boehm's Flycatcher (*Muscicapa boehmi*), Miombo Double-collared Sunbird (*Nectarinia manoensis*), etc. (Birdlife, 2007).

This assessment of current initiatives indicates that there does exist an active interest in the protection of biodiversity in the Albertine Rift countries. Current strategies can provide a sound basis that can inform future action that is compatible with the needs of a changed climate. An evaluation of these strategies will however be necessary in order to determine the extent of their applicability under changed climatic conditions in future and any revisions or modifications necessary will need to be designed. In addition entirely novel initiatives might be required to meet the future challenges of ecosystem and species adaptation.

7 Institutional Perceptions of Climate Change and Biodiversity Conservation in the Albertine Region

In addition to the information obtained from the review of current initiatives for biodiversity conservation in the Albertine Rift Region, our consultations with the various stakeholder institutions here also helped to develop an understanding of institutional knowledge and the current scientific and technical capacity of this region. The main focus of these consultations was on the determination of the level of awareness of the linkages between biodiversity and a changing climate. Most of the people consulted expressed awareness of the two concepts "biodiversity" and "climate change", though some could not explain the linkages. A majority of the interviewed stakeholders claimed to have perceived significant changes in the ecosystem in the last 20 years, and believed that such changes have contributed to a decrease in species diversity in the region. The reported main drivers of change include human activities (e.g. deforestation, and destruction of wildlife habitats) and climate change. Human pressure on biodiversity resources is mainly attributed to the high human dependence on biodiversity resources for livelihoods. Further losses in biodiversity are envisaged to occur if intervention measures are not taken to enhance conservation of biodiversity.

All the consulted institutions in Burundi, Rwanda, Tanzania and Uganda were aware of and concerned about notable changes in the several ecosystems in the Alberetine Rift Region over the last few decades. However, the magnitude and significance of change is still uncertain. Discussions with Makerere University Institute of Environment and Natural Resources (MUIENR), for instance, indicated that some animal species, such as elephants that migrated from Uganda to the Democratic Republic of Congo in the near past were now beginning to come back to Uganda. This could possibly be explained by temporal and spatial changes in ecosystem conditions in the two countries. Among the perceived causal factors to such trends are human activities (resulting in overexploitation and habitat loss) and climate change. These factors are believed to have caused a decrease in the biodiversity of the region.

Interviews with scientists at Zoology Department, Makerere University also revealed that there have been considerable changes in ecosystems as indicated by the increased prevalence of insect-related diseases, e.g. malaria, due to more favourable conditions for disease vectors. Little work has, however, been undertaken to document such patterns. In most of the institutions consulted, studies related to the relationships between ecosystems and climate change have largely been associated with individual members of staff than institutional efforts. These studies have noted that different species have variable tolerance levels to ecological conditions and climate. Thus any change in these conditions can affect biodiversity in several ways, including shifts in species distribution. For example some mosquito species that were usually not found in certain geographical areas in the past (in high altitude areas of Kabaale in Uganda) are now prevalent there, due to more favourable temperatures. Similar patterns with mosquitoes have also been reported for the Muleba highlands in northwestern Tanzania (Yanda et al., 2006; Wandiga et al., 2006a&b) and the southern highlands of Tanzania (Liwenga et al., 2007).

Scientists from the Zoology Department (Makerere University) also pointed out that there are other species, e.g. the three-horned chameleon (*Camedeleou johnsoni*) and Senacio trees that can now be found at very high altitudes in the Rwenzori Mountain, where they were unable to previously exist due to the generally low temperatures. Similar patterns are envisaged for other species over the next 20 to 50 years if necessary interventions are not undertaken.

There was also a general concern among interviewed professionals about the changes in the spatial distribution of plant and animal species; species abundance and distribution; migratory patterns of ungulates; as well as species extinctions and loss of populations due to climate change. In Burundi and Rwanda a majority of species within many species groups in their geographical area were reported to have faced a decline in the size of their population. A decline in the population of fish in the lakes had also been noted. Other observed phenomena attributed to climate change include the increase in the frequency of extreme events such as floods and drought during the last 20 years and the glacial retreat on the Kilimanjaro and Rwenzori Mountains, in Tanzania and Uganda respectively. This was reported to be accompanied by the loss of some species and shift of the alpine zone to higher altitudes on the mountains. Adequate data to support these observations was however stated to be a problem and the need for more research on these issues was suggested.

Besides climate, other perceived threats to biodiversity identified by the interviewees were human population pressures (and associated with overexploitation of natural resources and habitat loss) and natural disasters. In addition issues of incompatible political decisions and influences of civil wars and refugees (in Burundi, Democratic Republic of Congo, Rwanda and Uganda), which have resulted in the destruction of habitats were also stated to be a concern. The highly contested Madira forest in Uganda that was earmarked for development into a sugar plantation is one such example of distorted policies. In Tanzania, examples include forest clearing to establish camps for refugees from neighbouring countries and the subsequent high population pressures and demands on natural resources.

The awareness levels regarding the risks associated with climate change on biodiversity however varied among the different categories of respondents interviewed. The professional respondents from universities and institutions were usually found to be better informed about climate change projections for Africa and their implications for ecosystems and biodiversity. This can be explained by the fact that much of the information on this subject is available only through various scientific publications, and scientific conferences/workshops, venues that are not commonly accessible. Even among the category of professionals, those in the mid career range e.g. at Diploma and lower levels, had a much lower level of awareness on this subject. It was noted that very few professionals in the middle career were even aware of the climate predictions for either Africa or the Albertine region.

This current lack of awareness about the impacts of climate change on the region's biodiversity was in itself perceived to be an important risk by scientists in the consulted institutions. Thus an increase in the knowledge and skills related to biodiversity conservation was reported to be of critical importance due to the high dependence of local communities on natural resources e.g. water, biomass and land for their livelihoods (including nutrition, spiritually, medicine, etc) – though the extent of this dependence is not adequately quantified.

In response to these needs various organizations in the Albertine rift countries have initiated several awareness building measures in the recent past. In Uganda, for instance, such measures are undertaken by organisations like Nature Uganda, the Ministry of Water and Environment and training institutions that have included biodiversity conservation and climate change in various training modules. Other institutions in Uganda that are involved in awareness creation regarding biodiversity conservation include the Uganda Wildlife Authority, National Forestry Authority, Wildlife Conservation Society and WWF. The promotion of ecotourism is another strategy being used to raise awareness about biodiversity conservation. The Wildlife Section of the Biology Department at Mbarara University, for instance, undertakes ecotourism projects aimed at

educating the communities on the importance of biodiversity and its sustainable management. They also hold annual conferences for dissemination of information on various research findings.

In Tanzania the key institutions involved with building awareness are the Division of Environment and the National Environmental management council (both under the Vice President's Office); higher learning institutions, particularly University of Dar es Salaam and Sokoine University of Agriculture. For example, the Institute of Resource Assessment at the University of Dar es Salaam offers a course on Climate change and variability as part of its Master of Science curriculum in Natural Resources Assessment and Management (NARAM) programme. Among the Non-governmental organisations involved in climate change issues is the Centre for Energy, and Environmental sustainability in Tanzania (CEEST).

7.1 Relevant Research Experience in the Albertine Rift Region

Experiences from consultations with institutions in the Albertine Rift region indicate that although research on issues of biodiversity conservation and climate change is being undertaken by some of these institutions, the existing research programmes do not integrate the two aspects. To a large extent research activities on these aspects are addressed separately. This was reported for example at the Institute of resource Assessment – IRA (University of Dar es Salaam) and Zoology Department of Makerere University which also deals with climate change and biodiversity issues. Some staff members at IRA and in the Zoology Department (Makerere University), for example, have been involved in the preparation of the National Adaptation Plan of Action (NAPAs) for Tanzania and Uganda respectively. Other studies that have been undertaken on climate change are those related to the development of National Communications on Climate Change. In Burundi and Rwanda such research has mainly been undertaken by government institutions and most of the NAPA research activities here have focussed more on biodiversity and less on climate change issues. While their NAPAs reported some relationships between climate change and biodiversity, such linkages were rather scanty and only related to very few species. It has been further noted that among the institutions consulted in Rwanda and Burundi, it is mostly the universities that were involved in research on biodiversity conservation.

Other institutions consulted in Tanzania include the Tanzania wildlife research Institute (TAWIRI) and Tanzania National Parks (TANAPA). Both institutions do not undertake research on any aspect of climate change. Most of the studies done for example in TAWIRI have focused more on biodiversity for example the Biodiversity and Human Wildlife Interface Project in the Western Serengeti. This project was mainly undertaken by Botanists, wildlife and soil ecologists, economists, and livestock experts. The major research issues covered include: (i) Human and soil characteristics versus plant diversity; (ii) Human wildlife interface biodiversity in Western Serengeti; (iii) Vegetation, soils and land use pattern in western Serengeti; (iv) Impact of wildlife conservation on the food habits of local people in western Serengeti, Tanzania; (v) Ethno medicinal plant studies in Western Serengeti; (vi) Biodiversity and collaring of wildebeests in Serengeti Tanzania; (vii) Diversity of ungulates and primates in Serengeti National park in space and time; and (viii) Biological and economical factors influencing human migration west of Serengeti, Tanzania. Though none of this research explicitly considers the effects of climate change on biodiversity, it does provide a useful source of databases on mammal species and their distribution in Tanzania.

In Uganda, the Faculty of Forestry and Nature Conservation at Makerere University has undertaken some research that examines the linkages between climate change and biodiversity. In addition it also maintains a climate database at one of its forest project sites in Budongo area,

which provides climate data that are used for various purposes. Some examples of research activities undertaken by this institution include:

- Research studies on invasive species;
- Ecosystem restoration and vegetation changes along ecological gradients.
- Climate change and water resources
- Research on plant dynamics in a changing climate
- Alternative sources of energy (fuel wood) and medicinal plant (e.g. research on domestication of such plants so as to relieve pressure on the naturally occurring plants).

In addition, the MUIENR, also at Makerere University, is involved in a number of studies related to interventions in biodiversity management issues. For instance, it is involved in the preparation of and also hosts the National Biodiversity Data Bank (however, this databank lacks aspects of climate and/or climate change considerations); and participates in the predictive mapping of biodiversity and conservation genetics.

The Department of Biology (Faculty of Science) at Mbarara University is also involved in various research undertakings related to biodiversity and climate change and variability. These include topics related to:

- Plant biology
- Ethno botany and plant biodiversity conservation
- Rangeland utilisation and impacts on species distribution
- Conservation of indigenous medicinal plants
- Climate variability and environmental degradation in the lake Victoria region
- Utilisation and conservation status of medicinal plants in western Uganda.

Other research studies on various aspects of biodiversity and climate change are undertaken in collaboration between institutions and are transboundary in nature. For example the GEF-funded cross-border biodiversity project and the East African Regional Programme and Research Network for Biodiversity and Biotechnology Policy Development (BIOEARN) were implemented through collaboration with other institutions across borders. Both the IRA and MUIENR were participants in the GEF project. These Institutions also participate in various consultancy assignments related to biodiversity surveys, vegetation mapping and surveys of conservation status and benefits to local communities. MUIENR and the Faculty of Science of the University of Dar es Salaam, for example, also participated in international collaborations with the MacArthur Foundation for projects on biodiversity conservation in the Albertine Rift Region. MUIENR also participates in the East African Regional Programme and Research Network for Biodiversity and Biotechnology Policy Development (BIOEARN).

Some Institutes and departments at Universities in the Alberine Rift Region also participated in a collaborative project on climate change impacts on malaria and cholera in the Lake Victoria region (project funded by AIACC). This project was jointly implemented by various institutions in Kenya, Tanzania and Uganda and mainly addressed climate and health issues with very little focus on biodiversity concerns. However, the project did address the increasing altitudinal range of mosquitoes and malaria parasites as a result of increasing mean temperatures in the highland areas.

These consultations thus revealed that currently a considerable number of experts exist in the Albertine Rift Region dealing with biodiversity conservation and management related research. However there are very few dealing with climate change, especially on the linkages between

biodiversity and climate change. Some of the ongoing research also involves university students at various levels (BSc, MSc and PhD), which demonstrates that there are some efforts targeted at capacity building with respect to biodiversity research. Other efforts include knowledge upgrades through various forums. However the current research capacity to meet the highlighted research needs in the area of adapting biodiversity conservation to a changing climate is still insufficient with an inadequate number of trained professionals and a lack of supporting institutional infrastructures. None of institutions consulted were aware of any research initiatives in this area in any other institutions.

7.2 Educational Programs Directed at Climate Change and Biodiversity Conservation

Experiences from the various training institutions indicate that very few provide courses that address climate change and biodiversity issues in their degree programmes. Even where such training programmes exist, the two aspects i.e. biodiversity and climate change are taught as separate courses. In Makerere University for example, the BSc. Environmental Science programme at MUIENR has some courses on "Basic Ecology" and "Biodiversity" but these course curricula do not include any aspects of climate change. The MUIENR's MSc in Environment and Natural Resources Programme also emphasises the need for analysing biodiversity data for conservation planning and includes a course on "vegetation resources" and soils and their conservation. The "Biodiversity and its management" stream too however does not address the linkages between biodiversity and changing climate.

Mbarara's MSc degree programme is more elaborative on issues of climate and climate change. For example, among other things, the course "Key Aspects of Uganda's Environment" covers topics related to global climate, climate of Africa, climate of Uganda, climate measurements, global warming and its environmental effects. However impacts of climate change on biodiversity are not directly addressed in this degree course. The course on "Ecosystems and population" addresses issues of species diversity and ecological islands, among others but the influence of climate change is again not explicitly mentioned.

The IRA's MSc NARAM programme offers a course on climate change and variability, but as with other institutions it does not integrate aspects of biodiversity. The latter aspects are largely addressed in another course (Applied Ecology) within the programme. Some intermediate institutions in Tanzania offer biodiversity related training programmes, for example, the College of African Wildlife Management (CAWM), which offers certificate and diploma courses in wildlife biology, ecology and management approaches, as well as provides a more detailed focus on ecological monitoring, community conservation, wildlife utilisation, planning and administrative functions. In addition, apart from its traditional long courses, CAWM offers a variety of short courses, each lasting for about four weeks. These short courses are:

- Community Conservation and Wildlife Management Areas in Tanzania
- Natural Resources Entrepreneurship for Local Government Officers in Tanzania
- Participatory Planning and Management of Community Conservation in Tanzania
- Project Planning for Ecotourism for Forest Project Managers
- Sustainable Bush meat Management for Resource Managers

In addition, Burundi University, offers Masters Programme in Geography and Environment, which is run by the Faculty of Letters and Humanity, and two diploma programs on Applied

Biology and Environment Management, which are run by the Faculty of Sciences and Agriculture. It should, however, be pointed out that these programmes are taught by foreign experts due to lack of local experts. Likewise, the National University of Rwanda offers Masters Program on Natural Resources Management with modules on Land Degradation, Remote Sensing and Geographic Information Systems.

From these consultations it was evident that only few institutions in the Albertine Region currently offer any specialised courses on climate change. Most of the institutions surveyed have indicated their concern regarding the absence of a specific curricular/training module designed to address issues of climate change, including aspects of mitigation, vulnerability assessments, resilience, coping strategies, and clean development mechanism (CDM) opportunities. Makerere University for example expressed the need for a specific training program on restoration ecology and monitoring of long term changes in biodiversity and climate change.

This lack of education and training programs in the study of linkages between biodiversity conservation and climate changes results in a dearth of experts working in this area. In some cases, efforts have been made to reduce this capacity gap through the revision of some of the curricula to incorporate climate change issues and to thereby train more people in this field. Lack of adequate funding in the universities unfortunately represents one of the main a limiting factors in these efforts.

8 Emerging Issues

Based on the results of the consultations undertaken in the Albertine Rift region, an understanding of the key issues that present barriers to the adaptation of biodiversity conservation to a changing climate in this region was developed. These issues are primarily related to a lack of capacity arising out of inadequate research in this area as well as a scarcity of training programs that offer instruction in this area.

8.1 Unmet Research Needs

Among the key aspects of reported unmet research needs include, assessment of biodiversity loss and conservation in a changing climate; assessment of various adaptation strategies; and assessment of strategies for the protection of lakes, rivers, and natural and artificial forests. It was further noted that there is limited capacity to meet these research needs in most of the consulted institutions. For example, there is no institutional infrastructure dealing with region-wide issues related to biodiversity and climate change. The lack of integration of research on biodiversity conservation in a changing climate was also identified as the major research gap. In addition, there is also limited expertise in this area. Training is therefore crucial to develop capacity in these fields.

Other identified research needs include topics related to:

- Relationship between climate change and changes in biodiversity; climate change prediction and modelling.
- Peoples perceptions and strategies to effectively enlist their participation in sustainable environmental management, especially under the changing climate.
- Research on plant dynamics in a changing climate.
- Alternative sources of energy (fuelwood) and medicinal plants.
- Research on domestication of naturally occurring plants.

- Animal/wildlife responses to changing climate.
- Community based conservation initiatives.

8.2 Unmet Training Needs

The lack of adequate training programs devoted to biodiversity conservation in a changing climate was one of the critical capacity issues identified. Though most universities do have some programs that deal with topics of biodiversity to various extents, climate change is rarely addressed. The identified training needs from the consultations therefore include the need for programs that address:

- General concepts of biodiversity, climate change and their interactions.
- Climate change, including aspects of mitigation, adaptation, vulnerability assessments, resilience, coping strategies, and clean development mechanism (CDMs).
- Restoration ecology and monitoring of long term changes in biodiversity and climate change.
- A multidisciplinary training module including ecosystems management, biodiversity (plants and animals), human pressures and climate change.
- Training module on resource economics to enable resource users to appreciate the value of biodiversity and the need the biodiversity conservation.
- Modelling of climate change, including quantification of green house gases, carbon sequestration, and meteorological aspects.

9 Way Forward

The information outlined here, that was obtained from institutional consultations as well as from the review of existing literature serves as an important basis for implementing the second phase of this project that attempts to address the current lack of efforts to adapt biodiversity conservation to climate change. This is to be achieved by means of conducting intensive training through regular short courses to cover different cadres who are involved in climate change and biodiversity related activities. It will take into account the latest scientific information available on this subject to design a curriculum for Biodiversity Conservation in a Changing Climate that is applicable to the Albertine Rift region. The curriculum and training materials will be developed for a postgraduate-level education program that will integrate the various aspects identified as unmet training needs. In the pilot phase this program will be implemented at the Institute of Resource Assessment for the University of Dar es Salaam with plans to replicate it at other institutions at a later stage. The planned topics for program courses are:

i) Climate change risks to the ecosystem and biodiversity
ii) Conservation strategies in a changing climate

This education program will not only attempt to inform participants on climate change impacts for Africa and its potential influences on biodiversity in the Albertine Rift region but will also offer them training in various tools and methods than can be utilized to adapt current conservation strategies to meet these climate related challenges. Details about the program and course curricula will be provided in the upcoming phase two report.

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APPENDIX 2 – LIST OF CONSULTED INSTITUTIONS

Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
Makerere University, Institute of Environment and Natural Resources (MUIENR)	Institute of Environment and Natural Resources, P.O. Box 7062, Kampala, Uganda Email: muienr@muienr mak.ac.ug	Prof. Frank Kansiime, Director fkansiime@muienr mak.ac.ug	To provide leadership in and knowledge for and about natural resources, for human benefit and environmental protection	Teaching / research on Environment and natural resources management, database management, GIS and remote sensing
Department of Zoology, Faculty of Science, Makerere University	Department of Zoology, Faculty of Science, Makerere University, P.O. Box 7062, Kampala, Uganda	Prof. John B. Kaddu kaddujb@zoology.mak.ac.ug johnkaddu2006@yahoo.co.uk	Package and impart knowledge to society.	Aquatic sciences, parasitology, entomology, biodiversity conservation, mammalogy, cell biology and molecular biology.
Faculty of Forestry and Nature Conservation, Makerere University	Faculty of Forestry and Nature Conservation, Makerere University, P.O. Box 7062, Kampala, Uganda	Dr Gerald Eilu, Senior Lecturer eilu@forest mak.ac.ug or eilu@yahoo.com	To advance knowledge in the use, management and conservation of forests and other allied resources through training, research and technology transfer for accelerated national development.	Plant ecology, biodiversity conservation, plant taxonomy.
Department of Biology (Biodiversity Conservation Section), Mbarara University of Science and Technology	Department of Biology, Mbarara University, P.O. Box 1401 Mbarara, Uganda	Dr Julius Bunny Lejju	To provide quality education at national and international level with emphasis on science and technology and its applications to community.	Teaching and research in biology, zoology and climate related issues.
Department of Biology (Wildlife Management Section), Mbarara University of Science and Technology	Same as above	Dr Grace Kagoro Rugunda Kgraceug2002@yahoo.co.uk	Same as above	Same as above
Tanzania Wildlife Research	P.O. Box 661, Arusha, Tanzania. Tel .+255 (0)27	Dr. Julius Keyyu - Director of	To carry out and co-ordinate wildlife research in Tanzania	Conservation monitoring; – short and long-

Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
Institute (TAWIRI) - formerly Serengeti Wildlife Research Institute)	254-8240, Fax. +255 (0)27 254-8240 Email : tawiri@habari.co.tz	Research,	with an overall objective of providing scientific information and advice to the government and wildlife management authorities on the sustainable conservation of wildlife, consonant with the national vision 2025, that is sustainable conservation of natural resources.	term systematic measurement and evaluation of ecosystem processes- Aerial and ground wildlife censuses Conduct wildlife Research on the sustainable conservation of wildlife
Tanzania National Parks (TANAPA)	P.O. Box 3134, Arusha, Tanzania. Tel: 255-27-2508040 Fax: 255-27-2508216 E-mail: tanapa@habari.co.tz	Mr. Inyasi Lejora- Head Ecology Department	To preserve the country's rich natural heritage, and to provide secure breeding grounds where its fauna and flora can thrive, safe from the conflicting interests of a growing human population.	The primary areas of expertise of TANAPA is to promote wildlife conservation
College of African Wildlife Management, MWEKA	Principal College of African Wildlife Management, Mweka P.O.Box 3031 Moshi, Tanzania Telephone: +255 (0)27 2756451 Fax: +255 (0)27 2756414 Email: mweka@mwekawildlife.org	Mr. Lazaro Johannah	To provide high standards of relevant professional and technical training to meet the needs of African wildlife organization for qualified and competent management staff. This would be achieved through: provisional of diverse range of practical wildlife management training services carrying out research consultancy on wildlife management that enhances training capacity	Plant ecology, biodiversity conservation, plant taxonomy.
The Nile Basin Discourse Forum in Rwanda	National Coordinator The Nile Basin Discourse Forum in Rwanda Opposite Amahoro National Stadium Gate 17	Frank Habineza	To coordinate activities of the Nile Basin Discourse Forum in Rwanda. Such activities include natural resources management and environmental	Environmental Science

Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
	BP: 3967 Kigali Rwanda habinef@yahoo.com		conservation	
Rwanda Environmental Conservation Organisation (RECOR)	Executive Secretary Rwanda Environmental Conservation Organisation (RECOR) BP: 7001, Kigali Rwanda rwc@planet-save.com	Jean Chrysostome Sehene	To coordinate environmental conservation in the country.	Conservation, Agroforestry, Ecotourism and Environmental Education
The Nile Basin Discourse Forum in Rwanda	ICT and Graphics The Nile Basin Discourse Forum in Rwanda Opposite Amahoro National Stadium Gate 17 BP: 3967 Kigali walterov@mail ru Rwanda	John Gakumba	Responsible for Information and Communication Technology and Editor of Newsletters and other publications	Food Science and Technology, information dissemination
Faculty of Agronomy University of Burundi	Faculty of Agronomy University of Burundi BP. 1550 Bujumbura, Burundi gnusuku@yahoo.fr	Professor Gerard Rusuku	Dean of the Faculty of Agronomy	His areas of interest are agronomy, biodiversity, crop science
Faculty of Agronomy University of Burundi	Faculty of Agronomy University of Burundi BP. 1550 Bujumbura, Burundi habonimanab@yahoo fr	Professor Bernadette Habonimana	Professor in Forestry-Agroforestry and sustainable management	Forest conservation and biodiversity
Department of Geography University of Burundi	Department of Geography University of Burundi BP. 1550 Bujumbura Burundi Sabujm2000@yahoo fr	Professor Jean Marie Sabushimike	Professor in Geography	Land use, remote sensing and climate change

APPENDIX 3 – LIST OF CONSULTED EXPERTS FOR CURRICULUM DEVELOPMENT

Expert	Institutional Affiliation
Sandra Brown	Winrock International, Arlington, Virginia, United States
Steve Carpenter	University of Wisconsin, Madison, Wisconsin, United States
Wolfgang Cramer	Potsdam Institute for Climate Impact Research, Potsdam, Germany
Paul Desanker	UNFCCC Headquarters, Bonn, Germany
Pauline Dube	University of Botswana, Botswana
Andreas Fischlin	Terrestrial Systems Ecology Group, Institute of Integrative Biology, ETH-Zurich, Switzerland
Carl Folke	Department of Systems Ecology, Stockholms University, Sweden
Habiba Gitay	World Bank Institute, Washington DC, United States
Patrick Gonzalez	The Nature Conservancy, Arlington, VA, United States
Chris Gordon	Department of Zoology, University of Ghana, Accra, Ghana
Gregory Greenwood	Mountain Research Initiative, Bern, Switzerland
Lara Hansen	World Wildlife Fund, Washington DC, United States
Lee Hannah	Donald Bren School of Environmental Science and Management, University of California Santa Barbara, California, United States
Bruce Hewitson	Climate Systems Analysis Group, University of Cape Town, Rondebosch, South Africa
Frank Kansiime	Institute of Environment and Natural Resources, Makerere University, Uganda
Ann Kinzig	Arizona State University, Tempe, Arizona, United States
Thomas Lovejoy	The Heinz Center, Washington DC, United States
Chris Magadza	University of Zimbabwe, Harare, Zimbabwe
Jerry Melilo	The Ecosystems Center Marine Biological Laboratory, Woods Hole, Massachusetts, United States
Guy Midgley	South African National Biodiversity Institute, Pretoria, South Africa
Ron Neilson	Oregon State University, Oregon, United States
Ian Noble	World Bank, Washington DC, United States
Dennis Ojima	The Heinz Center, Washington DC, United States
Dan Olago	University of Nairobi, Nairobi, Kenya
Camille Parmesan	University of Texas, Austin, Texas, United States
Guy Picton-Phillipps	Wildlife Conservation Society, Tanzania
Stuart Pimm	Nicholas School Division of Environmental Sciences and Policy, Duke University, Durham, North Carolina, United States
Jeff Price	Department of Geological and Environmental Sciences, California State University, Chico, California, United States
Walter Reid	The David and Lucille Packard Foundation, Los Altos, California, United States
Terry Root	Center for Environmental Science and Policy, Stanford University, Stanford, California, United States
Steve Schneider	Stanford University, United States
Bob Scholes	CSIR Division of Water, Environment and Forest Technology, Stellenbosch, Western Cape, South Africa
Fred Semazzi	Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, North Carolina, United States

Ramajita Tabo	Consultative Group on International Agricultural Research, Washington DC, United States
Mark Tadross	Climate Systems Analysis Group, University of Cape Town, Rondebosch, South Africa
Peter Tyson	University of the Witwatersrand, Johannesburg, South Africa
Hazell Thompson	Birdlife International, Nairobi, Kenya
Coleen Vogel	School of Geology, Archeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa
Graham von Maltitz	CSIR Natural Resources and the Environment, Pretoria South Africa
Brian Walker	The Commonwealth Scientific and Industrial Research Organization, Sustainable Ecosystems Division, Canberra, Australia
Richard Washington	Oxford University Center for the Environment, Oxford, United Kingdom
Gina Ziervogel	Climate Systems Analysis Group, University of Cape Town, Rondebosch, South Africa

APPENDIX 4 – COURSE CURRICULUM

This program recognizes the need to adapt place-based conservation work in order to address the risks of a changing climate. A necessary condition for success will be local scientific and technical capacity in the respective Albertine countries to anticipate and evaluate the changing risks, to communicate risk information to conservation practitioners and stakeholders, and to engage research, practitioner and stakeholder communities in collaborative efforts to design, test and implement appropriate conservation strategies. Local capacity is required because (i) local ownership of conservation strategies is critical for success and can only be achieved with substantive local participation in evaluating and prioritizing risks and response options, (ii) while important drivers of change are global and regional, the risks to biodiversity and the feasibility and effectiveness of different adaptive responses are highly context specific, making local knowledge critical for successful conservation, and (iii) the climate will change continuously, possibly in unanticipated ways and likely with unanticipated impacts, requiring an iterative learning process of reassessment of risks and performance of conservation strategies that is best done by local partners.

This training program will encompass two courses, namely, climate change risks to ecosystems and biodiversity, and conservation strategies in a changing climate administered as 3-week intensive sessions at the University of Dar es Salaam. The 3-week intensive training format will facilitate the participation of students and conservation professionals from across Africa.

The longer-term intention is to establish this curriculum as a recognized focal area within the MSc. NARAM program to be offered on a continuing basis after the completion of the project. It is also planned to explore the possibility of offering these courses as online learning modules in the future to enable wider accessibility.

Course 1 - Climate Change Risks to Ecosystems and Biodiversity

Course description: Participants in the course will investigate climate change risks to ecosystems and biodiversity, with an emphasis on Africa and the Albertine Rift, and explore methods and tools for assessing climate impacts to ecosystems, species and human livelihoods. Course topics include the climate system and greenhouse effect; changes in palaeoclimate and their impacts on ecosystems and species distributions; more recent climate changes and their observed impacts; mechanisms by which climate affects ecosystems; projections of future climate change and potential impacts on ecosystems, ecosystem goods and services, and human livelihoods; ecological niche modeling; biogeography models; dynamic vegetation models; and social science methods for assessing human consequences of ecosystem changes and biodiversity losses. Working in teams, the course participants will develop and present case studies of climate change threats to the biodiversity of selected sub-regions of the Albertine Rift (see Module 6).

Course objectives: The overall aim of the course is to enable biodiversity conservation in a changing climate by generating deep understanding of the implications of climate change on ecosystems (including their goods and services), biodiversity and human well-being. Specific objectives for each of the course modules are detailed below.

Objectives of the course are to develop understanding of:

- The processes of climate variability, climate change and the greenhouse effect;
- Mechanisms by which ecosystems have been and are expected to be affected by climate change;

- Risks from climate change and other interacting pressures that act on ecosystems and biodiversity, ecosystem goods and services, and human well-being;
- Methods for assessing climate change risks; and
- Important knowledge gaps and uncertainties.

Course structure and sequence: The course is organized around 6 modules, several of which are composed of a number of sub-units. The modules and sub-units are:

1. Biodiversity in a Changing Climate: Framing the Issues
2. The Climate System: Processes, Variability and Change
   2.1. The Climate System and Greenhouse Effect
   2.2. Climate Change in the Past
   2.3. Climate Change Projections for the Future
3. Vulnerability and Adaptation to Climate Change
4. Ecosystems, Biodiversity and Climate Change
   4.1. Ecosystem Concepts and Processes
   4.2. Ecosystem Goods and Services
   4.3. Mechanisms by Which Climate Change Affects Ecosystems
   4.4. Climate Change Impacts on Ecosystems in the Distant and Recent Past
   4.5. Biomes and Biodiversity of Africa and the Albertine Rift
5. Future Impacts of Climate Change on Ecosystems and Biodiversity
   5.1. Methods for Modeling Climate Change Impacts
   5.2. Methods for Social Assessment of Ecosystem Changes
   5.3. Assessments of Future Impacts
6. Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift

Readings: Required readings are listed below for each of the modules and subunits and will be provided in paper copy to course participants at the start of the course. Many of these will also be available in electronic format before the course. Additional readings to explore course topics in greater detail are also listed, and many of these will be made available during the course.

As preparation for the course, participants should read the following before the start of the course, which will be available on the course website:

- Millennium Ecosystem Assessment (2003). Summary. *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 1-25.
- Millennium Ecosystem Assessment (2005). Summary for decision-makers, Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC, pp. 1-24.
- IPCC (2007a). Summary for Policymakers. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- IPCC (2007b). Summary for Policymakers. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.

Module 1: Biodiversity in a Changing Climate: Framing the Issues

The conceptual framework of the Millennium Ecosystem Assessment (MEA) will be presented and applied to place in context the multiple pressures acting on ecosystems, including climate change. Major pressures on ecosystems and biodiversity deriving from human activities will be examined, as will their observed impacts over the past 50 years and potential impacts in coming decades. Implications of the impacts for the goods and services that humans derive from ecosystems and for human well-being will be discussed. Course objectives and structure will be presented; students will briefly introduce themselves, their work and purposes for taking the course, and their expectations for the course.

Module 1 Objectives

Course participants will:

- Be able to identify the main components and interactions among components of the MEA framework;
- Understand the concepts of ecosystem goods and services;
- See climate change as one of multiple, interacting pressures on ecosystems and biodiversity but one that exerts unique pressures that are expected to grow in coming decades;
- Become familiar with the course objectives, structure and requirements;
- Become acquainted with the other course participants.

Module 1 Readings:

- Hannah, L., T. Lovejoy and S. Schneider (2005). Biodiversity and climate change in context. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 3-14.
- Millennium Ecosystem Assessment (2003). Summary. In *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 1-25.
- Millennium Ecosystem Assessment (2003). Chapter 1: Introduction and conceptual framework. In *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 26-48.
- Millennium Ecosystem Assessment (2005). Summary for decision-makers. In *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, pp. 1-24.

Module 2: The Climate System: Processes, Variability and Change

Students will be presented an overview of the climate system and greenhouse effect and examine evidence of climate changes of the distant and recent past and their causes. Students will be introduced to methods for projecting future climate change, projections of climate change at global and regional scales, and uncertainties in climate change projections. Observed and projected climate changes in Africa will be emphasized.

Module 2.1 The Climate System and Greenhouse Effect

The major components of the climate system (atmosphere, ocean, land and cryosphere) and interactions among the components (e.g. Earth's energy balance, surface energy balance, hydrologic cycle, atmospheric circulation, ocean circulation) that determine the state of the climate will be examined. Processes of natural climate variability and climate change will be

explored, with emphasis on Africa. Human-caused climate change, or the greenhouse effect, will be investigated.

Module 2.1 Objectives:

Course participants will:

- Understand at a basic level the climate system and processes of natural climate variability and natural climate change;
- Understand at a basic level the main processes that influence climate and climate variability in Africa;
- Understand the workings of the greenhouse effect; and
- Know the main greenhouse gases, their sources and past trends.

Module 2.1 readings:

- Karl, T., and K. Trenberth (2005). What is climate change? . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 15 – 28.
- FAQ 1.1: What factors determine Earth's climate? IPCC WGI AR4 Technical Summary, pp. 94-95.
- FAQ 1.2: What is the relationship between climate change and weather? IPCC WGI AR4 Technical Summary, pp. 96-97.
- FAQ 1.3: What is the greenhouse effect? IPCC WGI AR4 Technical Summary, pp. 98-99.
- FAQ 2.1: How do human activities contribute to climate change and how do they compare with natural influences? IPCC WGI AR4 Technical Summary, pp. 100-102.
- Hulme, M., R. Doherty., T. Ngara., and M. New (2005). Global Warming and African climate change: a reassessment. In. Low, P.S (ed), Climate Change and Africa. Cambridge University Press, pp 29-40

Additional Source Material for Instructors and Further Reading for Students:

- IPCC (2007a). Technical Summary, Changes in human and natural drivers of climate, pp. 21-35. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- Houghton, J. (1994). The greenhouse effect. In J. Houghton, *Global Warming, the Complete Briefing*, Lion Publishing, Oxford, pp. 19-28
- Houghton, J. (1994). The greenhouse gases. In J. Houghton, *Global Warming, the Complete Briefing*, Lion Publishing, Oxford, pp. 29-45.
- Unganai, L. (2007). Climate and extreme events. In L. Otter, D. Olago, and I. Niang, eds., *Global Change Processes and Impacts in Africa: A Synthesis*. East African ducational Publishers, Nairobi, pp. 33-55.

Module 2.2 Climate Change in the Past

Reconstructions of the Earth's climate in the distant past from palaeoclimate proxies and causes of climate changes in the palaeo-record will be examined, with emphasis on Africa. Also to be examined are more recent climate observations, climate trends, and evidence for human-caused climate change.

Module 2.2 Objectives:

Course participants will:

- Know what proxies are used to reconstruct palaeoclimate;
- Understand how the climate has changed in the distant past and what are the main drivers of the changes in the distant past;
- Learn what climate trends have been observed globally and in Africa over the past 100 years; and
- Understand the evidence for human-caused climate change.

Module 2.2 Readings:

- Overpeck, J., J. Cole, and P. Bartlein (2005). A 'paleoperspective' on climate variability and change. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 91-108.
- Hulme, M. (2005). Recent climate trends. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 31-40.
- FAQ 3.1 through 5.1. IPCC WGI AR4 Technical Summary, pp. 103-111.
- FAQ 6.1: What caused the ice ages and other important climate changes before the industrial era? IPCC WGI AR4 Technical Summary, pp. 112-113.
- FAQ 6.2: Is the current climate change unusual compared to earlier changes in Earth's history? IPCC WGI AR4 Technical Summary, pg. 114.
- FAQ 9.2: Can the warming of the 20th century be explained by natural variability? IPCC WGI AR4 Technical Summary, pp. 120-121.

Additional Source Material for Instructors and Further Reading for Students:

- Nicholson, S. (2001). Climatic and environmental change in Africa during the last two centuries. *Climate Research* 17, no. 2: 123-144.
- Olago, D., M. Umer, S. Ringrose, P. Huntsman-Mapila, E. Sow, and B. Damnati (2007). Palaeoclimate of Africa: an overview since the last glacial maximum. In L. Otter, D. Olago, and I. Niang, eds., *Global Change Processes and Impacts in Africa: A Synthesis*. East African Educational Publishers, Nairobi, pp. 1-32.
- IPCC (2007a). Technical Summary, Observations of changes in climate, pp. 35-58. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA..
- IPCC (2007a). Technical Summary, Understanding and attributing climate change, pp. 58-66. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- Manyanga, M (2007). Resilient Landscapes: Socio-Environmental Dynamics in Shashi-Limpompo Basin, Southern Zimbabwe C.AD 800 to the present, Uppsala Universitet, Studies in Global Archaeology 11

Module 2.3: Climate Change Projections for the Future

Climate modeling and uncertainties in climate model projections will be introduced and results of climate change projections from global models will be presented and interpreted. Approaches and challenges of downscaling global model projections to regional and finer spatial scales will be discussed and regional projections for Africa examined.

Module 2.3 Objectives:

Course participants will:

- Understand what climate models do and the main sources of uncertainties in climate change projections;
- Know the changes in climate and sea level that are expected based on projections from global climate models;
- Know the main approaches for downscaling global projections to regional scales and their uncertainties; and
- Know the ranges of projected climate changes for Sub-Saharan Africa.

Module 2.3 Readings:

- Raper, S., and F. Giorgi (2005). Climate change projections and models. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 199-210.
- Hewitson, B., R. Crane, and M. Tadross (2007). Regional climate scenarios for impact assessment. In L. Otter, D. Olago, and I. Niang, eds., *Global Change Processes and Impacts in Africa: A Synthesis*. East African Educational Publishers, Nairobi, pp. 56-71.
- Hulme, M., R. Doherty, T. Ngara, and M. New (2005). Global warming and African climate change: a reassessment. In P. Low, ed., *Climate Change and Africa*, Cambridge University Press, Cambridge, UK and New York, USA, pp. 29-40.

Additional Source Material for Instructors and Further Reading for Students:

- Christensen, J., B. Hewitson and others (2007). Regional climate projections. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA, pp. 847-940. [See in particular pp. 852-864 (Introduction); pp. 866-871 (Africa); and pp. 918-925 (Assessment of regional climate model projection methods)]
- Hulme, M., R. Doherty, T. Ngara, M. New and D. Lister (2001). African climate change: 1900 – 2100. *Climate Research* 17, no. 2: 145-168.

Module 3: Climate Change Vulnerability, Adaptation and Mitigation

The coupled human-environment systems framework of vulnerability will be presented to students and the framework will be used to provide a general overview of the nature and causes of vulnerability of human systems to climate change and adaptation and mitigation options for reducing and managing climate change risks. The module will cover climate change risks to agriculture, water resources, livelihoods, human settlements, coastal zones, food security, and human health. Looking on how climate change impacts on these areas in turn can affect the biodiversity conservation efforts in Africa. Emphasis will be on vulnerabilities and adaptation in Africa.

Module 3 Objectives:

Course participants will:

- Understand the concepts vulnerability, exposure, sensitivity, adaptive capacity, resilience and thresholds;
- Understand at a basic level the causes of vulnerability;
- Learn the key vulnerabilities for Africa; and
- Understand the response strategies of adaptation and mitigation and the factors that enable and impede these responses;

Module 3 Readings:

- IPCC (2007b). Summary for Policymakers. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- IPCC (2007c). Summary for Policymakers. In B. Metz, O. Davidson, P. Bosch, R. Dave, and L. Meyer, eds., *Climate Change 2007: Mitigation*. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R., and Yanda, P. Africa (2007). In, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Chang. Cambridge University Press, Cambridge, UK and New York, USA, 433-467.

Additional Source Material for Instructors and Further Reading for Students:

- IPCC (2007b). Technical Summary. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- Leary, N., and others (2008a). "A stitch in time, general lessons from specific cases," in N. Leary, J. Adejwon, V. Barros, I. Burton, J. Kulkarni and R. Lasco, eds., *Climate Change and Adaptation*. Earthscan, London, pp. 1-27.
- Leary, N., and others (2008b). "For whom the bell tolls, vulnerabilities in a changing climate" in N. Leary, C. Conde, A. Nyong and J. Pulhin, eds., *Climate Change and Vulnerability*. Earthscan, London, pp. 3-30.
- Leary, N., and S. Beresford (2008), "Vulnerability of People, Places and Systems to Environmental Change," in G. Knight and J. Jaeger, editors, *Integrated Regional Assessment*, Cambridge University Press (in press; pre-publication manuscript available).
- Van der Post, C. (2007). Human dimensions of African climate and environmental change. In L. Otter, D. Olago, and I. Niang, eds., *Global Change Processes and Impacts in Africa: A Synthesis*. East African Educational Publishers, Nairobi, pp. 72-93.
- Hansen, L.J., J.L, Biringer, J.R, Holfman (2003). Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems, WWF, 2003. Hansen, L.J., J.L, Biringer, J.R, Holfman (eds)

Module 4: Ecosystems, Biodiversity and Climate Change

The concepts of ecosystems and biodiversity will be presented. Students will learn about different types of biomes and ecosystems, ecosystem processes, ecosystem goods and services as well as biodiversity in Africa and the Albertine Rift. Students will also learn how climate change affects ecosystems and biodiversity and vice versa. The focus will be on understanding the mechanisms by which the ecosystems absorb carbon dioxide from the atmosphere and how climate change affects ecosystems and its impacts in the distant and recent past.

Module 4.1: Ecosystem Concepts and Processes

Key ecological concepts, ecosystem dynamics and resilience will be examined.

Module 4.1 Objectives:

Course participants will:

- Understand the concepts of ecosystems and their types
- Learn the ecosystem processes and dynamics
- Understand interaction between ecosystems and climate change.
- Learn the ecosystems resistance and resilience capacity to different changes including climate change

Module 4.1 Readings:

- Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, Upper Saddle River, New Jersey (4th edition). Ecology and Ecosystems; pp 1-30
- Chapman, J.L., and M.J. Reiss (2005). Ecology: Principles and Applications. Cambridge University Press (2nd edition). Ecosystems processes; pp 187-205
- Townsend, C.R,. M. Begon and J.L. Harper (2003). Essentials of Ecology. Blackwell Publishing (2nd edition). Individuals, Populations, Communities, and Ecosystems. Pp 155-222

Module 4.2: Ecosystem Goods and Services

The MEA framework, introduced in Module 1, will be explored in more detail. The role of ecosystems and biodiversity in providing goods and services, supporting livelihoods, and enabling development will be explored. Human pressures on ecosystems and the resulting changes in ecosystems and ecosystem goods and services over past 50 years will be examined.

Module 4.2 Objectives:

Course participants will:

- Understand how the processes and interactions represented by the MEA framework can lead to changes in ecosystems that degrade the environment and threaten human well-being;
- Be able to identify many of the major pressures from human activities that act on ecosystems and biodiversity;
- Understand the rate, extent and character of human impacts on ecosystems and biodiversity and on ecosystem goods and services over the past 50 years.

Module 4.2 Readings:

- Millennium Ecosystem Assessment (2003). Chapter 2: Ecosystems and their services. In *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 49-70.
- Millennium Ecosystem Assessment (2003). Chapter 3: Ecosystems and human well-being. In *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 71-84.
- Millennium Ecosystem Assessment (2005). Key questions in the Millennium Ecosystem Assessment. In *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, pp. 25-102.
- Millennium Ecosystem Assessment (2005). Appendix A: Ecosystem service reports. In *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, pp. 103-122.
- Kinzig, A., Perrings, C., Scholes, B. 2007 *Ecosystem services and the economics of biodiversity conservation*. Working paper (downloaded November 2007). http://www.public.asu.edu/~cperring/Kinzig%20Perrings%20Scholes%20(2007).pdf

Module 4.3: Mechanisms by which Climate Change Affects Ecosystems

A general overview of the mechanistic processes by which climate (under normal situation; in the absence of global climate change) affects species composition and distribution, biome composition and distribution as well as ecosystems processes and functions will be presented. Specifically, mechanisms by which climate change affects species and biomes composition and distribution, ecosystems functions and processes will be covered.

Module 4.3 Objectives:

Course participants will:

- Understand at a basic level the main processes by which climate change affects species composition and distribution
- Learn generally how climate change affects different ecosystems in Africa and in the Albertine Rift in particular.
- Know the most prone (sensitive) ecosystems to the impacts of climate change in the Albertine Rift.
- Know other ecosystems non-climate stressors and how they contribute to the realized distant and recent past impacts of climate change.

Module 4.3 Readings:

- Kirschbaum, M. and others (1995). Ecophysical, ecological, and soil processes in terrestrial ecosystems: a primer on general concepts and relationships. In R. Watson, M. Zinyowera, R. Moss and D. Dokken (eds.), *Climate Change 1995: Impacts, Adaptation and Mitigation of Climate Change*. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA, pp. 57-74.
- Hewitt, G., and R. Nichols (2005). Genetic and evolutionary impacts of climate change. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 176-192.
- Naeem, S., and others (2007). Predicting the ecosystem consequences of biodiversity loss: the Biomerge Framework. In J. Canadell, D. Patakki, L. Pitelka, eds., *Terrestrial*

Ecosystems in a Changing World. Springer, Berlin, Hedeilberg and New York. pp. 113-126.

Additional Source Material for Instructors and Further Reading for Students:

- Norby, R., and others (2007). Ecosystem responses to warming and interacting global change factors. In J. Canadell, D. Patakki, L. Pitelka, eds., *Terrestrial Ecosystems in a Changing World*. Springer: Berlin, Hedeilberg and New York. pp. 23-36.
- Kirschbaum, M. and others (1995). Climate change impacts on forests. In R. Watson, M. Zinyowera, R. Moss and D. Dokken (eds.), *Climate Change 1995: Impacts, Adaptation and Mitigation of Climate Change*. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA, pp. 95-129.

Module 4.4: Climate Change Impacts on Ecosystems in the Distant and Recent Past

Both distant and recent climate change impacts in ecosystems will be presented. This will entail examination of changes in ecosystems and species distributions in response to climate changes from palaeo-records and from observations of the recent past.

Module 4.4 Objectives:

Course participants will:

- Understand that climate has had major impacts on ecosystems, species distribution and evolution in the distant past;
- Learn how ecosystems have been affected by climate in the more recent past; and
- Understand the evidence for human-caused climate change impacting ecosystems and species distributions.

Module 4.4 Readings:

- Parmesan, C. (2005). Biotic response: range and abundance changes. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 41-55.
- Root, T. and L. Hughes (2005). Present and future phenological changes in wild plants and animals. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 61-69.
- Pounds, J., M. Fogden, and K. Masters (2005). Case study: responses of natural communities to climate change in a highland tropical forest. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 70-74.
- Bush, M. and H. Hooghiemstra (2005). Tropical biotic responses to climate change. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 125-137.

Additional Source Material for Instructors and Further Reading for Students:

- IPCC (2007b). Technical Summary, Current knowledge about observed impacts of climate change on the natural and managed systems. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth

Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA, pp. 26-31.

- Rosenzweig, C., and others (2007). Assessment of observed changes and responses in natural and managed systems. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA, pp. 79-131.

- Markgraf, V. and M. McGlone (2005). Southern temperate ecosystem responses. . In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 142-156.
- Parmesan, C. (2006). Ecological and evolutionary responses to recent climate change, *Annual Review of Ecology, Evolution and Systematics*, 37: 637-639. http://cns.utexas.edu/communications/File/AnnRev_CCimpacts2006.pdf

Module 4.5: Biomes and Biodiversity of Africa and the Albertine Rift

The major biomes of Africa and the Albertine Rift will be examined. The focus will be on their distribution and the role of climate in determining their distribution; the diversity and endemism of their species; human uses of and pressures on ecosystems and biodiversity of the region; and recent changes in ecosystems, biodiversity as well as their goods and services.

Module 4.5 Objectives:

Course participants will:

- Be able to identify the major biomes of Africa and the Albertine Rift and major hotspots of species diversity and endemism; and
- Know the main pressures on ecosystems and biodiversity of the region.

Module 4.5 Readings:

- Plumptre, A. J., Davenport, T. R. B., Behangana, M., Kityo, R., Eilu, G., Ssegawa, P., Ewango, C., Meirte, D., Kahindo, C., Herremans, M., Peterhands, J. K., Pilgrim, J. D., Wilson, M., Languy, M., and Moyer, D. 2007. The biodiversity of the Albertine Rift, *Biological Conservation*, 134: 178-194. http://webdocs.dow.wur.nl/internet/fem/uk/pdf/plumptre%20et%20al%202007.pdf
- Olago, D. (2001). Vegetation changes over palaeo-time scales in Africa. *Climate Research* 17, no. 2: 105-121.
- Justice, C., and others (2001). Central African forests, carbon and climate change. *Climate Research* 17, no. 2: 229-246.

Additional Source Material for Instructors and Further Reading for Students:

- Balling, R. (2005). Interactions of desertification and climate in Africa. In P. Low, ed., *Climate Change and Africa*, Cambridge University Press, Cambridge, UK and New York, USA, pp. 29-40.
- Gonzalez, P. (2001). Desertification and a shift of forest species in the West African Sahel. *Climate Research* 17, no. 2: 217-228.

- Maitima, J., and D. Gumbo (2007). Land use in Sub-Saharan Africa. In L. Otter, D. Olago, and I. Niang, eds., *Global Change Processes and Impacts in Africa: A Synthesis*. East African Educational Publishers, Nairobi, pp. 109-130.

Module 5: Future Impacts of Climate Change on Ecosystems and Biodiversity

Module 5.1: Methods for Modeling Climate Change Impacts

An overview of methods for modeling climate change impacts on ecosystems and biodiversity will be presented and selected methods will be explored in detail, including computer laboratory exercises. The methods to be presented include single species ecological niche models, biogeography models, 'gap' models of dynamic changes in forest patches, and dynamic global vegetation models.

Module 5.1 Objectives:

Course participants will:

- Be able to identify the major approaches to modeling ecosystem and species responses to climate pressures;
- Understand the different purposes of the major modeling approaches and how the models work;
- Gain sufficient familiarity with one or two modeling approaches to be able to use and apply the models.

Module 5.1 Readings:

- Hannah, L. (2003). Regional biodiversity impacts assessments for climate change: a guide for protected area managers. In L. Hansen, J. Biringer and J. Hoffman, eds., *Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems*, WWF, Washington. Pp. 233-242.
- Peterson, A., H. Tian, E. Martinez-Meyer, J. Soberon, V. Sanchez-Cordero, and B. Huntley (2005). Modeling distributional shifts of individual species and biomes. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 211-228.
- Midgley, G. and D. Millar (2005). Modeling species range shifts in two biodiversity hotspots. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 229-231.
- Betts, R., and H. Shugart (2005). Dynamic ecosystem and Earth system models. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 232-255.

Additional Source Material for Instructors and Further Reading for Students:

1. Midgley, G., W. Thuiller and S. Higgins (2007). Plant species migration as a key uncertainty in predicting future impacts of climate change on ecosystems: progress and challenges. In J. Canadell, D. Patakki, L. Pitelka, eds., *Terrestrial Ecosystems in a Changing World*. Springer, Berlin, Hedeilberg and New York. pp. 129-137.
2. Prentice, I.C., and others (2007). Dynamic global vegetation modeling: quantifying terrestrial ecosystem responses to large-scale environmental change. In J. Canadell, D. Patakki, L. Pitelka, eds., *Terrestrial Ecosystems in a Changing World*. Springer, Berlin, Hedeilberg and New York. pp. 175-192.

3. Desanker, P.V., C.O. Justice., G. Munthali., and K. Masamvu (2005). Requirements for Integrated Assessment Modelling at the Regional and National Levels in Africa to Address Climate Change. In. Low, P.S. (ed), *Climate Change and Africa*, Cambridge University Press, pp 260-270

Module 5.2: Methods for Social Assessment of Ecosystem Changes

Methods will be explored for assessing the relationship between human communities and the ecosystems on which they depend for goods and services, indigenous knowledge and practices for management of ecosystems, perceptions of climate and other pressures on ecosystems, vulnerability of human communities to changes in ecosystems, and capacities for adapting the management of ecosystems to changing pressures. Environmental assessment tools such as EIA, SEA and Environmental Review and Audit for highlighting the socio-economic value of functions and products of an ecosystem will be presented and analyzed. Participatory processes such as Participatory Rural Appraisal, Stakeholder Analysis and Consensus Building, will also be discussed.

Module 5.2 Objectives:

Course participants will:

- Be able to apply the methods learned during the course to gain an in-depth understanding of how human well-being is linked to ecosystem services
- Develop skills for assessing the relationship between human communities and the ecosystems
- Have a thorough grasp of how the economy is linked to the ecosystem services
- Understand how changes in ecosystem services affect supply and quality of social capital and technology, and
- Understand how poverty is linked to change in ecosystem services
- Learn on the use of historical sources in establishing ecosystem changes over time
- Understand the use of present land use/cover patterns in assessment of ecosystem changes
- Know the use of archaeological records (e.g. fauna and flora remains) in sheding the light about the distant and recent past changes in different ecosystems.

Module 5.2 Readings:

- Holling, C.S. (2003). Foreword: the backdrop to sustainability. In Berkes, F., J. Coolding and C,Folke (eds), *Navigating Social-Ecological Systems: building resilience for complexity and change*, Cambridge University Press, Cambridge, UK, pp. xv-xxi.
- Holling, C.S., and L.H. Gunderson (2002). *Resilience and Adaptive Cycles.* In, Gunderson, L.H. and C.S. Holling (eds), *Panarchy: understanding transformations in human and natural systems*, Island Press, Washington DC, pp. 25-62.
- Holling, C.S.,L.H. Gunderson and Ludwing, D. (2002). In quest of theory of adaptive change. In, Gunderson, L.H. and Holling, C.S. (eds), *Panarchy: Understanding transformations in human and natural systems*. Island Press, Washington DC, pp. 3-22.
- Millennium Ecosystem Assessment (2003). Summary. *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 1-25.
- Millennium Ecosystem Assessment (2005). Summary for decision-makers, *Ecosystems and Human Well-being: Synthesis,* Island Press, Washington, DC, pp. 1-24.

Module 5.3: Assessments of Future Impacts of Climate Change

Findings of assessments of the future impacts of climate change on ecosystems and biodiversity will be explored.

Module 5.3 Objectives:

Course participants will:

- Understand the wide range and severity of potential climate change impacts on ecosystems and biodiversity;
- Learn about climate sensitivities and thresholds of different ecosystems; and
- Understand the major sources of uncertainty about the potential impacts of climate change;

Module 5.3 Readings:

- Fischlin, A. and others (2007). Ecosystems, their properties, goods and services. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA, pp. 211-272.
- Mwandosya, M.J., Nyenzi, B.S., and Luhanga, M.L (1998). The Assessment of Vulnerability and Adapation to Climate Change Impacts in Tanzania, CEEST-Dar es Salaam, Tanzania: *Assessment of Climate Change Impacts on Tanzanian Forests; pp 187-214: Assessment of Hydrologic Resources Vulnerability and Adaptation to Climate Impacts in Tanzania; pp 27-57*

Module 6: Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift

Working in teams, course participants will develop case studies of climate change threats to the biodiversity of selected sub-regions of the Albertine Rift. The case studies will draw on available information to assess the nature and severity of climate change risks to biodiversity, the interactions of climate change with other pressures, and the implications for human communities in the region. The case studies will also identify major gaps in knowledge and sources of uncertainty that are likely to inhibit effective decisions for conserving biodiversity in a changing climate and develop recommendations of actions to address knowledge gaps and uncertainties. Each team will prepare a short report and will present its findings and recommendations to a mock governing board that is responsible for conservation in the sub-region.

Module 6 Objectives:

Course participants will:

- Be able to apply concepts learned during the course to understand climate threats to biodiversity in the regions in which they live and work;
- Develop skills for identifying knowledge gaps and developing assessment plans to address gaps in knowledge; and
- Improve their skills for communicating information about climate change, climate change risks to biodiversity.

Course 2: Conserving Biodiversity in a Changing Climate

Course description: Participants in this course will examine current conservation strategies in terms of their effectiveness in addressing changing risks under a changing climate and will learn to develop new and/or modified strategies where necessary to address these risks. Participants will also learn to use methods and tools that can assess ecosystem responses to climate variability and change and thus guide the development of new/modified conservation strategies. Course topics include: The role of ecosystems and biodiversity in sustaining the planet and major stresses; traditional approaches to biodiversity conservation including legal and policy aspects as well as community scale strategies; effectiveness of traditional approaches; status of managed and natural systems in the Albertine Rift region; approaches to designing landscapes for protecting ecosystems and biodiversity under climate change; use of spatial analysis tools to guide landscape design; management strategies; policies and tools for protecting matrix areas; community participation; planning for long term monitoring and evaluation; and case study approaches to designing climate sensitive conservation strategies for the Albertine rift region. Participants will design a conservation plan that is sensitive to changing risks in a changing climate for an area of their choice within the Albertine Rift region.

Course objectives: The overall aim of this course is to generate strategies for adapting biodiversity conservation to changing risks under a changing climate by using existing/ new/modified conservation approaches, either singly or in any combination thereof, keeping in mind applicable legal and policy instruments, and accounting for the role of local communities.

The objectives of the course are:

- To develop an understanding of traditional approaches to biodiversity conservation and legal and policy instruments, which govern conservation at the international or national/regional/local levels
- To evaluate the effectiveness of traditional conservation approaches in terms of their benefits and shortcomings and in their ability to address changing risks due to climate change
- To determine goals and priorities for conservation under a changing climate
- To develop new and/or modified strategies for protecting areas of conservation importance under a changing climate
- To develop tools and plans for the long term monitoring of protected areas to ensure the effectiveness of conservation strategies

Course structure and sequence: The course is organized around 5 modules, of which modules 2 and 4 are further organized into a number of sub-modules. The modules and their sub-units are as below:

1. Need for protecting ecosystems and conserving biodiversity
2. Current biodiversity conservation strategies and their effectiveness
    2.1 Traditional approaches to biodiversity conservation
    2.2 Effectiveness of traditional approaches against various stressors
3. Extent and status of managed and natural systems in the Albertine rift
4. Protecting ecosystems and conserving biodiversity under a changing climate in the Albertine Rift region
    4.1 Approaches to designing conservation responses that address climate change risks
    4.2 Designing landscapes

4.3 Management of protected areas
4.4 Protecting the matrix areas
4.5 Community inclusive approaches
4.7 Monitoring the effectiveness of adaptive strategies

5. Case Study: Designing conservation strategies for addressing climate impacts in the Albertine Rift region

Readings: Required readings are listed below for each of the modules and subunits and will be provided in paper copy to course participants at the start of the course. Many of these will also be available in electronic format before the course. Additional readings to explore course topics in greater detail are also listed, and many of these will be made available during the course.[1]

Module 1: Need for Protecting Ecosystems and Conserving Biodiversity

This module will briefly cover the material covered in Course 1 on the role of ecosystems in the provision of goods and services and thus in sustaining the planet and supporting human development. An understanding of areas of high species endemism including endangered species and landscapes will be developed. Major stresses on ecosystems and biodiversity and their observed impacts over the past 50 years and potential impacts in the future will be discussed.

Module 1 Objectives:

Course participants will:

- Understand the concept of ecosystems goods and services and the role of ecosystems in supporting human development
- Learn about the importance of areas of high endemic biodiversity
- Learn about major climatic and non-climatic stresses, including those with anthropogenic origins, that affect ecosystem functioning and threaten biodiversity
- Become familiar with major stresses that affect ecosystems and biodiversity
- Become familiar with course objectives, structure and requirements
- Become acquainted with other course participants

Module 1 Readings:

[1] Note: This course is designed as a follow-on to the course Climate Change Risks to Ecosystems and Biodiversity. In case this course is taken independently of the first it is suggested that the participants read the following before the start of the course in order to be better equipped to handle course requirements:

- Millennium Ecosystem Assessment (2003). Summary. *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washingtion, DC, pp. 1-25.
- Millennium Ecosystem Assessment (2005). Summary for decision-makers, Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC, pp. 1-24.
- IPCC (2007a). Summary for Policymakers. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor and H. Miller, eds., *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
- IPCC (2007b). Summary for Policymakers. In M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.

- Millennium Ecosystem Assessment (2005). Summary for decision-makers. In *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, pp. 1-24.
- Millennium Ecosystem Assessment (2005). Summary for decision-makers. In *Ecosystems and Human Well-being: Biodiversity Synthesis*. Island Press, Washington, DC, pp. 1-16.

- Battarbee, R., P. Cox, C. Freeman, J. Lawton, G. Mace, A, Mackay, D. Read and J. Shepherd (2007). Biodiversity-Climate interactions: adaptation, mitigation and human livelihoods, Report of an international meeting held at the Royal Society 12-13 June 2007, Royal Society, UK
  Available: http://royalsociety.org/document.asp?tip=0&id=6830
- Mainka, S. A., McNeely, J. A. and Lackson, W. J. (Posted March 11, 2008) Depending on nature: ecosystem services for human livelihoods, Heldref Publications, March/April 2008
  Available:
  http://www.redorbit.com/news/science/1290207/depending_on_nature_ecosystem_services_for_human_livelihoods/

Additional source material for instructors and further reading for students

Lockwood, M (2006) Values and benefits. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 101-115[2]

Module 2: Current Biodiversity Conservation Strategies and their Effectiveness

Students will learn about strategies and methods that are commonly employed for the conservation of biodiversity. International treaties, agreements and laws applicable to the protection of ecosystems and biodiversity will also be discussed. The extent of success of currently utilized strategies in meeting their objectives will be examined.

Module 2.1: Traditional Approaches to Biodiversity Conservation

Students will be presented an overview of the legal, policy and governance aspects of biodiversity conservation including international conventions and multilateral agreements and actions taken at the regional/national/local scales. Students will be introduced to the various methods of conservation employed and will learn about protected areas, their categories and their global distribution. The social context of conservation and the important role local communities have been playing both historically and in the present in conserving biodiversity and protecting ecosystems will be discussed.

Module 2.1 Objectives:

Course participants will:

- Learn about international treaties and agreements, most importantly the convention on biological diversity, and will develop an idea of actions taken at regional/national/local scales.
- Understand the concepts of in-situ and ex-situ conservation

[2] Note: this reading refers more specifically to the value and benefits from protected areas but does offer a good description, which can be applicable to natural systems in general

- Develop an understanding of place based conservation methods i.e. protected areas and learn about protected area categories based the World Conservation Union (IUCN) classification
- Learn about the global distribution of protected areas
- Learn about the traditional role of communities in protected area management, the diverse kinds of community efforts as well as popular approaches to community engagement such as the Community Based Natural Resource Management (CBNRM) strategies

Module 2.1 Readings:

- Lockwood, M (2006) Global protected area framework. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 73-100
- Lockwood, M (2006) Social Context. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 41-72
- Borrini-Feyerabend, G., Johnson, J. and Pansky, D (2006) Governance of protected areas. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 116-145
- Kothari, A. (2006). Community conserved areas. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 549-573

Additional source material for instructors and further reading for students

- Kothari, A. (2006). Collaboratively managed protescted areas. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 529-548
- Escobar, Arturo (1998). Whose knowledge, whose nature? Biodiversity, Conservation, and the Political Ecology of Social Movements. *Journal of Political Ecology*, 5:53-82.
- World Parks Congress (2003): WPC Recommendation 31. Protected areas, freshwater and integrated river basin management frameworks. Available at: http://www.iucn.org/themes/wcpa/wpc2003/english/outputs/recommendations.htm

Module 2.2: Effectiveness of Traditional Approaches Against Various Stressors

The effectiveness of existing protected areas in terms of biodiversity conservation, maintaining ecosystem resilience in the face of various non-climatic and climatic stressors, and in sustaining livelihoods and development will be examined. Students will also learn about the challenges associated with ensuring and maintaining protected area effectiveness. An assessment of the benefits and shortcomings of current approaches to conservation will be performed.

Module 2.2 Objectives:

Course participants will:

- Learn about the effectiveness of current protected area systems in protecting ecosystems and biodiversity against various stressors and therefore in supporting human development
- Become aware of some of the key challenges in maintaining protected areas

- Understand the strengths and weaknesses of traditional approaches to conservation, including in the context of climate change impacts

Module 2.2 Readings:

- Naughton-Treves, L., Buck Holland, M. and Brandon, K. (2005). The role of protected areas in conserving biodiversity and sustaining local livelihoods, *Annual Review of the Environment and Resources,* 30: 219-252.
- Dudley, N. and Stolton, S. (2003). Ecological and Socio-economic benefits of protected areas in dealing with climate change. In L. Hansen, J. Biringer and J. Hoffman, (Eds.), *Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems*, WWF, Washington. Pp. 215-231.
- Worboys, G., Winkler, C. and Lockwood, M. (2006) Threats to protected areas. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide,* Earthscan, London, UK and Sterling, USA, pp. 223-261
- Lockwood, M., Worboys, G. L. and Kothari, A. (2006) Challenges and opportunities. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide,* Earthscan, London, UK and Sterling, USA, pp. 677-681

Module 3: Extent and Status of Natural and Managed Systems in the Albertine Rift

A general understanding of the status of biodiversity and its conservation in Africa will be provided and a more detailed focus will be placed on the Albertine rift region, which will be studied in terms of current climatic and non-climatic stressors as well as projected impacts of climate change in the future decades. Current conservation practices in this region for the protection of ecosystems and biodiversity, including the degree of success of such programs will be examined. The ability of these approaches to address climate change impacts will be evaluated. In addition, applicable institutional, legal and policy aspects in this region will be explored, as will be the role of local communities and other stakeholders.

Module 3 Objectives:

Course participants will:

- Learn about the status of biodiversity conservation in the Albertine Rift region
- Evaluate the effectiveness of conservation programs in addressing climatic and non-climatic stressors here
- Become familiar with institutional, legal and policy aspects that inform conservation in this region
- Learn about the influence of local communities in conservation in this region
- Learn about the role of other stakeholders e.g. international/national NGOs and institutions, local/regional organizations, national/regional/local governments and officials, etc.

Module 3 Readings:

- UNEP (2002) The state of Africa's environment and policy analysis: Part B: Biodiversity, *Africa Environment Outlook*, Earthprint Limited, UK, pp. 53-93
- Plumptre, A. J., Davenport, T. R. B., Behangana, M., Kityo, R., Eilu, G., Ssegawa, P., Ewango, C., Meirte, D., Kahindo, C., Herremans, M., Peterhands, J. K., Pilgrim, J. D., Wilson, M., Languy, M., and Moyer, D. 2007. The biodiversity of the Albertine Rift,

Biological Conservation, 134: 178-194. http://webdocs.dow.wur.nl/internet/fem/uk/pdf/plumptre%20et%20al%202007.pdf

- Mahinya, Stephen G. (2005). Assessment of ecological integrity of land use systems using birds and bio-indicators in Malagarasi-Muyovosi Ramsr Site, Western Tanzania. MSc. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania; 103pp.
- Patterson, G. and J. Makin (eds) (1998). The state of biodiversity in Lake Tanganyika – A literature review. Chatham (UK): National Resources Institute; 134pp.
- Rogers, P.J. (2002). Global Governance/Governmentality, Wildlife Conservation, and Protected Area Management: A Comparative Study of Eastern and Southern Africa. Paper presented at the African Studies Association 45th Annual Meeting, Washington DC, December 5
- Goldman, Mara (2003). Partitioned nature, privileged knowledge: Community-based conservation in Tanzania. *Development and Change* 34(5); pp. 833-862.
- Balint, P.J. (2006). Improving community-based conservation near Protected Areas. The importance of development variables. *Environmental Management* 38(1); pp. 137-148.
- Cambell, L.M. and A. Vainio-Mattila (2003). Participatory development and community-based conservation. Opportunities missed for lessons learned. *Human Ecology* 31(3); pp. 417-437

Additional source material for instructors and further reading for students

- Taylor, D. and Hamilton, A. (1994). Impact of climatic changes on tropical forests in Africa: implications for protected area planning and management. In, *Impacts of Climate Change on ecosystems and Species: Implications for Protected Areas*, Proceedings of the IVth World Congress on national Parks and protected Areas, Caracas, Venezuela, The World Conservation Union, pp. 77-94
- Tutin, C.E.G. (2002). Parks in the Congo Basin: Can Conservation and Development Be Reconciled? In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, pp 76-85
- Hart, T. (2002). Conservation in Anarchy: Key Conditions for Successful Conservation of the Okapi Faunal Reserve. In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, pp 86-96
- Struhsaker, T.T. (1998). Causal factors of Tropical Deforestation and Recommendations, In, *Ecology of an African Rainforests: Logging in Kibale and the conflict between Conservation and Exploitation*, University Press of Florida, pp 310-343
- Terborgh, J (2002). Overcoming Impediments to Conservation. In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington, DC, pp 243-249
- Salafsky, N., and Margoluis, R. (2002). Breaking the Cycle: Developing Guiding Principles for Using Protected Area Conservation Strategies. In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 409-423
- Schaik, C.V., and Rao, M. (2002). The frontier Model of Development and its Relevance to Protected Area Management. In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 424-440
- Brandon, K. (2002). Putting the Right Parks in the Right Places. In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 443-467

- Schaik, C.V., Terborgh, J., L Davenport, and Rao, M. (2002). Making Parks Work: Past, Present and Future, In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 468-480

Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift region

This module will be devoted to understanding the manner in which response strategies can be designed to address the impacts of climate change on ecosystems and biodiversity in addition to the impacts of other pre-existing stressors as well as any synergistic outcomes. Each sub-module will address a key step in the process of designing conservation strategies suited to a more dynamic environment and students will be given the opportunity to participate in case study exercises aimed at conservation planning for the Albertine Rift region.

Module 4.1: Approaches to Designing Conservation Responses that Address Climate Change Risks

Students will be introduced to certain key guiding principles that can inform the design of conservation strategies under a changing climate. Students will also learn to define conservation targets based on the status of biodiversity and ecosystems in the local/regional context as well as the impact of other non-climatic stressors.

Module 4.1 Objectives:

Course participants will:

- Learn about key guiding principles to designing climate change responsive conservation strategies e.g. conserving existing biodiversity; reducing the impacts of non-climatic stressors; protecting and restoring habitats and maintaining habitat connectivity; relying on analytical evidence to guide decision-making; and integrating adaptation and mitigation efforts (from Hopkins et al, 2007)
- Learn to use these guidelines to set broad conservation goals and priorities for their local/regional areas, keeping in mind institutional, legal and governance aspects.

Module 4.1 Readings:

- Hopkins, J. J., Allison, H. M., Walmsley, C. A., Gaywood, M. and Thurgate, G. 2007. *Conserving Biodiversity in a Changing Climate: guidance on building capacity to adapt*, DEFRA, United Kingdom
- Hannah, L., T. Lovejoy and S. Schneider (2005). Conservation with a changing climate. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 325-328.
- Price, M. F. and Neville, G. R. (2003). Designing strategies to increase the resilience of Alpine/Montane systems to climate change. In. L. J. Hansen, J. L. Biringer and J. R. Hoffman (Eds.), *Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems: Protected Areas*, World Wildlife Fund. Pp. 73-92

Module 4.2: Designing Landscapes

Students will learn about various databases and analytical tools that can be used for planning the design of landscapes for biodiversity conservation under a changing climate. This will enable them to learn to set specific targets for their eco-regions and determine the scope and boundaries of their planning areas.

Module 4.2 Objectives:

Course participants will:

- Learn about various modeling methods for determining climate change impacts on ecosystems and species and therefore on conservation targets (e.g. regional climate projections, modeling changes in species distribution, species range shift models, etc.)
- Based on these methods learn to determine future changes in conservation targets, keeping in mind the synergistic interactions of climate change impacts with non-climatic stressors
- Learn to determine the future distribution and boundaries of protected areas, including the importance of maintaining landscape connectivity
- Understand the need for a dynamic conservation plan in response to current and projected future distribution of species under a changing climate and informed by reserve planning tools (e.g. reserve selection algorithms)

Module 4.2 Readings:[3]

- Hannah, L., T. Lovejoy and S. Schneider (2005). Designing landscapes and seascapes for change. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 329-341.
- Hannah, L. (2003). Regional biodiversity impacts assessments for climate change: a guide for protected area managers. In L. Hansen, J. Biringer and J. Hoffman, eds., *Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems*, WWF, Washington. Pp. 233-242.

Module 4.3: Management of Protected Areas

The importance of planning and management for formally conserved areas will be discussed. Current strategies for biodiversity conservation and protected area management will be evaluated for their applicability and new/modified strategies developed where necessary. The need for spatial coordination across national/regional boundaries to ensure protection in the event of shifting margins of species ranges and habitats will be highlighted. Planning and regulatory tools that can address the impacts of non-climatic stressors will be discussed. The importance of designing cost effective strategies that maintain flexibility and reversibility will be addressed. Key stakeholders and their roles in the conservation planning and management process will be discussed.

Module 4.3 Objectives:

Course participants will:

- Understand the role of planning and management in protected area design and conservation

[3] Note: It is suggested that participants refer to readings on methods and tools from Course 1, module 5

- Learn to evaluate current management tools in terms of their long-term applicability under a changing climate
- Understand the importance of spatial coordination
- Identify key stakeholders and their roles
- Understand the need for planning and regulatory tools that can address climatic and non-climatic stressors and can maintain flexibility and reversibility as risks change with a changing climate
- Identify additional costs in terms of staff, resources, training, and equipment needs.

Module 4.3 Readings:

- Hannah, L. and Salm, R. (2005). Protected area management in a changing climate. In T. Lovejoy and L. Hannah (Eds.), *Climate Change and Biodiversity*. Yale University, New Haven, pp. 211-228.
- Lockwood, M. (2006) Management Planning. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide,* Earthscan, London, UK and Sterling, USA, pp. 292-327
- Lockwood, M. and Quintela, C. E. (2006) Finance and Economics. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 328-358
- Schaik, C.V., Terborgh, J., L Davenport, and Rao, M. (2002). Making Parks Work: Past, Present and Future, In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 468-481

Module 4.4: Protecting Matrix Areas

Besides the need to protect formally conserved areas, participants will also be made aware of the important value of the matrix. A large amount the biodiversity currently occurs outside of any formal protected areas, in the matrix, which is currently subject to a variety of land uses. The importance of developing management strategies to protect the matrix as a part of a dynamic landscape conservation plan will be discussed in order to conserve its biodiversity and preserve its capacity to serve as a source of resources for certain species, or as a potentially new suitable habitat for others due to shifting ranges, or as migratory corridors. Methods and tools used for determining future species distributions and ranges and therefore for delineating matrix areas that will require protection will once again be applied here. The need for spatially and sectorally coordinated management responses and the role of key stakeholders will also be highlighted.

Module 4.4 Objectives:

Course participants will:

- Learn about the key role of the matrix as a source of biodiversity, as a source of resources for species, as a connective landscape, and as a potential suitable habitat for species under a changing climate.
- Learn to apply analytical methods and tools to determine the current and future functions of matrix areas in biodiversity conservation
- Understand the importance of periodic monitoring of climate induced changes as well as changes in other stressors in matrix areas, which are often under various land uses
- Learn about the various options for protecting matrix areas to preserve their structure and function

- Be informed about policy and regulatory approaches to protecting matrix areas

Module 4.4 Readings:

- Da Fonseca, G. A. B., Sechrest, W. and Oglethorpe, J. (2005). Managing the matrix. In T. Lovejoy and L. Hannah (Eds.), *Climate Change and Biodiversity*. Yale University, New Haven, pp. 346-362.
- Sandwith, T. and Lockwood, M. (2006). Linking the landscape. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 574-602

Module 4.5: Community Inclusive Approaches

The role of local communities as important stakeholders in the process of adapting biodiversity conservation strategies to address climate change impacts will be highlighted. Emphasis will be placed on approaches that can include the successful cooperation and participation of local communities, as they are likely to be more effective, especially in natural resource dependent communities and in the matrix areas where land-use is often mixed. Traditional community conserved areas will be evaluated for their ability to continue to offer a refuge for biodiversity.

Module 4.5 Objectives:

Course participants will:

- Evaluate traditional and current community conservation strategies in terms of their applicability for conservation under a changing climate
- Identify other community stakeholders that could potentially play a role in biodiversity conservation under climate change
- Identify current land-uses by local communities in areas that might need protection for biodiversity conservation under climate change and the ways in which these land uses can be made compatible with conservation objectives (are social appraisal tools like participatory rural appraisal useful here?)
- Evaluate the usefulness of popular approaches such as the CBNRM in aiding community participation for biodiversity conservation under climate change
- Identify policy and regulatory measures as well as incentives that could be used to elicit community cooperation and participation

Module 4.5 Readings:

- Goldman, Mara (2003). Partitioned nature, privileged knowledge: Community-based conservation in Tanzania. *Development and Change* 34(5); pp. 833-862.
- Balint, P.J. (2006). Improving community-based conservation near Protected Areas. The importance of development variables. *Environmental Management* 38(1); pp. 137-148.
- Cambell, L.M. and A. Vainio-Mattila (2003). Participatory development and community-based conservation. Opportunities missed for lessons learned. *Human Ecology* 31(3); pp. 417-437.
- Baldus, R.D., Kaggi, D.Th. and Ngoti, P.M. (2004). Community based conservation: Where are we now? Where are we going?' *Miombo,* **27**, 3-7.
- Nelson, F., E. Sulle and P. Ndoipo 2006. Wildlife Management Areas in Tanzania. A Status Report and Interim Evaluation prepared for the Tanzania Natural Resource Forum. Final Draft.

- Emerton, L. and Mfunda, I. (1999). Making wildlife economically viable for communities living around the Western Serengeti, Tanzania. Evaluating Eden Series, Working Paper No. 1.
- Hill, C.M. (2002). People, crops and wildlife: A conflict of interests' in Hill, C., Osborn, F. and Plumptre, A.J. (eds.), Human-wildlife conflict: Identifying the problem and possible solutions. Albertine Rift Technical Report Series, Vol. 1. Wildlife Conservation Society; pp. 61-68.
- International Resources Group (2000). Community based conservation experience in Tanzania: An assessment of lessons learned. Report prepared for USAID/Tanzania by International Resources Group, Washington, DC, USA. August, 2000.
- Balint, P.J. and J. Mashinya (2006). The decline of a model community-based conservation project: Governance, capacity and devolution in Mahenye, Zimbabwe. Geoforum 37; pp. 805-815.

Additional source material for instructors and further reading for students

- Borrini-Feyerabend, G., Johnson, J. and Pansky, D (2006). Governance of Protected Areas. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 116-145
- Tutin, C.E.G. (2002). Parks in the Congo Basin: Can Conservation and Development Be Reconciled? In, J. Terborgh, C.V Schaik, L. Davenport and M. Rao (eds), *Making Parks Work: Strategies for Preserving Tropical Nature*, Island Press, Washington DC, pp 76-85

Module 4.6: Monitoring the Effectiveness of Adaptive Strategies

Participants will learn that, while designing a conservation plan to address climate change impacts is critical, it is equally important at the same time to develop a system for periodic monitoring in order to track the success or failure of any management strategies that have been implemented. In addition a monitoring system can also track changing responses of biodiversity to changing climatic conditions and therefore to determine changing conservation needs. Various tools that can be used for this purpose will be discussed.

Module 4.6 Objectives:

Course participants will:

- Understand the importance of monitoring for effective conservation planning to address a changing climate
- Understand the basics of designing a monitoring system that produces the desired results and is cost-effective
- Learn to determine what must be monitored i.e. focus on key target species, processes and resources
- Learn to select eco-regions or landscapes that must be monitored
- Learn to determine the frequency of monitoring required
- Learn to use various methods and tools for this purpose e.g. spatial analysis, survey methods, etc.

Module 4.6 Readings:

- Hockings, M., Leverington, F. and James, R. (2006) Evaluating management effectiveness. In, M. Lockwood, G. L. Worboys and A. Kothari (Eds.), *Managing Protected Areas: A Global Guide*, Earthscan, London, UK and Sterling, USA, pp. 635-655
- Hannah, L. and Salm, R. (2005). Protected area management in a changing climate. In T. Lovejoy and L. Hannah, eds., *Climate Change and Biodiversity*. Yale University, New Haven, pp. 211-228. [4]

Module 5: Case Study: Designing Conservation Strategies for Addressing Climate Impacts in the Albertine Rift Region

This module is designed as a hands-on activity where students will use the knowledge acquired from this course to design a conservation plan that is sensitive to changing risks under climate change for an area of their choice within the Albertine rift region. Students will be expected to use the tools and resources provided in this course to develop their designs and must include all the key considerations, including the need for periodic monitoring. This exercise includes presentation of the conservation plans developed during this activity.

Module 5 Objectives:

Course participants will work in groups and select an eco-region within the Albertine Rift region to design a conservation plan that must:

- Identify broad goals and priorities
- Identify climatic and non-climatic stressors, both current and future, and be able to determine potential future impacts in terms of changing species distribution and ranges
- Identify matrix areas that important for future conservation needs
- Assess the applicability of current conservation strategies in that region to address climate risks in future
- Include a climate risk integrated management plan that considers future conservation landscapes, including matrix areas.
- Identify key stakeholder roles, including community participation strategies
- Identify policy/regulatory approaches
- Include a periodic monitoring plan identifying key targets and landscapes to be monitored, monitoring frequency and methodology
- Include an analysis of cost effectiveness

As a conclusion to this exercise, each sub-group will be expected to formally present their conservation plan to their colleagues.

2.3 Mode of Conducting the Course

The two courses will be conducted consecutively using lectures, case studies, field visits, group discussions, computer labs and seminar presentations.

2.4 Course Evaluation

[4] Note: Repeat reading from Module 4.3; some sections from this reading are applicable to this module

At the end of the training program course participants will be evaluated through written assignments (e.g. written reports), assessed seminar presentations, and written examinations.

APPENDIX 5 - DISTRIBUTION OF PROGRAM APPLICANTS

Table 1: Distribution of Albertine Rift Applicants

Country	Gender		Total
	Female	Male	
Tanzania	18	66	84
Uganda	11	23	34
Rwanda	2	7	9
Burundi	1	3	4
DRC	0	7	7
Grand Total			138

Table 2: Distribution among Non-Albertine-Rift applicants

Country	Number of applications
Kenya	20
Nigeria	16
Botswana	1
South Africa	1
Madagascar	1
Namibia	1
Burkinafaso	1
Zimbabwe	2
Ethiopia	8
Cameroon	7
Malawi	2
Ghana	5
Total (Non-Albertine Rift Countries)	65

APPENDIX 6 – PROGRAM PARTICIPANTS

TANZANIA

Jokha Takdir Mtoro
Jozani National Park-Zanzibar
Email: zeyanamtoro@yahoo.com

Case study: *Climate change threats to the biodiversity – The case of Zanzibar*.

Externship research: *Observation on water characteristics and aquatic biota at Pangani River delta.**

Mentor: Prof A.A.O. Aboud

Nicholas Joseph Kisambuka
Tanzania National Parks (TANAPA), Katavi
Email: joenicky2002@yahoo.com

Case study: *Threats to biodiversity conservation in Tanzania: The case of Katavi, Rukwa ecosystem*

Externship Research: *Climate variability and extremes: Implications in the management of biodiversity in the Katavi-Rukwa Ecosystem, Tanzania*.
Summary: The study established the implications of biodiversity loss in the Katavi-Rukwa Ecosystem in Western Tanzania. Analysis of data collected in this research indicates a major loss of crocodiles and large mammals such as hippos in recent years primarily due to extreme droughts and wild fires.

Mentor: Prof. Pius Yanda

Emilian Kihwele
Tanzania National Parks (TANAPA) - Lake Manyara National Park
Email: kihwele2001@yahoo.co.uk

Case study: *Climate Change and its implications for ecosystems, biodiversity and livelihoods, Tanzania: Manyara National Park*

Externship research: *Assessment of the impacts of climate variability on biodiversity conservation and livelihoods in the Lake Manyara Sub basin, Tanzania*
Summary: The study observed a substantial variation in rainfall from the year 1963 to year 2008 with minimum rainfall record of 89.9mm in 1966 and maximum record of 1052.4mm in 2006 in the Lake Manyara Sub-basin. Data analysis established seasonal patterns of a series of extreme high rainfall and extreme low rainfall periods. Together with literature review and inputs from local community members, significant impacts on local biodiversity and community livelihoods were noted.

Mentor: Prof. Pius Yanda

Julitha Raphael Munishi
Tanzania Wildlife Research Institute (TAWIRI)
Email: julitha2003@yahoo.co.uk

Case study: *Climate change threats to the biodiversity of Tanzania: Case study of Serengeti National Park*

Externship research: *Effect of climate change on stinging bee's behaviour (Apis milifera) and honey production: A case of Arumeru District, Tanzania*
Summary: This research explored recent reports of decreased honey production and changes in harvesting seasons over the last five years by a majority of respondents in the Arumeru district. Associated changes in flowering seasons leading into changes in the behavior of bees have also been reported. The research examined the role of climatic parameters i.e. rainfall and temperature on the behavior and productivity of bees. However a significant statistical correlation between honey production and weather parameters (rainfall and temperature) could not be established.

Mentor: Dr. S.D. Liseki

Sood Athuman Ndimuligo
Jane Goodall Institute-Kigoma
Email: dkatutu@yahoo.com

Case study: *Impact of climate change on vegetation phenology: The experience from Gombe National park*

Externship research: *The impact of climate change on the phenology of chimpanzee (Pan troglodytes) tree food species in Gombe National Park, Western Tanzania*
Summary: The study revealed a shift in temperatures over the past five years especially in 2003 with a variation of 1.3°C. The trends in temperatures match flowering and fruiting patterns in the area over the five-year study period. A resulting decrease in the abundance of ripe fruits per year indicates the growing scarcity of food resources for Chimpanzees. Additional analysis of the data collected in this study could help establish more conclusive results.

Mentor: Dr. S. Kamenya

Anna Titus Laroya
Tanzania Wildlife Research Institute (TAWIRI)
Email: laroyaanna@yahoo.com

Case study: *Climate threats to the biodiversity: A case of Kilimanjaro National Park*

Externship research: *Effect of climate change and non-climatic variability to butterflies of Njiro Forest, Tanzania*
Summary: A positive correlation between variability in climatic parameters (temperature and rainfall) and butterfly species diversity was revealed by comparing the composition of butterfly species in the Njiro forest area in 2008 with data collected in 2002. Some species recorded in 2002 were found to be missing in 2008. While the short duration of the study prevented any conclusive establishment of climate change impacts on butterfly species diversity, butterfly and climate datasets from other regions in Tanzania were used to demonstrate the correlation between these parameters.

Mentor: Dr. S.D. Liseki

UGANDA

Opio Alfonse
Gulu University
Email: alfonseopio@yahoo.com

Case study: *Hydrological dynamics and wastewater treatment in Kinawataka wetlands, Kampala, Uganda*

Externship research: *Decomposition rate of fish pond organic fertilizers in changing climate in Uganda.*[#]
Summary: The study investigated the effect of temperature on the decomposition of organic fish pond fertilizer to determine impacts on aquatic flora and fauna. Such organic fertilizers are used to increase fish production as a source of food and livelihoods in Uganda. Changes in the decomposition rate due to changes in temperature as indicated by this study can affect the heath of the aquatic ecosystem and impact fish production. Additional work is currently under progress for this research activity and results will be updated once available.

Mentor: Dr. Frank Kansime

Rita Mugenyi
National Environment Management Authority
Email: rmugenyi@nemaug.org, vickritam@yahoo.com

Case study: *Threats of climate change to Mountain Gorillas*

Externship research: *Structural changes of Neuboutina macrocalyx tree in a changing microclimate around Mubwindi Swamp, Bwindi Impenetrable National Park, Uganda*
Summary: The primary finding of this study is that the slope and aspect of the land areas are important determinants in the local microclimate, which in turn influences the growth and distribution of the *Neoubotonia macrocalyx* tree. The microclimate is also affected by the changes in solar radiation flux. This study was essentially a continuation of an existing study in the area but additional data is necessary to establish the connection with climate change.

Mentor: Mary Kitutu Kimono Goretti

Proscovia Khanzila
Greenwatch
Email: khanzops@yahoo.com

Case study: *Climate change threats to biodiversity in Uganda*

Externship research: *Assessment of the existing legal framework in relation to biodiversity conservation in a changing climate in Uganda*
Summary: The findings from this study underscored that poverty, lack of political will and poor coordination amongst ministries can pose major challenges to addressing climate change risks to biodiversity conservation in Uganda. Additional quantifiable data would be useful in better establishing the results.

Mentor: Irene Ssekyana

Lawrence Aribo
Meteorology Department, Uganda
Email: aribo311@yahoo.co.uk

Case study: *Wetland assessment in Entebbe*

Externship research: *Climate variability and waterbird diversity at Lutembe wetland Uganda.**

Mentor: Dr. Frank Kansime

Nelson Kisaka
Makerere University
Email: kisakajnelson@yahoo.co.uk

Case study: *Climate change threats to Uganda's biodiversity*

Externship research: *Climate change impacts and environmental risk assessment in Rwenzori mountains ecosystem in Uganda.**

Mentor: Prof. Derek Pomoroy

Irene Nadunga
Uganda Coalition For Crisis Prevention
Email: irenenadunga@yahoo.com

Cast study: *Climate concerns and threats to biodiversity: Case of Lake Victoria, Uganda*

Externship research: *A Baseline study on the vegetation cover of the Mabira Forest Reserve Uganda, in the existing climatic conditions*[#]
Summary: The study established the forest structure and plant species composition in the reserve. While this research in itself does not directly establish linkages with climate change, it serves as the baseline for the future monitoring studies of vegetation responses to a changing climate trend in the area. Additional information to support this effort is currently being compiled.

Mentor: Dr. John R.S. Tabuti

RWANDA

Runyambo Irakiza
Conservation Association Of Rwanda
Email: clauruny@yahoo.fr, acnrwanda@yahoo.fr

Case study: *Climate change and threats to biodiversity in wetland and aquatic ecosystems in Rwanda*

Externship research: *Recent changes in vegetation structure of the Ngezi Swamp in the face of climate change: Case of Volcanoes Biosphere Reserve and National Park, Rwanda*
Summary: Changes in vegetation composition of the swamp were determined by a comparison of data collected in 2005 with that collected in 2008 (i.e. by the present study). An increase in the average number of cyanobacterial species was observed in the floating swamp and the swamp edge between 2005 and 2008. In this case additional research to

establish the influence of climatic and non-stressors on the cyanobacterial proliferation would be useful.

Mentor: Dr. Elias Bizulu

Nyirambangutse Brigitte
National University Of Rwanda
Email: nbrite82@yahoo fr

Case study: *Climate Change and threats to the biodiversity of Rwanda*

Externship research: *Evaluating the impact of climatic parameters on Ericaceous species of Nyungwe National Park, Rwanda*
Summary: The study looked at the impacts of climatic parameters, specifically increasing temperature, on the distribution of the *Ericaceae* species, which are highly temperature sensitive. The species were widely distributed in the Park and the study noted a linkage between the disappearance of some *Ericaceae* and increasing in temperatures in the area. In future research, the influence of other climatic parameters and non-climatic factors could also be investigated.

Mentor: Dr. Elias Bizulu

BURUNDI

Liliane Hatungimana
Geographic Institute Of Burundi
Email: hatungalili@yahoo.fr

Case study: Climate change threats to the biodiversity of Burundi

Externship research: *Effect of climate change and variability on socio-economic activities in Burundi: Implications for biodiversity conservation.*[#]
Summary: The study revealed a decrease in bean production due to changing climatic conditions in the Kirundo Province of Burundi mainly due to extreme droughts and increased temperature. It found that this has made people rely increasingly on biodiversity resources as alternate livelihood means and pose challenges to conservation. Additional data to support this conclusion would be beneficial to this research.

Mentor: Dr. Elias Bizulu

Masharabu Tatien
University Of Burundi
Email: masharabin@yahoo.fr

Case study: *Deterioration of wetlands in Burundi: Case of swamps*

Externship research: *Climate change and the Ruvubu National Park, Burundi*
Summary: The study revealed reflexive links between climate change and invasive species in the park. As a result of frequent drought, fire incidences have been seriously affecting native plant species leading to an increased number of invasive fire-resistant species. Eight varieties of invasive species were recorded during the course of this study. The importance of mitigating non-climatic stressors like fire stemming from climate related phenomena is underscored for the adaptation of conservation. Future research could possibly investigate

the role of other factors that may also encourage the proliferation of invasive species.

Mentor: Dr. Bizulu Elias

DEMOCRATIC REPUBLIC OF CONGO

Jean Jacques Bagalwa Mashimango
Centre For Research In Natural Science
Email: mashibagalwa@yahoo.fr

Case study: *Climate change threats to the biodiversity of Lake Kivu*

Externship research: *Impact of climate change on the Biogeochemistry of Lake Kivu, Western Basin (Kalehe), Democratic Republic of Congo*
Summary: The study determined climate change impacts on nutrient dynamics and phytoplankton composition in Lake Kivu. Significant changes in the biomass of phytoplankton, zooplankton composition over time have been linked to decreasing nutrient concentration (by comparing with past data) due to warming occurring in the lake. Further changes in changes in nutrient dynamics, phytoplankton and zooplankton community structure and phytoplankton biomass in the lake are expected with rising temperatures.

Mentor: Dr. Augustin Basabose Kanyunyi

Desire Khasrikani
Tayna Centre For Conservation Biology
Email: deskhasirikani@yahoo.fr

Case study: *Climate change threats to biodiversity in Virunga National Park*

Externship research: *Altitudinal distribution of small mammals in relation to climate change: The case of Muridae family in Kabwe Kandongwe station*
Summary: The study served to generate baseline information for altitudinal variation in the Muridae family in the study area. Although some members of the Muridae family are moisture-dependant, the observed variation could not be conclusively linked to the impacts of climate change during the limited duration of this study. Additional research and data collection is necessary to monitor changes over time

Mentor: Valentin Kamaru Vasombolwa

Richard Kialungira
General Commission Of Atomic Energy
Email: richardkial4@gmail.com

Case study: *Climate change threats in biodiversity in the DRC*

Externship research: *Climate change impacts on aquatic biodiversity conservation in an urban ecosystem: Case study of the Ithchyo biodiversity of pool malebo in Congo River, Democratic Republic of Congo*
Summary: The results from the study show that there is an existing relationship between changes in climate and the loss of biodiversity/decrease in number of species in the ecosystem. The loss of biodiversity in the Pool Malebo was found to be governed by the weather and physico-chemical parameters namely, atmospheric temperature, water temperature, dissolved oxygen, pH, humidity and electric conductivity that directly affect the ithchyology in the ecosystem. The study could benefit from additional information on

the role of non-climatic stressors and their interactions with the physico-chemical parameters noted here

Mentor: Mr. Jean Ndembo Longo

David Sivalingana Matsisi
Tayna Gorilla Reserve
Email: davidmatsitsi@yahoo fr

Case study: *Climate change threats to the biodiversity of Tayna Gorilla Reserve*

Externship research: *Impact of climate change on the parasitology of Gorilla graueri in Tayna Gorilla Reserve, Democratic Republic of Congo*

Summary: The study investigated the manner in which climate change affects biodiversity by facilitating an increase of parasites species in *Gorilla graueri* in the Tayna Reserve. Data was collected by means of analysis of *Gorilla* fecal material and an increasing abundance of parasites was recorded. However, the linkage with changing climatic parameters could not be conclusively established.

Mentor: Valentin Kamaru Vasombolwa

* Pending research report submission
\# Research report under revision

APPENDIX 7 – PROGRAM FACULTY AND EXTERNSHIP SUPERVISORS

FACULTY

Pius Yanda
Institute of Resource Assessment, University of Dar es Salaam, Tanzania
Email: yanda@ira.udsm.ac.tz

Richard Kangalawe
Institute of Resource Assessment, University of Dar es Salaam, Tanzania
kangalawe@ira.udsm.ac.tz

Emma Liwenga
Institute of Resource Assessment, University of Dar es Salaam, Tanzania
Email: liwenga@ira.udsm.ac.tz

J. Lyimo
Institute of Resource Assessment, University of Dar es Salaam, Tanzania
Email: lyimo@ira.udsm.ac.tz

C. Mung'ong'o
Institute of Resource Assessment, University of Dar es Salaam, Tanzania
Email: claudem@ira.udsm.ac.tz

C. Nahonyo
Department of Zoology and Wildlife Conservation, University of Dar es Salaam, Tanzania
Email: nahonyo@uccmai.co.tz

Flora Ismail
Botany Department, University of Dar es Salaam, Tanzania
Email: ismailf@udsm.ac.tz

H.V. Lyaruu
University of Dar es Salaam, Tanzania
Email: lyaruu@amu.udsm.ac.tz

A. Muzuka
University of Dar es Salaam, Tanzania
Email: muzuka@ims.udsm.ac.tz

Elias Bizulu
University of Rwanda
Email: ebisous@yahoo.fr

S. Madoffe
Faculty of Forestry, Sokoine University of Agriculture
Email: madoffe@suanet.ac.tz

Ursula Heyder
Potsdam Institute for Climate Impact Research
Email: UHeyder@gmx.de; Ursula.Heyer@pik-potsdam.de

Rob Marchant
Environment Department, University of York, UK
Email: rm524@york.ac.uk

EXTERNSHIP SUPERVISORS

Country	Name/Title	Institution and Email	Participant (s) supervised
Tanzania	Prof, P.Z. Yanda	Institute of Resource Assessment University of Dar es Salaam E-mail: yanda@ira.udsm.ac.tz	Emilian Kihwele Nicholas Joseph
	Dr. S.D. Liseki	Tanzania Wildlife Research Institute Email: sdliseki@yahoo.com	Anna T. Laroya Julitha Raphael Munishi
	Prof. A.A.O. Aboud	Sokoine University of Agriculture Email: aboud@suanet.ac.tz; aoaboud@yahoo.com	Jokha Takdir Mtoro
	Dr. S. M. Kamenya	Jane Goodall Institute, Tanzania Email:skamenya@janegoodall.or.tz	Sood Ndimuligo
Uganda	Prof. F. Kansiime	Institute of Environment and Natural Resources, Makerere University E-mail: muienr@muienr.mak.ac.ug; fkansiime@muienr mak.ac.ug	Opio Alfonse Aribo Lawrence
	Prof. D. Pomoroy	Institute of Environment and Natural Resources, Makerere University. Email: Derek@imul.com	Nelson Kisaka
	Prof. John R.S. Tabuti	Institute of Environment and Natural Resources, Makerere University E-mail: jrstabuti@yahoo.com	Irene Nadunga
	Mrs. Irene Ssekyana	Green-watch, Uganda Email: irene@greenwatch.or.ug; environment@greenwatch.or.ug	Proscovia Khanzila
	Mrs. Mary Kitutu Kimono Goretti	National Environmental Management Authority (NEMA), Uganda Email: gkitutu@nemaug.org	Rita Mugenyi
Rwanda and Burundi	Dr. E. Bizulu	National University of Rwanda and Burundi Email: ebisous@yahoo fr	Briggite Nyirambangutse Claude Runyambo Tatien Masharabu Lilian Hatungimana
DR-Congo	Mr. Jean Ndembo Longo	General Atomic Energy Commission / Regional Centre of Nuclear Studies of Kinshasa And University of Kinshasa Email: jndelongo@yahoo fr	Richard Kialungira
	Prof. Valentin Kamaru Vasombolwa	Tayna Centre for Conservation Biology-University for Nature Conservation and Development at Kasugho Email: vkamabu@yahoo.fr	Mbakwiravyo Desire Khasirikani David Sivalingana Matsitsi
	Dr. A.B. Kanyunyi	Center of Research in Natural Sciences of Lwiro Email: bdepartement@yahoo.fr	Mashimango Jean Jacques Bagalwa

APPENDIX 8 – COURSE TIMETABLE (1ST JULY-15TH AUGUST)

COURSE 1: Climate Risks to Ecosystems and Biodiversity (July 1 - July 18, 2008)

WEEK 1: JULY 1 – 5, 2008	
Tuesday: July 1, 2008 ***Module 1: Biodiversity in a Changing Climate: Framing the Issues***	
9:00 am – 12:00 noon	Module 1: Introduction *Prof. P.Z. Yanda*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 1: Conceptual Framework of the Millennium Ecosystem Assessment (MEA) *Prof. P.Z. Yanda*
Wednesday: July 2, 2008 ***Module 2: The Climate System: Processes, Variability and Change***	
9:00 am – 12:00 noon	Module 2.1: The Climate System and the Greenhouse Effect *Prof. P.Z. Yanda*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 2.2: Climate Change in the Past *Prof. A. Muzuka*
Thursday: July 3, 2008 ***Module 2: The Climate System: Processes, Variability and Change***	
9:00 am – 12:00 noon	Module 2.3: Climate Change Projections for the Future *Prof. A. Muzuka*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 2.3: Climate Change Projections for the Future *Prof. A. Muzuka*
Friday: July 4, 2008 ***Module 2: The Climate System: Processes, Variability and Change*** ***Module 6: Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift***	
9:00 am – 12:00 noon	Module 2.3: Climate Change Projections for the Future *Prof. A. Muzuka*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 6: Case Study Design / Presentations *Dr. E. Liwenga / Dr. J. Lyimo / Dr. R. Kangalawe*

WEEK 2: JULY 7 – 11, 2008

Monday: July 7, 2008

Module 3: Climate Change Vulnerability, Adaptation and Mitigation

9:00 am – 12:00 noon	Module 3 *Dr. Rob Marchant / Dr. R. Kangalawe*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 3 *Dr. Rob Marchant / Dr. R. Kangalawe*

Tuesday: July 8, 2008

Module 4: Ecosystems, Biodiversity and Climate Change

9:00 am – 12:00 noon	Module 4.1: Ecosystems Concepts and Processes *Dr. Rob Marchant*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.2: Ecosystems Goods and Services *Dr. H. V. Lyaruu*

Wednesday: July 9, 2008

Module 4: Ecosystems, Biodiversity and Climate Change

9:00 am – 12:00 noon	Module 4.1: Ecosystems Concepts and Processes *Dr. Rob Marchant*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.5: Biomes and Biodiversity of Africa and the Albertine Rift *Dr. H. V. Lyaruu*

Thursday: July 10, 2008

Module 4: Ecosystems, Biodiversity and Climate Change

9:00 am – 12:00 noon	Module 4.5: Biomes and Biodiversity of Africa and the Albertine Rift *Dr. H. V. Lyaruu*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.3: Mechanisms by Which Climate Change Affects Ecosystems *Dr. Rob Marchant*

Friday: July 11, 2008

Module 4: Ecosystems, Biodiversity and Climate Change
Module 6: Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift

9:00 am – 12:00 noon	Module 4.3: Mechanisms by Which Climate Change Affects Ecosystems *Dr. Rob Marchant*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 6: Case Study Design / Presentations *Dr. E. Liwenga / Dr. J. Lyimo / Dr. R. Kangalawe*

WEEK 3: JULY 14 – 18, 2008	
Monday: July 14, 2008 ***Module 4: Ecosystems, Biodiversity and Climate Change*** ***Module 5: Future impacts of Climate Change on Ecosystems and Biodiversity***	
9:00 am – 12:00 noon	Module 4.4: Climate Change Impacts on Ecosystems in the Distant and Recent Past *Dr. Elias Bizulu*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 5.1: Methods for Modeling Climate Change Impacts *Ursula Heyder*
Tuesday: July 15, 2008 ***Module 4: Ecosystems, Biodiversity and Climate Change*** ***Module 5: Future impacts of Climate Change on Ecosystems and Biodiversity***	
9:00 am – 12:00 noon	Module 5.1: Methods for Modeling Climate Change Impacts *Ursula Heyder*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.4: Climate Change Impacts on Ecosystems in the Distant and Recent Past *Dr. Elias Bizulu*
Wednesday: July 16, 2008 ***Module 5: Future impacts of Climate Change on Ecosystems and Biodiversity***	
9:00 am – 12:00 noon	Module 5.2: Methods for Social Assessment of Ecosystem Changes *Dr. C. Mung'ong'o*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 5.3: Assessment of Future Impacts of Climate Change *Prof. P. Z. Yanda*
Thursday: July 17, 2008 ***Module 5: Future Impacts of Climate Change on Ecosystems and Biodiversity***	
9:00 am – 12:00 noon	Module 5.2: Methods for Social Assessment of Ecosystem Changes *Dr. C. Mung'ong'o*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 5.3: Assessment of Future Impacts of Climate Change *Prof. P. Z. Yanda*
Friday: July 18, 2008 ***Module 6: Case Studies of Climate Change Threats to the Biodiversity of the Albertine Rift***	

9:00 am – 12:00 noon	Module 6: Case Study Design / Presentations *Dr. E. Liwenga / Dr. J. Lyimo / Dr. R. Kangalawe*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 6: Case Study Design / Presentations *Dr. E. Liwenga / Dr. J. Lyimo / Dr. R. Kangalawe*

FIELD TRIP

WEEK 4: JULY 21 – 27, 2008	
July 21	Travelling from Dar es Salaam to Arusha
July 22	Arusha National Park (Mommela Lakes and Mount Meru)
July 23	Lake Manyara National Park and the Jangwani Migratory Corridor
July 24	Tarangire National Park and Makuyuni archaeological site
July 25	Ngorongoro Conservation Area and Olduvai archaeological site
July 26 - 27	Travelling to Arusha - Dar es Salaam

COURSE 2: Biodiversity Conservation Strategies in a Changing Climate (July 28 - August 15, 2008)

WEEK 5: JULY 28 – AUGUST 1, 2008	
Monday: July 28, 2008 ***Module 1: Need for Protecting Ecosystems and Conserving Biodiversity*** ***Module 2: Current Biodiversity Conservation Strategies and Effectiveness***	
9:00 am – 12:00 noon	Module 1 *Dr. C. Nahonyo*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 2.1: Traditional Approaches to Biodiversity Conservation *Prof. S. Madoffe*
Tuesday: July 29, 2008 ***Module 1: Needs for Protecting Ecosystems and Conserving Biodiversity*** ***Module 2: Current Biodiversity Conservation Strategies and Effectiveness***	
9:00 am – 12:00 noon	Module 2.1: Traditional Approaches to Biodiversity Conservation *Prof. S. Madoffe*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 1 *Dr. C. Nahonyo*
Wednesday: July 30, 2008 ***Module 2: Current Biodiversity Conservation Strategies and Effectiveness*** ***Module 3: Extent and Status of Natural and Managed Systems in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 2.2: Effectiveness of Traditional Approaches Against Various Stressors

	Prof. S. Madoffe
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 3 *Dr. Flora Ismail*
Thursday: July 31, 2008 ***Module 3: Extent and Status of Natural and Managed Systems in the Albertine Rift Region*** ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 3 *Dr. Flora Ismail*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.1: Approaches to Designing Conservation Responses that Address Climate Risks *Dr. R. Kangalawe*
Friday: August 1, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.1: Approaches to Designing Conservation Responses that Address Climate Risks *Dr. R. Kangalawe*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.2: Designing Landscapes *Dr. H. V. Lyaruu*

WEEK 6: AUGUST 4 – 8, 2008	
Monday: August 4, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.2: Designing Landscapes *Dr. H. V. Lyaruu*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.3: Management of Protected Areas *Dr. J. Lyimo*
Tuesday: August 5, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.3: Management of Protected Areas *Dr. J. Lyimo*

12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.2: Designing Landscapes *Dr. H. V. Lyaruu*
Wednesday: August 6, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.4: Protecting Matrix Areas *Prof. P. Z. Yanda*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.5: Community Inclusive Approaches *Dr. C. Mung'ong'o*
Thursday: August 7, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.5: Community Inclusive Approaches *Dr. C. Mung'ong'o*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.4: Protecting Matrix Areas *Prof. P. Z. Yanda*
Friday: August 8, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region*** ***Module 5: Case Study: Designing Conservation Strategies for Addressing Climate Change Impacts in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.4: Protecting Matrix Areas *Prof. P. Z. Yanda*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 5: Case Study Design / Presentations *Dr. R. Kangalawe / Dr. J. Lyimo / Prof. P. Z. Yanda*

WEEK 7: AUGUST 11 – 15, 2008	
Monday: August 11, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.6: Monitoring the Effectiveness of Adaptive Strategies *Dr. H. V. Lyaruu*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.5: Community Inclusive Approaches

	Dr. C. Mung'ong'o
Tuesday: August 12, 2008 ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 4.6: Monitoring the Effectiveness of Adaptive Strategies *Dr. H. V. Lyaruu*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.5: Community Inclusive Approaches *Dr. C. Mung'ong'o*
Wednesday: August 13, 2008 ***Module 5: Case Study: Designing Conservation Strategies for Addressing Climate Change Impacts in the Albertine Rift Region*** ***Module 4: Protecting Ecosystems and Conserving Biodiversity under a Changing Climate in the Albertine Rift Region***	
9:00 am – 12:00 noon	Module 5: Case Study Design / Presentations *Dr. R. Kangalawe / Dr. J. Lyimo / Prof. P. Z. Yanda*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Module 4.6: Monitoring the Effectiveness of Adaptive Strategies *Dr. H. V. Lyaruu*
Thursday: August 14, 2008 ***Externship Guidance and Reporting***	
9:00 am – 12:00 noon	Proposal Preparation and Report Writing *Dr. J. Lyimo / Dr. E. Liwenga*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Proposal Preparation and Report Writing *Dr. J. Lyimo / Dr. E. Liwenga*
Friday: August 15, 2008 ***Externship Guidance***	
9:00 am – 12:00 noon	Externship Guidance *Dr. R. Kangalawe / Dr. J. Lyimo / Dr. E. Liwenga*
12:00 noon – 2:00 pm	Lunch Break
2:00 pm – 5:00 pm	Externship Guidance *Dr. R. Kangalawe / Dr. J. Lyimo / Dr. E. Liwenga*

APPENDIX 9 – FIELD TRIP REPORT

INTRODUCTION

A field trip component was incorporated into the program during the one-week recess between Courses 1 and 2, with the primary objective of providing participants a first hand experience of some of the stressors on and risks to ecosystems and biodiversity that were particularly addressed in course 1 curriculum. While distance, logistics of travel and resource constraints prevented visits to actual locations within the Albertine Rift, key locations of conservation significance nearer to the University of Dar es Salaam were visited. These included:

- Protected areas: The Arusha National Park, the Lake Manyara National Park and the Tarangire National Park were visted which are fall in the highest category of protected areas in Tanzania with no human land-use activities permitted within the premises. All three parks are managed by an autonomous organization called Tanzania National Parks (TANAPA). In addition the Ngorongoro Conservation Area was also visited, which is a World Heritage Site and Biosphere reserve and is a mixed-use landscape supporting multiple land-uses mainly pastoralism, conservation and tourism. The Ngorongoro Conservation Area Authority (NCAA) manages this area.
- The Jangwani migratory corridor: This is an important connective landscape for migratory animals, particularly elephants, and also supports a thriving human community and associated infrastructure and economic activities including agriculture, animal rearing, local businesses and tourism related services.
- The Olduvai and Makuyuni archeological sites: Visits to these sites served to inform participants about the role of paleo-climatic and archaeological information in contributing to our understanding of the impacts and vulnerability from current climate stressors.

The focus of the exercise was primarily on observation and understanding of the issues and challenges due to the impacts of climatic and non-climatic stressors. Due to the large number of protected areas covered over the short one-week break between Course 1 and 2 and the considerable time necessary for travel, it was not possible to accommodate more in-depth assessment activities.

The format of learning was once again interactive and participants were encouraged to pay particular attention to the specific roles of these areas from a conservation and ecosystems goods and services perspective, observed impacts of stressors, existing conservation strategies and policies and primary challenges to conservation. In doing so, participants were urged to note important similarities and differences with the situation in the Albertine rift region. Much of the information was provided by several program participants who are employed with TANAPA is various capacities and IRA faculty accompanying the group. In addition park ecologists, managers, researchers and other expert personnel were also invited to address the group on various conservation related issues where possible. Some information was also available from park brochures and other literature. A summary description of the filed trip observations is provided below.

PROTECTED AREA CHARACTERISTICS

Ecosystem types

Ecosystem types were varied across the areas visited and even within the same park area depending upon the availability of water resources and other influences such as fire and other causes of forest degradation. This was especially observed in the Lake Manyara Park where the ecosystem ranged from dense forests in the water resource rich areas (largely due to rain fed mountain streams) to acacia woodlands and savannas. This gradation was also observed to a smaller extent in Arusha National Park. The Ngorongoro Conservation area too was characterized by dense forest in the mountainous regions followed by landscape largely dominated by scrubland and grassland. While most of this observed variation is natural, in some areas degraded landscapes were also noted due to the impact of external stressors like forest fires (e.g. in Arusha) and habitat destruction. The Tarangire National Park on the other hand is mostly savanna grasslands and dry scrubland.

Many parks were characterized by the presence of water bodies i.e. the Momella lakes in Arusha, Lake Manyara, Tarangire River and the crater lake in Ngorongoro. The lakes are highly alkaline in nature, formed due to the impact of ancient volcanic activity in the region, and serve as a rich source of food for the many migratory birds. Flamingoes are an especially important migratory species noted in Lake Manyara and thrive on the phytoplankton resources in the lake. The Tarangire river is a very critical perennial water resource in the Tarangire National Park, especially serving as a lifeline for wild animals during the dry season. This makes the Tarangire National park characteristically seasonal in nature wherein animals migrate away from the park to better pastures during the wet season and return to the vicinity of the Tarangire river in the wet season.

Connective landscapes, corridors and matrix areas generally exhibited more degraded ecosystems ranging anywhere from scrubland, grassland to cleared landscapes for development due to the presence of human communities in this area and their activities.

Ecosystem goods and services

Besides fulfilling the primary task of supporting the rich diversity of wildlife, it was observed that these protected areas also provide a range of goods and services for local communities of which water resources are the most critical. The Arusha national park is an important source of water resources for the Arusha municipality and neighboring communities. Similarly Lake Manyara is an important source of water for agriculture and other activities in its six neighboring villages. Upstream water resources in the lake Manyara region are also often diverted for irrigation purposes, which impact water levels in the lake. On the other hand the Ngorongoro Conservation Area is a designated mixed use area, which allows local communities like the Masai and other tribes to live within the park boundaries and practice a range of livelihood activities such as small scale farming, animal rearing, traditional crafts, etc. Other resources provided by the parks include fuel wood, fishing resources, other forest products, grazing pastures for animals and as a source of food from the cultivation they support. Vegetation in the protected areas also serves as an important carbon dioxide sink and helps regulate the microclimate in the local area.

Besides the direct benefits from natural resources, local communities also benefit from the economic opportunities emanating from the tremendous tourist interest in the protected areas. Economic developments in the area has been significant in the recent years primarily resulting from tourist lodging and other amenities, safari tours, small businesses catering to tourist interests, and related activities. Besides tourism, phosphate mining is an activity that has brought about significant development in the Lake Manyara region. The large number of buried fossils in the area resulting from ancient tectonic activity serves as an important source of phosphate for the mine, which was established before the designation of the park as a protected area.

Stakeholders

The local communities that depend upon local resources for livelihoods are clearly among the most important stakeholders. This includes the Masai and the other tribes that practice a relatively more sustenance based lifestyle as well as communities that thrive off the economic opportunities afforded by tourism, industry and other development activities. A specialized group of stakeholders that work directly for the protection of the park resources include the park managers, ecologists, rangers, researchers and other personnel. Other local government officials, civil servants and policy makers are also a part of the stakeholder pool. Finally the tourists themselves are a very important stakeholder group.

Protected area governance

Current policies and strategies used to manage the protected areas are largely a mix of approaches that include:

- Law enforcement: This is the traditional approach and relates to the enforcement of government laws and rules and regulations pertaining to the particular conservation area with a range of penalties for law breakers
- Engagement of local communities: This is a relatively new approach that seeks to engage local community participation in conservation and enables the sharing of benefits using different schemes and approaches. For example community conservation outreach programs in Tanzania provide a range of social services are provided such as schools, health centres, provision of water etc. Similarly TANAPA also provides services through Community Conservation Services (CCS) program and Benefit-Sharing scheme-SCIP program to support local projects.
- Environmental and wildlife resources monitoring: This include monitoring trends in wildlife population and health, status of migratory corridors, vegetation dynamics, weather, water quality, etc. and activities such as regular road transects, animal censuses, early burning and fire break making for fire management, various research activities and environmental impacts assessments.
- Establishment of Wildlife Management Areas: To serve as corridors to facilitate animal movements.
- Community outreach programs: to raise awareness about conservation and provide conservation and environmental education to various social groups, particularly those living in the periphery of protected areas
- Land-use guidelines: Advocating and facilitating sustainable land use development in surrounding communities
- Relocation and rehabilitation of communities: This is sometimes necessary for areas that are deemed to be of critical conservation importance. For example the Ngorongoro Conservation Area Authority (NCAA) plans to relocate staff housing outside the area and the Maasai that reside within the area are also being encouraged to move out to reduce human pressures on natural resources. The management has already acquired land outside the park to facilitate this process although there is some resistance to the effort from local communities particularly the Maasai.

ROLE OF STRESSORS

Climatic stressors

A particular effort was made to focus on climatic and non-climatic stressors in the visited conservation areas and note changes in the ecosystems. On the part of park personnel, there is currently no directed effort to identify climatic stressors although severe weather events are noted since they can result in forest degradation and impact resource availability for wild animals as well as surrounding communities. However there is currently no institutional knowledge of any longer term climatic trends. The El Nino/La Nina event of 1997/98 is particularly recorded as a major climatic phenomenon that brought severe rainfall and flooding in the Lake Manyara. During this event the lake and a good portion of the surrounding landscape was flooded resulting in several flamingo deaths. The entire population of flamingoes completely disappeared from the area for a few years following the event, only to return in the early 2000s. The exact cause of the flamingo disappearance has not been investigated although it is possible that the flooding diluted plankton food resources in the lake water. This El Nino event also killed many acacia trees, which are arid climate vegetation and are an important source of food for elephants.

On the other hand extreme drought results in a lack of water resources for wildlife and lower water levels in lakes and other waster bodies also affect the availability of food resource like planktons and fish. For example decreasing water resources in Lake Manyara can be partly attributed to prolonged drought and/or reduced rainfall and impact the Flamingo populations that depend on its resources.

In the Tarangire National Park, there is regular monitoring of weather variables such as temperature and rainfall with databases maintained at the park monitoring center. However this information has not been used to establish any linkages with long-term drought and rainfall patterns in the area. The only observation of the park personnel is that a severe rainfall period occurs approximately every decade. Overall fluctuation in rainfall over the last decade was observed to be very small.

Non-climatic stressors

Non-climatic stressors stem largely from the growing human populations in the area and related activities. Population has been steadily increasing in the previously sparsely inhabited regions where the protected areas are now located with a resulting increase in the demand for natural resources. Besides the original inhabitants of the area, the growing tourist interest is one of the most important factors responsible for rapid business development and infrastructure growth and driving a significant population increase. The carrying capacity of the parks in terms of the increasing number of tourists visiting per day is becoming an important concern. This was particularly noted by the Lake Manyara park personnel, who informed that despite the existence of several park regulations pertaining to tourists, they are often not strictly followed. For example there is a specific limitation to the number of tourist vehicles that may be in the park at a given point of time but this regulation is largely ignored in the interest of maximizing revenues.

Besides tourism, other businesses that may precede the declaration of the area as protected and may now pose a threat to the biodiversity. For example, the Minjingu phosphate mine near Lake Manyara precedes the National Park and the impacts of pollutants from the mine on the park lands and water resources are a now cause of concern, that are yet to be investigated. This industry has been an added factor in spurring development in the region and encouraging population growth.

The construction of paved roads cater to the increasing development has also resulted in increasing vehicular traffic in these areas and presents challenges to conservation. In the Arusha National park for example, there now exists a public access road that goes through sections of the

park and connects settlements. In the Lake Manyara region, road kills from the vehicular traffic are common, especially when animals stray out of the park boundaries in search of food and water resources during times of scarcity.

Group discussions and inputs from park management and researchers resulted in the identification of some of the key impacts of non-climatic stressors on these ecologically important regions that result in resource competition between human and natural systems. These are briefly discussed below.

Forest degradation

Forest degradation in protected areas in Tanzania stems largely from non-climatic issues such as intensive fuel wood gathering and forest fires and results in increased soil erosion, reduced water holding capacity of the ground and encourages invasive species. Fuel wood gathering is a common activity for communities that live within and/or outside the protected area boundaries. This is particularly true of the more densely forested park areas, which serve as a good source of fuel wood for local communities. In the Lake Manyara National Park, forest degradation due to intensive fuel wood collection and land cultivation on the fringes of the park has created problems of soil erosion and siltation in the lake.

Forest fire was particularly reported to be a problem by Arusha, Lake Manyara and Tarangire National Park personnel and areas of degraded forest stemming from the impacts of forest fires were noted within these parks. Park personnel reported that the close proximity of the park with the surrounding community villages is an issue and the origins of most fire incidents could usually be traced back to these communities. Forest fires tend to modify the vegetation composition and structure, render habitats inhospitable for wildlife, kill small mammals and young wildlife and encourage encroachment by invasive species. To remedy this problem the Lake Manyara Park management has recently instituted a program to educate local communities about wildfires and have made the availability of forest resources to local communities conditional to their following certain fire safety rules. This program appears to be successful in diminishing the occurrence of fires and over the past two years no wildfires have been reported. Controlled burning techniques to prevent forest fire occurrences were also practiced by personnel in the Tarangire National Park.

Among the other factors, logging was not reported to be any major issue in any of the parks visited, although the problem does persist to some extent. Some protection to particular species of trees comes from the scared status attributed to them by local communities. Invasive alien species were also not considered to be a significant problem in the parks visited. Exotic species such as *Solanum incunum* and *Osumum suave*, that may be indicators of disturbed areas or may be brought in by the importation of various materials into the park, have been observed but invasiveness was not reported to be an issue. In the Tarangire Park, the seasonal nature (describe above) of the park was considered to discourage the establishment of alien species. Charcoal burning activity was also reported to contribute to forest destruction in the Tarangire National Park area. In the Ngorongoro conservation area, the growing farmland sizes of the Maasai do have impacts from the clearing of forest for cultivation and has raised concern among park managers as discussed above. The growing cattle herds of the Maasai here also create a competition for grazing resources with the wild animals besides exposing large tracts of soil to evaporative stress.

Water resource degradation and depletion

Local communities also depend on the protected areas for water resources for their consumption, agriculture and other activities where sources of water are available. For example in the Arusha National Park, water from the park's lakes is legally provided to the local communities. It is important to note that right on the fringes of the larger Momella Lake in Arusha and directly adjoining the park boundary exists a local communities that engages in agriculture in this area. The lack of any buffer zone between the community and the park boundary poses a potential threat to the water quality of the larger Momella lake from agricultural run-off although any formal studies have not been conducted to examine this and therefore there is no documented evidence. This lake is an important wildlife habitat particularly for a large population of flamingoes and any impact on water quality could in turn affect the wildlife here.

Similarly Lake Manyara is also an important source of water for irrigation, among other uses, for the surrounding communities, although in this case there does exist a distinct buffer zone between the park boundary and community lands. In this region, upstream river water is often directed for community agriculture and this tends to impact water levels in the lake. This lake is also particularly affected by siltation due to erosion and this has resulted in the creation of a marshland in the area near the lake. Siltation also causes reduced water levels, changes in water chemistry and results in the appearance of unwanted vegetation. This has important negative impacts on the availability of food and water resources for wildlife, particularly flamingoes. The management currently supports villages land use plans to ensure sustainable use of the resources and particular plant species that can help reduce erosion are also being planted though the success rate is unknown. Phytoplankton blooms in the lake, which kill Pelicans, are also a problem, although the their source has not been traced

The Ngorongoro conservation area is an important multiple use area and its water resources fulfill the needs of the Maasai and other communities that inhabit it. In the Tarangire ecosystem, growing agricultural activities outside the park depend on water resources in the Tarangire river catchment area to various extents. This reduces river flow and decreases the availability of water for wildlife. Erosion in the area also adds to the silt load of the river. In other conservation areas, hippo pools have also been wiped out due to siltation, greatly affecting their survival in summer months.

Other impacts on wildlife

The competition between humans and wildlife for scare natural resources is the primary factor that negatively impacts wildlife populations. Some of these such as forest degradation, impacts on water resource quality and quantity and the increasing development in the area have been discussed above. In addition illegal activities such as poaching are an important factor that decimate animal numbers. Park personnel in Arusha, Lake Manyara and Tarangire National Parks reported poaching as a major issue that must be addressed on a frequent basis. Some park managers also raised concerns with the legal hunting of animals in the game reserves since the improper allocation of hunting quotas often leads to uncontrolled licensed hunting. In situations where game reserves adjoin protected areas, for example in Tarangire, it is very difficult to account for animals that may stray into the game reserves from the protected areas and get killed. In the Lake Manyara National park, the hunting of elephants for ivory greatly reduced their numbers in the 1970s but since this activity was legally banned in the 1980s the area has subsequently seen an improvement in the elephant population. Poaching was not reported to be as much of an issue in the Ngorongoro Conservation area, which follows a multiple use policy allowing local communities of Maasai and other tribes to reside within the area and use its resources. The tribes here are mainly pastoralists and typically do not consume wild meat and

therefore do not pose a direct threat to the park animals. On the contrary the Maasai in the Tarangire National Park are known to hunt lions.

The impacts of stressors on connective landscapes

Many of the stressors described above also play out over the connective landscapes between protected areas, which serve as important migratory routes for the wild animals in search of food and water. Although protected area boundaries are legally designated, wildlife typically cannot be constrained by boundaries drawn on the map and must move in search of resources when necessary. The protected areas visited in Tanzania over the course of this field trip are all interconnected by means of important migratory corridors. For example, animals such as elephants and wildebeest are typically migratory and require extensive tracts of connective landscapes for their movements, far greater than the boundaries of any designated protected area. In the case of the Tarangire National Park, changes in the availability of food and water resources necessitates the movement of animals towards and away from the river in the dry and wet seasons respectively. Elephants from the Tarangire National Park typically migrate towards the Lake Manyara National Park in search of resources. Elephants from Lake Manyara also migrate to the Marang Forest Reserve on the other side since they favor it as a breeding ground.

Human communities often populate unprotected corridor areas linking protected areas. Increasing population and development brings with it the clearing of forests for building and infrastructure and results in the defragmentation of the landscape and disruption of migratory corridors. This often raises issues of competition between humans, their domestic animals and the migrating wildlife, some of which have been noted in the discussion above. For instance the potential impacts of community agriculture and animal rearing directly bordering the larger Momella lake outside the Arusha National park is a prime example from the areas visited. Similarly the demands on water resources from the catchment areas of the Tarangire river and the impact on river flow; the potential impacts of the phosphate mine outside Lake Manyara; forest fires originating from human communities bordering the park; and the decimation of migratory animals in road kills due to increasing vehicular traffic are other important examples that have been previously discussed.

During the field visit, a special effort was made to visit one important migratory corridor, the Jangwani corridor, which connects the Lake Manyara Park with the Tarangire National Park via a mixed use area known as the Manyara Ranch. Particular attention was paid to noting the different stressors in the corridor that could potentially disrupt animal migration between resource rich areas. A significant community settlement was observed in the Jangwani corridor, practicing agriculture, animal rearing and tourism related businesses as sources of livelihoods. Patches of maize cultivation were noted, as were several groups of cattle grazing not far from a group of zebra and wildebeest on the outer fringes of the park. Such close encounters between domestic animals and wild life also raise concerns about the cross transmission of diseases and in the past outbreaks of anthrax among wild animals, particularly impalas, have been directly linked to cattle from human communities. A relatively new tourist hotel was also observed and this is apparently enabled by a local land-use laws that allow for such commercial activities in areas identified as corridors. Clearly, there exists a conflict between policies and laws that govern protected areas and land-use. Economic incentives offered by such tourism related ventures are important considerations in community decision-making and take precedence over conservation.

DRAWING LINKAGES WITH THE ALBERTINE RIFT REGION

In carrying out this field visit activity the main emphasis remained on enabling participants to gains a first hand understanding of issues and challenges for biodiversity conservation, particularly since many of these topics had been covered in theory in the recently concluded Course 1 of the program. It was clear from the interactive discussions that the participants identified several commonalities between the stressors noted for the field areas visited and conservation areas in the Albertine Rift. Some of the key common stressors include:

- Climatic changes such as temperature increases and related loss of ice cover in higher elevations
- Extreme weather phenomena such as droughts and floods
- Wildfire
- Disease
- Invasive alien species
- Population increases
- Poor agricultural practices
- Habitat fragmentation
- Encroachment and uncontrolled resource extraction
- Poaching
- Shortage of trained conservation professionals

Some of the suggested strategies and approaches to addressing the impacts of such climatic and non-climatic stressors that came out of group discussions over the course of the field trip include:

- Awareness building among conservation professionals, policy and decision makers and local communities
- Developing conservation plans that are customized to the unique situation and requirements of each specific protected area
- Participatory involvement of local communities in conservation efforts and benefits sharing opportunities to provide them a sense of ownership
- Discouraging immigration to communities adjacent to protected areas to reduce pressures on scarce resources
- Seeking strategies to prevent encroachment of wildlife corridors
- Inviting conservation experts to provide advice on any plans of new economic development in protected area localities
- Imparting protected area status to additional biodiversity rich areas to serve as a migratory refuge for species
- Additional data and research on past and current climate and other critical parameters in the region is necessary to clearly assess threats
- Forecasting techniques and early warning systems, particularly for extreme weather events must be developed
- Existing capacity of conservation professionals to address climatic and non-climatic threats must be assessed and enhanced
- Regional collaboration to integrate strategies in Albertine Rift countries is important

Participants were encouraged to apply the experience from the field trip along with the knowledge from course modules to seeking solutions in executing their next set of case study designs for the education program and more so for implementing their externship research projects. In their feedback, a majority of participants reported the field trip as an effective exercise and recommended building this into a larger and essential component of the program to allow for a practical understanding of the different conservation related challenges.

APPENDIX 10 – SAMPLE COURSE EVALUATION FORM

INSTITUTE OF RESOURCE ASSESSMENT,
UNIVERSITY OF DAR ES SALAAM

Education Program on Climate Change and Biodiversity Conservation

PARTICIPANT EVALUATION

SECTION 1

Pick an appropriate response to each question from the list of options

1. The training program achieved its objectives of equipping me with climate related knowledge and skills that are applicable to my/my institution's ongoing work on biodiversity conservation.

   ☐ Strongly agree
   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree
   ☐ Strongly disagree

   Any additional remarks:

2. I expect to incorporate the knowledge and skills gained in my/my institution's ongoing work on biodiversity conservation.

   ☐ Strongly agree
   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree
   ☐ Strongly disagree

   Any additional remarks:

3. The training program will benefit my future career goals.

   ☐ Strongly agree
   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree
   ☐ Strongly disagree

   Any additional remarks:

4. The content of the training program was useful and relevant.

   ☐ Strongly agree

☐ Agree
☐ Mixed opinions
☐ Disagree
☐ Strongly disagree

Any additional remarks:

5. The program instructors managed to effectively communicate the subject matter of the courses.

☐ Strongly agree
☐ Agree
☐ Mixed opinions
☐ Disagree
☐ Strongly disagree

Any additional remarks:

6. The program challenged me to think in new ways.

☐ Strongly agree
☐ Agree
☐ Mixed opinions
☐ Disagree
☐ Strongly disagree

Any additional remarks:

SECTION 2

Rate the following on a scale of 1 – 5

7. Program organization (1 = very poor; 5 = very good)

☐1 ☐2 ☐3 ☐4 ☐5

8. Program format (1 = very poor; 5 = very good)

☐1 ☐2 ☐3 ☐4 ☐5

9. Duration of the program (1 = too short; 5 = too long)

☐1 ☐2 ☐3 ☐4 ☐5

10. Faculty expertise and capability (1 = very poor; 5 = very good)

☐1 ☐2 ☐3 ☐4 ☐5

11. Composition of the participant group (i.e. by country, gender, age, etc.) (1 = very unbalanced; 5 = very well balanced)

☐1 ☐2 ☐3 ☐4 ☐5

Any additional remarks:

SECTION 3

Rate the following on a scale of 1 – 5

12. Level of the course material (1 = too simple; 5 = too difficult)

    Course 1: ☐1 ☐2 ☐3 ☐4 ☐5
    Course 2: ☐1 ☐2 ☐3 ☐4 ☐5

13. Scope of the course material (1 = too broad; 5 = too narrow)

    Course 1: ☐1 ☐2 ☐3 ☐4 ☐5
    Course 2: ☐1 ☐2 ☐3 ☐4 ☐5

14. Relevance of the course material (1 = irrelevant; 5 = relevant)

    Course 1: ☐1 ☐2 ☐3 ☐4 ☐5
    Course 2: ☐1 ☐2 ☐3 ☐4 ☐5

15. Effectiveness of the course materials (1 = ineffective; 5 = very effective)

    Course 1: ☐1 ☐2 ☐3 ☐4 ☐5
    Course 2: ☐1 ☐2 ☐3 ☐4 ☐5

Any additional remarks:

SECTION 4

Rate the following on a scale of 1 – 5 (1 = ineffective; 5 = very effective)

16. Lectures

    ☐1 ☐2 ☐3 ☐4 ☐5

17. Group discussions

    ☐1 ☐2 ☐3 ☐4 ☐5

18. Seminar sessions

    ☐1 ☐2 ☐3 ☐4 ☐5

19. Training in methods and modelling exercises

☐1 ☐2 ☐3 ☐4 ☐5

20. Case study exercises

☐1 ☐2 ☐3 ☐4 ☐5

21. Report writing exercises

☐1 ☐2 ☐3 ☐4 ☐5

22. Externship proposal development exercises

☐1 ☐2 ☐3 ☐4 ☐5

23. Quality of guidance received for seminar presentations/case study design/report writing/externship proposal development

☐1 ☐2 ☐3 ☐4 ☐5

24. Effectiveness of the field excursion in terms of its relevance to the program objectives

☐1 ☐2 ☐3 ☐4 ☐5

25. Management of the field excursion

☐1 ☐2 ☐3 ☐4 ☐5

Any additional remarks:

SECTION 5

Pick an appropriate response or answer briefly

26. What is your overall assessment of this training programme?

☐ Excellent
☐ Good
☐ Average
☐ Bad

Any additional remarks:

27. What were the major strengths?

28. What were the major weaknesses?

29. If this training were to be repeated in future what would be your suggested improvements?

30. Do you think that you will maintain contact professionally with any of the participants or faculty you met at the program?

31. Would you recommend this training to someone else?

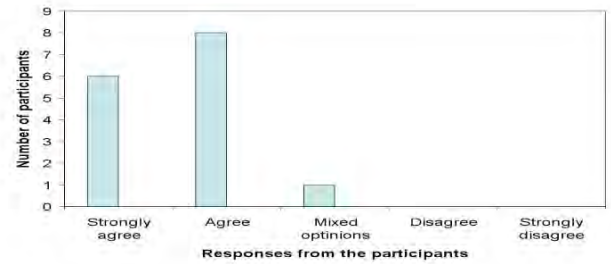
32. Any other comments?

Thank you very much for your cooperation

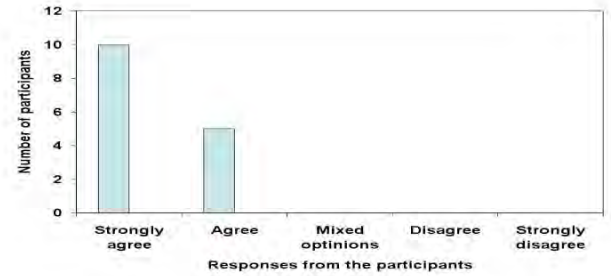
APPENDIX 11 – ANALYSIS OF PARTICIPANT COURSE EVALUATIONS

SECTION 1

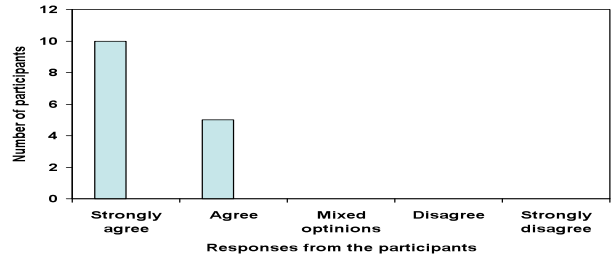
1. The training program achieved its objectives of equipping me with climate related knowledge and skills that are applicable to my/my institution's ongoing work on biodiversity conservation.



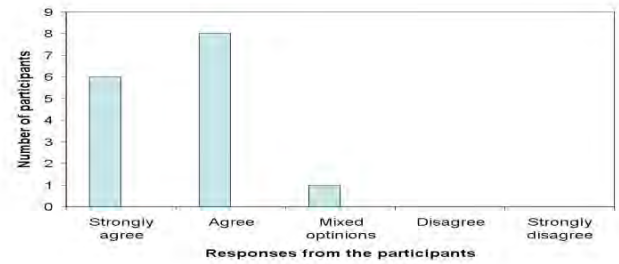
2. I expect to incorporate the knowledge and skills gained in my/my institution's ongoing work on biodiversity conservation.



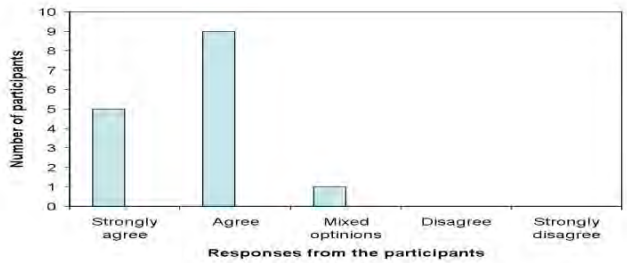
3. The training program will benefit my future career goals



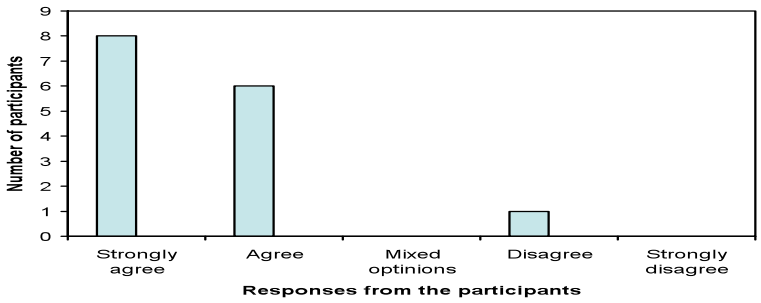
4. The content of the training program was useful and relevant



5. The program instructors managed to effectively communicate the subject matter of the courses

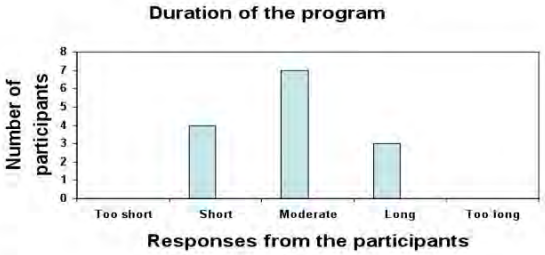


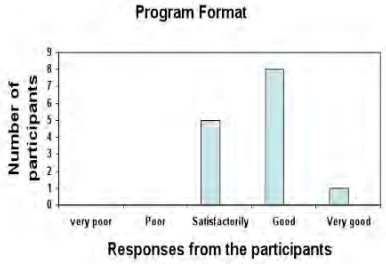
6. The program challenged me to think in new ways

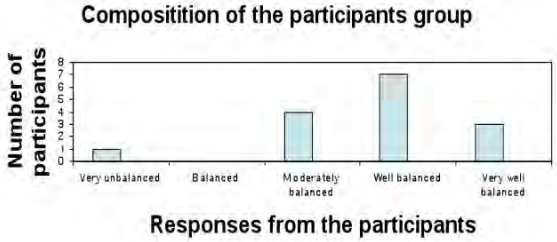


SECTION 2

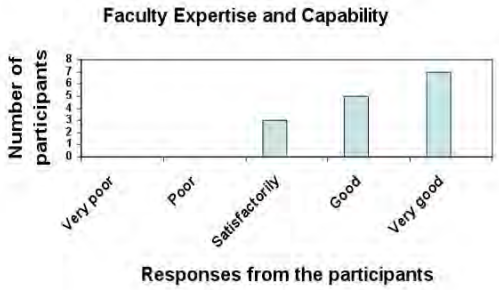
7. Program organization, duration, format and participant group composition

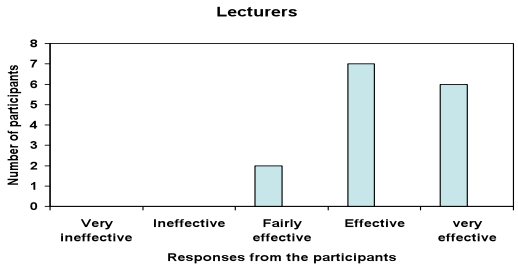






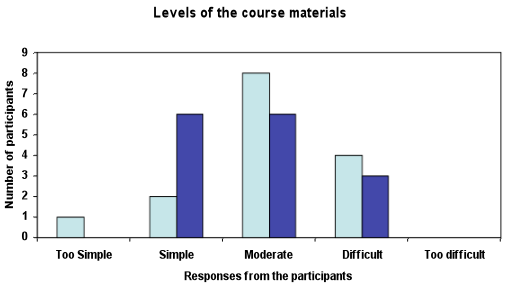
8. Faculty expertise capability and lecture quality

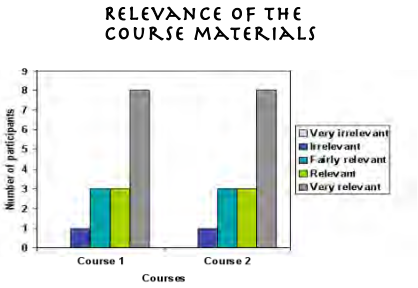


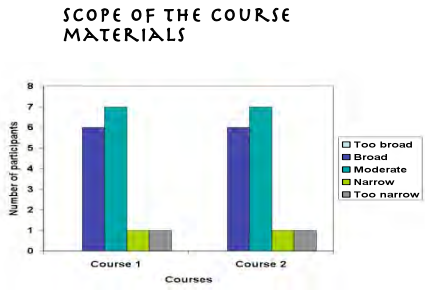


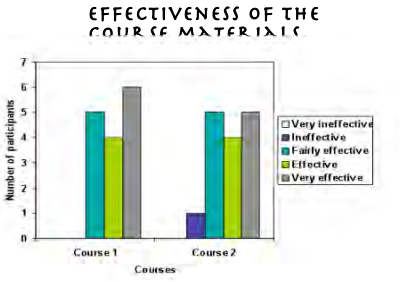
SECTION 3

9. Level, scope, relevance and effectiveness of course material



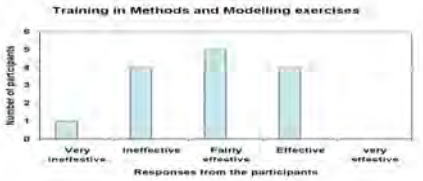


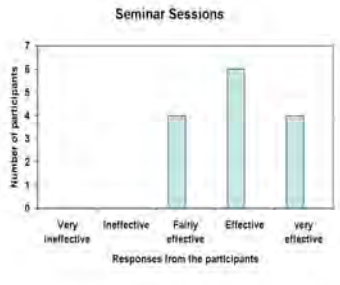


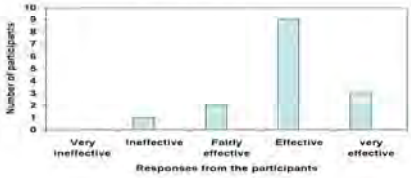


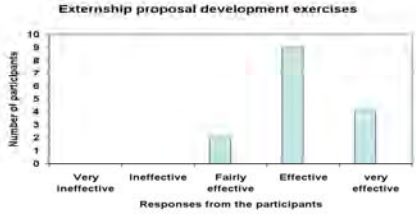
SECTION 4

10. Effectiveness of program components

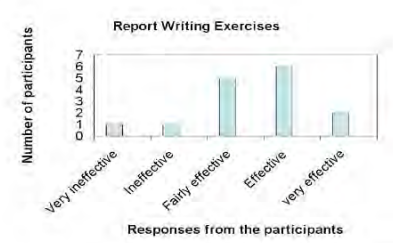


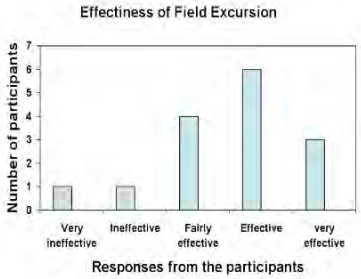


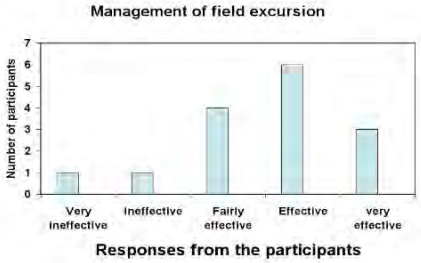




11. Effectiveness of program supervision and guidance

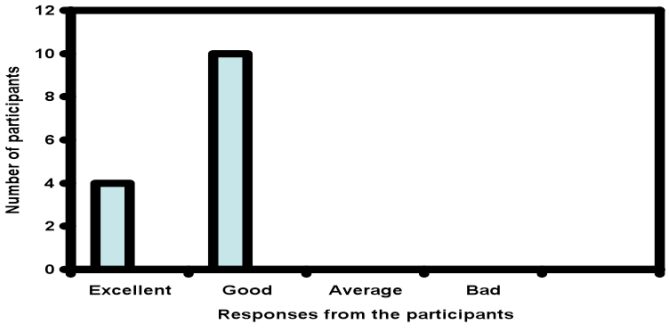






SECTION 5

12. Overall assessment of the training program



13. Major strengths of the program

- Unique nature of the program due to the linkage between climate change and biodiversity conservation issues
- Diversified team of participants with different stakes in conservation
- Diverse faculty group

- Well managed with approachable and friendly organizers
- Competence and expertise of the course instructors
- Participatory nature of teaching methods
- Participants opinions always taken on board and wherever possible, considered
- Cooperation among participants

14. Major weaknesses of the program

- The time for the program was too short for the participants to fully absorb the concepts, which were new to many
- Some logistical arrangements were inadequate (e.g. organization of local transport and fares back to participants home countries)

15. Suggestions for improvements in future

- Organization of internal transport to facilitate participants' commute to and from the hotel to the campus
- Longer field excursions, since more time in the field is useful for practical knowledge of different conservation-climate change-related issues.
- Need for additional modules on GIS, Meteorology, hydrology and climatology
- Longer time necessary for methods related modules such as modeling and GIS. More modeling software must be made available
- Longer length of the program (at least 3 months)
- Additional training facilities such as larger number of computers and better internet facilities for students
- Additional support for reaching a larger group of African conservators. The majority are unable to afford the travel from their home countries for such courses.
- Francophone and Anglophone groups should preferably be separated. Some participants in the Francophone group experienced issues at times with the English instructions
- It is important to maintain similar participant backgrounds in future programs too as in this one.

16. Future communication and networking among participants

- Maintaining contact by email is important, including for the purpose of data sharing.

17. Willingness to recommend the program to others

- Highly recommended, particularly for conservation professionals working in the field (e.g. wildlife managers, ecologists, foresters, other environmental or natural resources conservation professionals)

18. Additional comments

- Need for a follow-up meeting for this first group of the trainees
- Need for collaborative trans-boundary projects; development of new projects
- Establishment of a network of program participants, experts, faculty and organizers.
- In organizing a similar course in future, policy makers and other conservation experts from other Albertine Rift countries could be invited to share their experience with program participants at the end of the course (for example in a capacity-building workshop)

APPENDIX 12 – SAMPLE EXTERNSHIP EVALUATION FORMS

1. PARTICIPANT EVALUATION

INSTITUTE OF RESOURCE ASSESSMENT,
UNIVERSITY OF DAR ES SALAAM

Education Program on Climate Change and Biodiversity Conservation

SECTION 1: Participant and externship information

1. Participant contact information (Optional)

   Last name: _____

   First name / other names: _____

   Address: _____
   (Line 1: Name of the institution, if applicable)

   _____
   (Address line 2)

   _____
   (Address line 3)

   City: _____ State/Province: _____

   Postal code: _____ Country: _____

   Telephone: _____
   (Please include country and city codes)

   Email address: _____

2. Title of your externship project: _____
3. Name and contact information of your externship supervisor: _____
4. When did you execute the externship project and what was the duration? _____
5. When did you submit the report of your externship project? _____
6. Please provide a brief description of your externship research and key findings: _____

SECTION 2: Participant's experience

Pick an appropriate response for each question from the list of options

7. The externship provided a good overall learning experience (agree – disagree)

   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree

   Additional comments on your experience: _____

8. The training received during coursework was directly applicable to carrying out proposed externship research

   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree

   Additional comments / suggestions for enhancing the coursework in future to increase its usefulness to the externship research: _____

9. The knowledge and skills gained during the externship will supplement classroom education and benefit your ongoing work on biodiversity conservation

   ☐ Agree
   ☐ Mixed opinions
   ☐ Disagree

   Additional comments: _____

10. The duration of the externship was sufficient for accomplishing the proposed research

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    Additional comments: _____

11. The level of supervision was appropriate and the supervisor effectively assisted you in addressing your questions, concerns and difficulties in a timely manner

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    Additional comments: _____

12. The supervisor provided timely and appropriate feedback on progress reports

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    Additional comments: _____

13. You received timely and adequate assistance from IRA/PASS when requested, including timely and appropriate feedback on progress reports you submitted

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    Additional comments: _____

14. Communication arrangements with your host institution and IRA/PASS were appropriate

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    Additional comments: _____

SECTION 3: Grant management

Rate your satisfaction with the following on a scale of 1-5 (1 = highly unsatisfied, 5 = highly satisfied)

15. Overall grant management

    ☐1 ☐2 ☐3 ☐4 ☐5

16. Grant amount

    ☐1 ☐2 ☐3 ☐4 ☐5

17. Reporting schedule

    ☐1 ☐2 ☐3 ☐4 ☐5

18. Payment schedule

    ☐1 ☐2 ☐3 ☐4 ☐5

19. Payment method

    ☐1 ☐2 ☐3 ☐4 ☐5

20. Transparency in managing funds and disbursement

    ☐1 ☐2 ☐3 ☐4 ☐5

21. Reimbursement procedure (case by case basis subject to request for funding to monitor grantees)

    ☐1 ☐2 ☐3 ☐4 ☐5

22. Termination and recovery of funds

    ☐1 ☐2 ☐3 ☐4 ☐5

Any additional remarks on grant management: _____

SECTION 4: Project impact

Pick an appropriate response for each question

23. Will outputs from your externship research have an impact on field applications of biodiversity conservation and / or conservation policy in your region?

    ☐Yes ☐No

    If you selected yes, please explain in what way: _____

24. Will outputs from your externship research have a direct or indirect impact on public mobilization or awareness about biodiversity conservation and climate change?

    ☐Yes ☐No

    If you selected yes, please explain in what way: _____

25. Did your externship project generate linkages with other institutions and researchers (besides IRA)

    ☐Yes ☐No

    If you selected yes, please explain in what way: _____

SECTION 5: Future plans

Pick an appropriate response for each question

26. Have you planned any follow-up work to your externship research?

    ☐Yes ☐No

    If yes, please describe the planned work and its relevance to biodiversity conservation and climate change: _____

27. If you selected yes to the question in 26 above, will you require any support, financial or otherwise, for conducting this activity?

    ☐Yes ☐No

    If yes, please describe the nature of support and your plans to acquire it: _____

SECTION 6: Lessons learnt and way forward

28. In your opinion what were the main strengths of the externship program? _____
29. In your opinion what were the main weaknesses of the externship program? _____
30. What suggestions do you have to offer for improving the externship program in future? _____
31. Would you be available and willing to become a part of a regional network of practitioners in climate change and biodiversity conservation? _____
32. Would you be interested in participating in and contributing to future efforts on assessments of ecosystem goods and services? _____
    If yes, what additional training do you think you might require? _____

Thank you for you cooperation!

2. SUPERVISOR EVALUATION

INSTITUTE OF RESOURCE ASSESSMENT,
UNIVERSITY OF DAR ES SALAAM

Education Program on Climate Change and Biodiversity Conservation

SECTION 1

1. Supervisor contact information

   Last name: _____

   First name / other names: _____

   Address: _____
   (Line 1: Name of the institution, if applicable)

   _____
   (Address line 2)

   _____
   (Address line 3)

   City: _____ State/Province: _____

Postal code: _____ Country: _____

Telephone: _____
(Please include country and city codes)

Email address: _____

33. Name of participant supervised: _____

34. Externship project supervised: _____

35. Externship project location: _____

36. Duration of externship supervision? _____

SECTION 2: Rate the participant and his/her externship research using the following criteria on a scale of 1-5 (1 = Poor; 5 = Excellent)

37. Overall externship performance

☐1 ☐2 ☐3 ☐4 ☐5

38. Technical competence in executing the externship

☐1 ☐2 ☐3 ☐4 ☐5

39. Quality of work

☐1 ☐2 ☐3 ☐4 ☐5

40. Attitude towards learning new skills

☐1 ☐2 ☐3 ☐4 ☐5

41. Organizational skills

☐1 ☐2 ☐3 ☐4 ☐5

42. Reporting punctuality

☐1 ☐2 ☐3 ☐4 ☐5

43. Communication with supervisor(s)

☐1 ☐2 ☐3 ☐4 ☐

44. Quality of reports

☐1 ☐2 ☐3 ☐4 ☐5

45. Value of the externship research to your institution (i.e. host institution)

☐1 ☐2 ☐3 ☐4 ☐5

Additional comments: _____

SECTION 3: Pick an appropriate response for each question from the list of options

46. The participant displayed adequate background knowledge of the proposed subject

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

47. The participant displayed adequate background knowledge of the activities and methodology required for proposed project

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

48. The participant was effectively able to apply such knowledge in executing the proposed project

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

49. The participant displayed a capacity to work independently with minimum supervision

☐ Agree
☐ Mixed opinions
☐ Disagree

If you selected “mixed opinions” or “disagree”, please describe the extent of your supervision required: _____

50. The participant was effectively able to take into consideration the impact of climate variability and change on biodiversity conservation in his/her externship research

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

51. The participant was effectively able to take into consideration the impact of non-climatic stressors arising out of natural and human influences on biodiversity conservation in his/her externship research

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

52. The participants research project accounted for the role of various stakeholders and their influence on conservation outcomes

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

53. Outputs from the participant's research project have the potential to inform and influence biodiversity conservation practices under the influence of climatic and non-climatic stressors in your region

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

54. The findings from the participant's research project have the potential to influence policy related to biodiversity conservation in your region

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

55. The participant's research project generated linkages with other institutions and individuals working on biodiversity conservation in your region

☐ Agree
☐ Mixed opinions
☐ Disagree

Additional comments: _____

56. The participant displayed a continued interest in remaining involved with initiatives aimed at conserving biodiversity under a changing climate

    ☐ Agree
    ☐ Mixed opinions
    ☐ Disagree

    If you selected “mixed opinions” or “disagree”, please describe the potential shortcomings of the program in initiating participant interest and how these might be addressed in future: _____

SECTION 4: Please provide brief responses to the following

57. Strengths of the externship program: _____

58. Weaknesses of the externship program: _____

59. Suggestions for improvements to the program: _____

Thank you for you cooperation!

APPENDIX 13 – ANALYSIS OF EXTERNSHIP EVALUATIONS

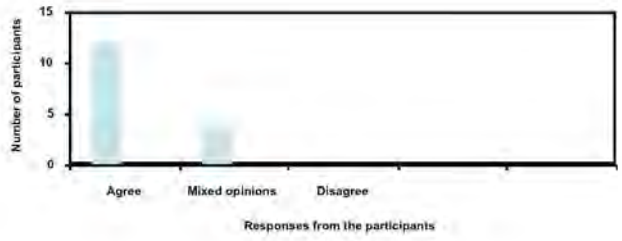
A. Participant Evaluations

SECTION 1: Participant's experience

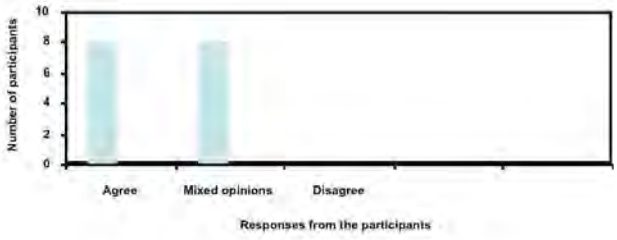
Questions 1 – 6 were related to logistical details such as participant information and externship title, supervisor, etc. See Appendix 6 for this information.

SECTION 2

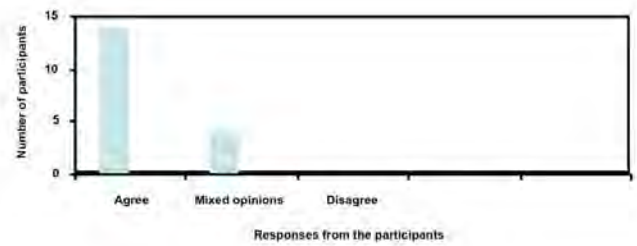
1. The externship provided a good overall learning experience



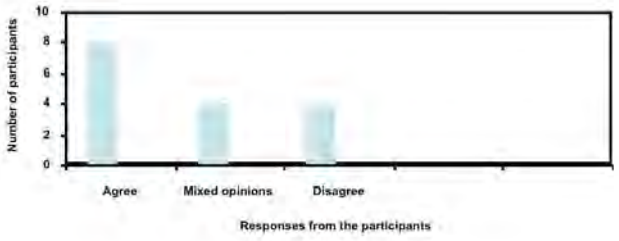
2. The training received during coursework was directly applicable to carrying out proposed externship research



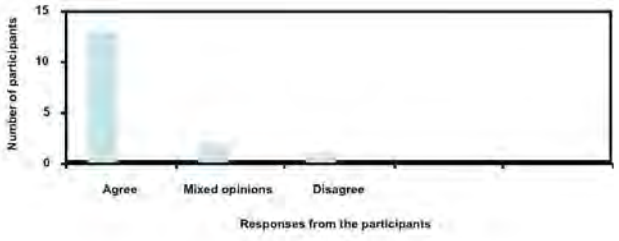
3. The knowledge and skills gained during the externship will supplement classroom education and benefit your ongoing work on biodiversity conservation



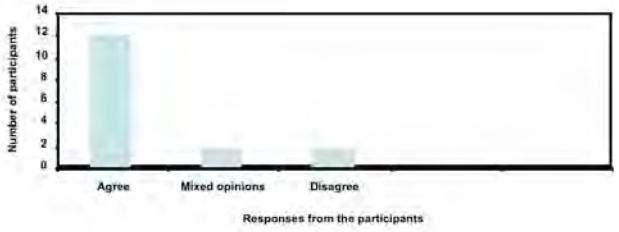
4. The duration of the externship was sufficient for accomplishing the proposed research



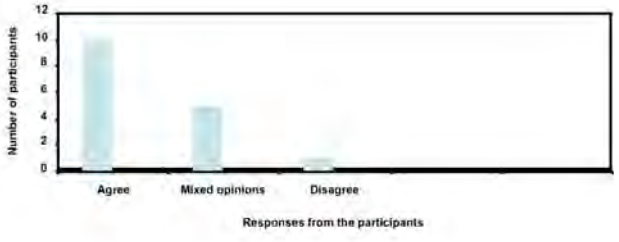
5. The level of supervision was appropriate and the supervisor effectively assisted you in addressing your questions, concerns and difficulties in a timely manner



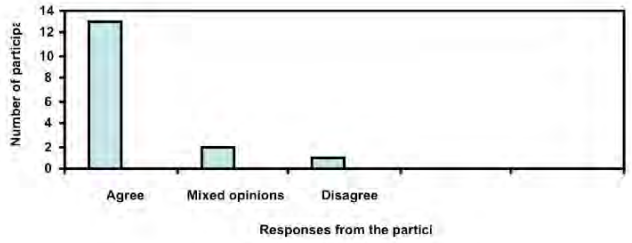
6. The supervisor provided timely and appropriate feedback on progress reports



7. You received timely and adequate assistance from IRA/PASS when requested, including timely and appropriate feedback on progress reports you submitted

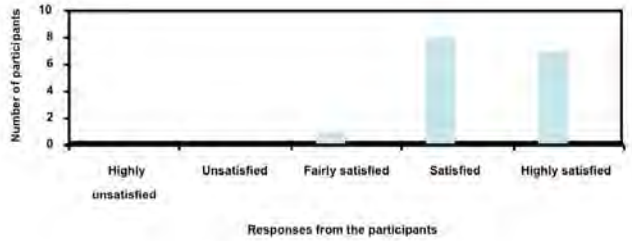


8. Communication arrangements with your host institution and IRA/PASS were appropriate

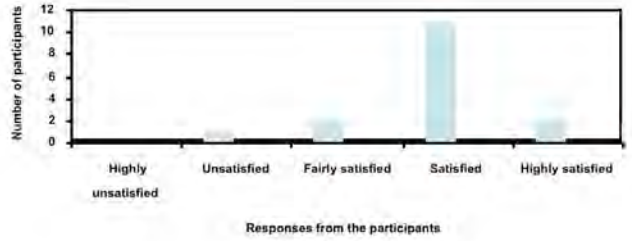


SECTION 3: Grant Management

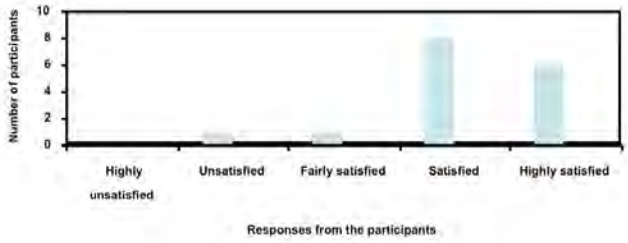
9. Overall grant management



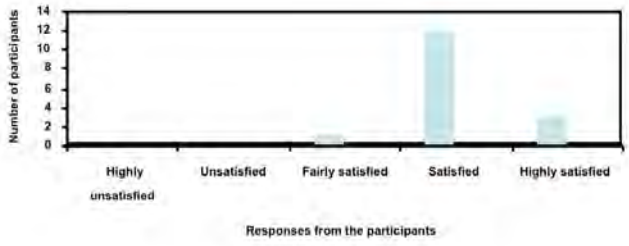
10. Grant amount



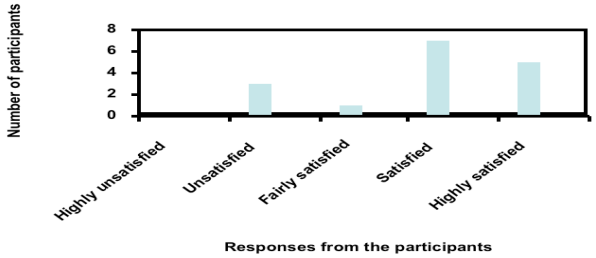
11. Reporting schedule



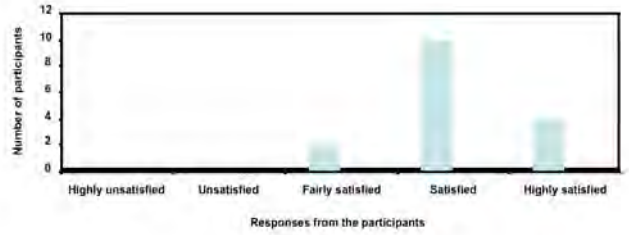
12. Payment schedule



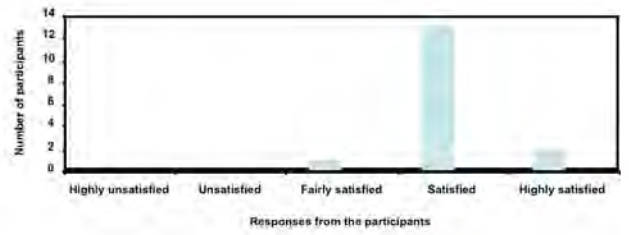
13. Payment method



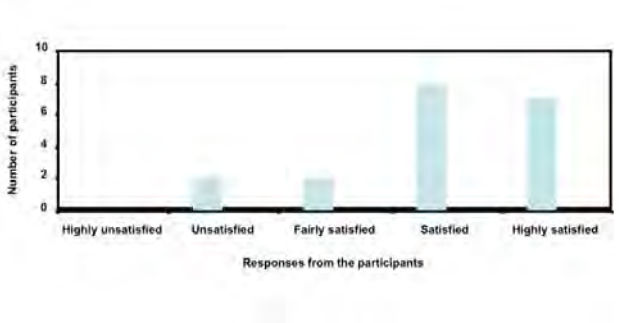
14. Transparency in managing funds and disbursement



15. Reimbursement procedure (case by case basis subject to request for funding to monitor grantees)



16. Termination and recovery of funds



SECTION 4: Project impact

In terms of the overall impact of the project, all the participants felt that their externship research outputs could potentially make useful contributions to field applications of biodiversity conservation and conservation policy in the region. They also believed that they could help with the process of raising awareness about biodiversity conservation and climate change and mobilizing the public in their respective countries. In addition, they expected to contribute towards the training of other conservation professionals in the region and in helping national teams in preparing mitigation and adaptation plans. Most importantly, the majority of participants (85%) agreed that the externship research activity had enabled them to generate linkages with other institutions and researchers (beside IRA).

SECTION 5: Future plans

Most participants displayed an interest in doing further work in their externship research areas and hoped to be able to do this as a part of and advanced learning program such as a Masters or a PhD at an university within or outside the region. However, they admitted that financial support would be an important necessity in allowing them to follow-through with such plans.

SECTION 6: Strengths and weaknesses

1. Main Strengths of the externship activity

    - Provided valuable research experience in linking climate change and biodiversity conservation-related issues.
    - Enabled the testing of some theoretical concepts on ground.
    - Built capacity on better managing biodiversity under changing climatic risks.

2. Main weaknesses of the externship activity

    - Insufficient funds for conducting the externship research activity.
    - Insufficient time allocated for conducting the externship research activity.
    - Lack of access to modeling tools and software for analyzing climate change impacts on various ecosystems components as a part of the research activity.

3. Suggestions for future improvements

- A change in the grant payment delivery method to avoid transmission delays, particularly in the case of Uganda and the Democratic Republic of Congo.
- Need to allocate externship funds in proportion to the actual tasks to be conducted in the field
- Enable access to modeling tools and other software for analysis of climate change-biodiversity issues.
- Need to encourage participants to make thorough reconnaissance surveys in their field research location to enable them to develop appropriate data collection tools. This would also help to minimize the length of time spent in the field.

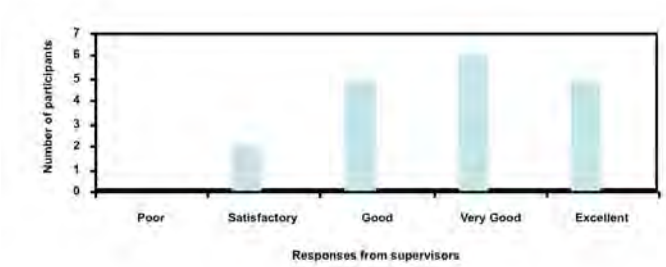
Participants also expressed a desire to be a part of a regional network of practitioners that works towards addressing climate change and biodiversity conservation issues and to assist with any future efforts related to the assessment of ecosystem goods and services.

B. Supervisor Evaluations

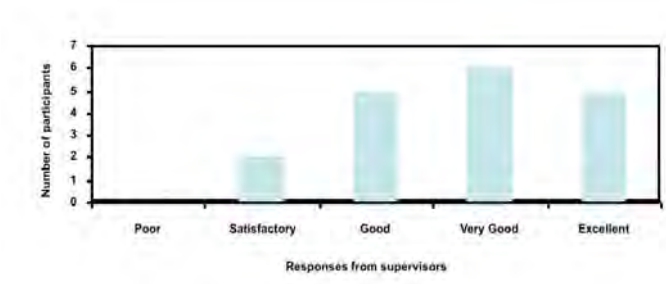
SECTION 1: Supervisor information – see Appendix 7

SECTION 2: Participant performance

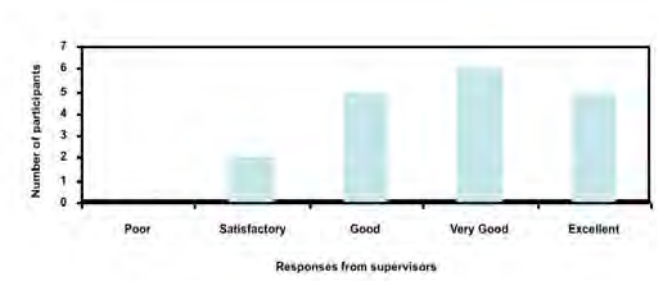
1. Overall externship performance



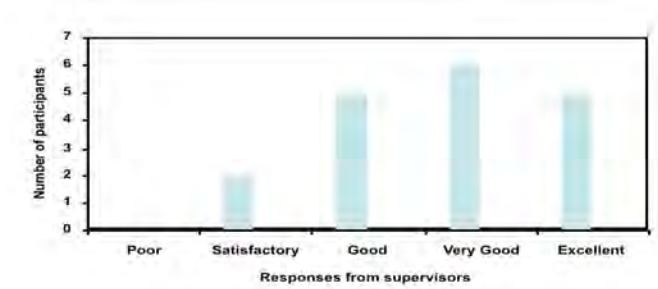
2. Technical competence in executing the externship



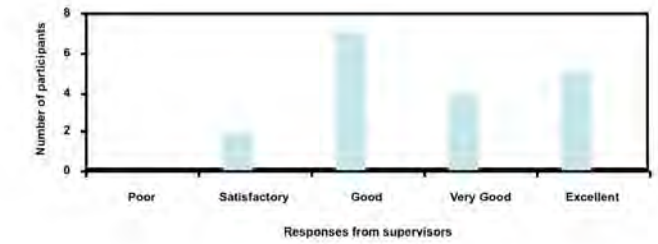
3. Quality of work



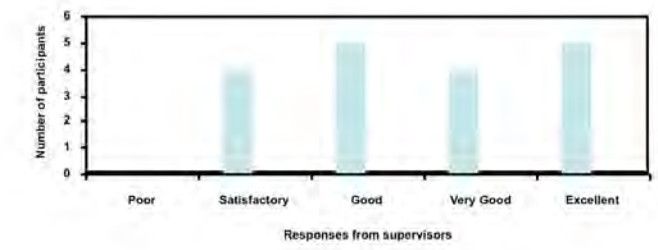
4. Attitude towards learning new skills



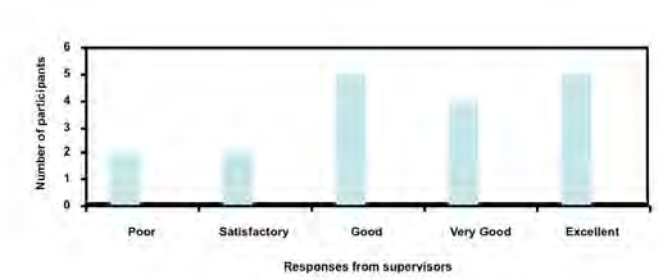
5. Organizational skills



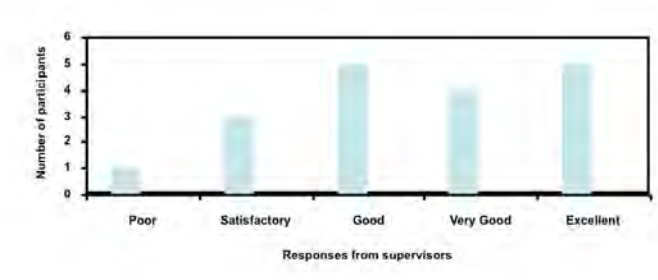
6. Reporting punctuality



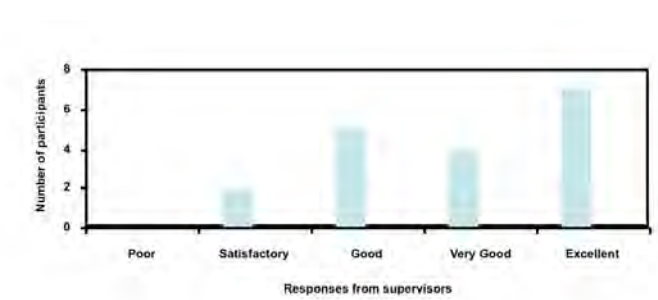
7. Communication with supervisor(s)



8. Quality of reports



9. Value of the externship research to your institution (i.e. host institution)



SECTION 3: Assessment of participant capacity

	Evaluation Parameters	**Supervisors' responses (%)**		
		Agree	**Mixed opinions**	**Disagree**
1	Adequate background knowledge of the proposed subject	83	17	0
2	Adequate background knowledge of activities and methodology	78	22	0
3	Effectiveness in applying this knowledge to the research project	89	11	0
4	Capacity to work independently	83	17	0
5	Effectively considering climate variability and change impacts on biodiversity conservation	72	28	0
6	Effectively considering non-climatic stressor impacts on biodiversity conservation	56	33	11
7	Stakeholder role and their influences on conservation outcomes considered	67	11	6
8	Potential of research output to inform and influence regional conservation practices	61	22	17
9	Potential of research outputs to inform and influence regional conservation policies	50	28	22
10	Linkages generated with other regional institutions and individuals engaged in biodiversity conservation	100	0	0
11	Interest in continued involvement with climate change and biodiversity conservation initiatives	83	17	0

SECTION 4: Strengths and weaknesses

1. Strengths of the externship activity

    - It reinforces the networking in the region by generating important linkages with other institutions and individuals engaged in biodiversity conservation and climate change work
    - Enables capacity building in addressing climate change and biodiversity conservation by taking into consideration multiple stressors and the role of various stakeholders.
    - It benefits both supervisors and the participants by bringing in new knowledge and research skills.
    - The financial support offered to participants served to facilitate this capacity enhancement.
    - Participants received good guidance in developing his/her research project and in report writing.
    - Participants' had the flexibility to select their own research topics of interest.

2. Weaknesses of the externship activity

    - The short research period was insufficient for adequate data collection and proper statistical analyses to ensure better results

- The lack of a travel allowance for supervisors to facilitate visits to participant field research location affected the level of supervision and limited the activities that could have been undertaken.
- Linkages between IRA/PASS, participants and the externship host institutions were inconsistent.

3. Suggestions for improvement

- Establishing stronger linkages between PASS/IRA and externship host institutions.
- Allocating additional funds for externship research activities.
- Support for participants to conduct long-term research with plots for monitoring changes over time.
- Creating and maintaining a formal network of climate change and biodiversity conservation experts to enable the exchange of knowledge about biodiversity conservation and climate change in the region.
- Implementing repeated training programs to generate a critical number of climate change-biodiversity conservation experts in the region.
- Encouraging PASS/IRA to establish a permanent program on climate change and biodiversity conservation in the region.
- Implementing national workshops to generate awareness and build capacity on managing biodiversity in a changing climate (communication strategy).
- Encouraging other universities in the region to establish similar courses, possibly as an outcome of the national workshops.

International START Secretariat
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