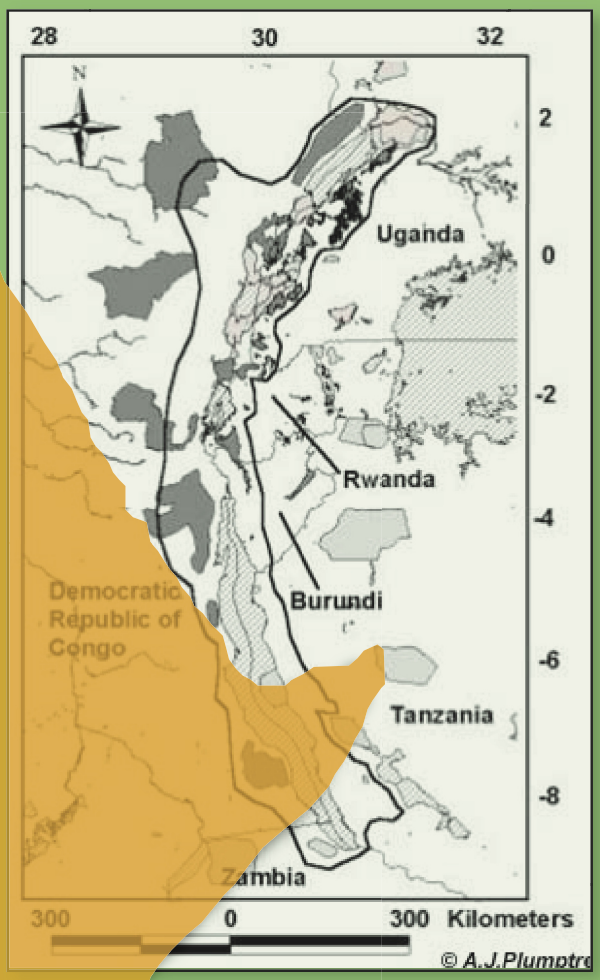
Biodiversity in the Albertine Region: Baseline Assessment Report



By

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and
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GLOBAL CHANGE STYSTEM ANALYSIS RESEARCH AND TRAINING

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

Baseline Assessment Report

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

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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. 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 (Appendix 1) 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 (Hananh 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.

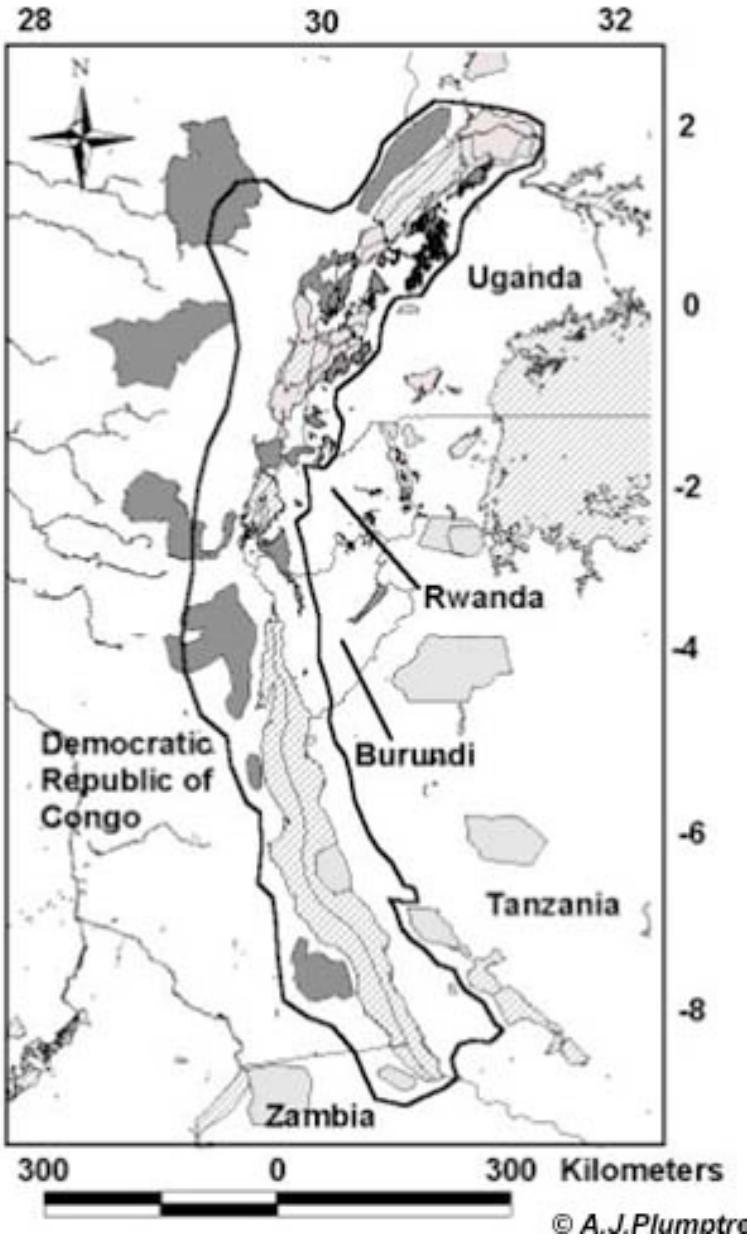

Figure 1: The boundary of the Albertine Rift

(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.

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). One of the main intra-Africa migratory patterns is followed by waterfowl, which spends the austral summer in southern Africa and winter in central Africa. Palearctic migrants spend the austral summer in locations such as Langebaan lagoon, near Cape Town, and the boreal summer in the wetlands of Siberia. 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. Although these species have some capacity to alter their destinations, this could be hindered by the alteration of habitat due to human land use.

African biodiversity is also defined by the concentration of species in several unique native environments. The Cape Floral Kingdom (fynbos), which occupies only 37,000 square kilometres at the southern tip of Africa, has 7,300 plant species—of which 68 percent occur nowhere else in the world (Gibbs, 1987). The adjacent Succulent Karoo biome contains 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). For instance, a reduction in winter rainfall or an increase in summer rainfall would alter the fire regime that is critical to the life cycle in the fynbos. 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 threatened by increases in temperature because many contain isolated plant populations with no possibility of migration. Several thousand species of plants could potentially be affected.

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. 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 to these policies, Tanzania has a number of programmes, projects and activities geared towards implementing these policies. Most of these are sectorally 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 (Appendix 2a-c). 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 1: Consulted Institutions

No	Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
1	Makerere University, Institute of Environment and Natural Resources (MUIENR)	Institute of Environment and Natural Resources, P.O. Box 7062, Kampala, Uganda 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
2	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.
3	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.
4	Department of Biology	Department of Biology,	Dr Julius Bunny Lejju	To provide quality education at	Teaching and research in

No	Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
	(Biodiversity Conservation Section), Mbarara University of Science and Technology	Mbarara University, P.O. Box 1401 Mbarara, Uganda		national and international level with emphasis on science and technology and its applications to community.	biology, zoology and climate related issues.
5	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
6	Tanzania Wildlife Research Institute (TAWIRI) - formerly Serengeti Wildlife Research Institute)	P.O. Box 661, Arusha, Tanzania. Tel .+255 (0)27 254-8240, Fax. +255 (0)27 254-8240 Email : tawiri@habari.co.tz	Dr. Julius Keyyu - Director of Research,	To carry out and co-ordinate wildlife research in Tanzania 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.	Conservation monitoring; – short and long-term systematic measurement and evaluation of ecosystem processes- Aerial and ground wildlife censuses - Conduct wildlife Research on the sustainable conservation of wildlife
7	Tanzania National Parks	P.0. Box 3134,	Mr. Inyasi Lejora- Head	To preserve the country's rich	The primary areas of

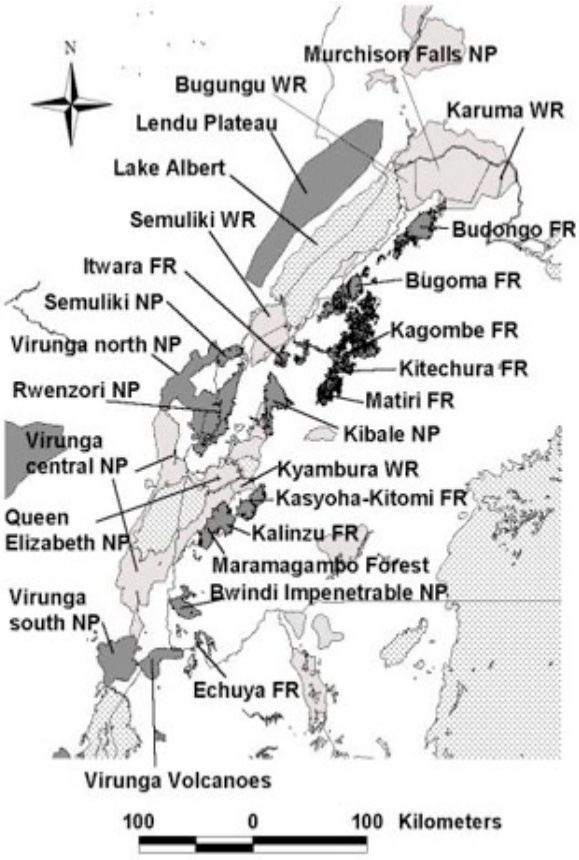
No	Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
	(TANAPA)	Arusha, Tanzania. Tel: 255-27-2508040 Fax: 255-27-2508216 E-mail: tanapa@habari.co.tz	Ecology Department	natural heritage, and to provide secure breeding grounds where its fauna and flora can thrive, safe from the conflicting interests of a growing human population.	expertise of TANAPA is to promote wildlife conservation
8	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.
9	The Nile Basin Discourse Forum in Rwanda	National Coordinator The Nile Basin Discourse Forum in Rwanda	Frank Habineza	To coordinate activities of the Nile Basin Discourse Forum in Rwanda. Such activities include	Environmental Science

No	Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
		Opposite Amahoro National Stadium Gate 17 BP: 3967 Kigali Rwanda habinef@yahoo.com		natural resources management and environmental conservation	
10	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
11	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
12	Faculty of Agronomy University of Burundi	Faculty of Agronomy University of Burundi	Professor Gerard Rusuku	Dean of the Faculty of Agronomy	His areas of interest are agronomy, biodiversity,

No	Name of Institution	Contact Address	Contact person	Mission	Areas Of Expertise
		BP. 1550 Bujumbura, Burundi gnusuku@yahoo.fr			crop science
13	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
14	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

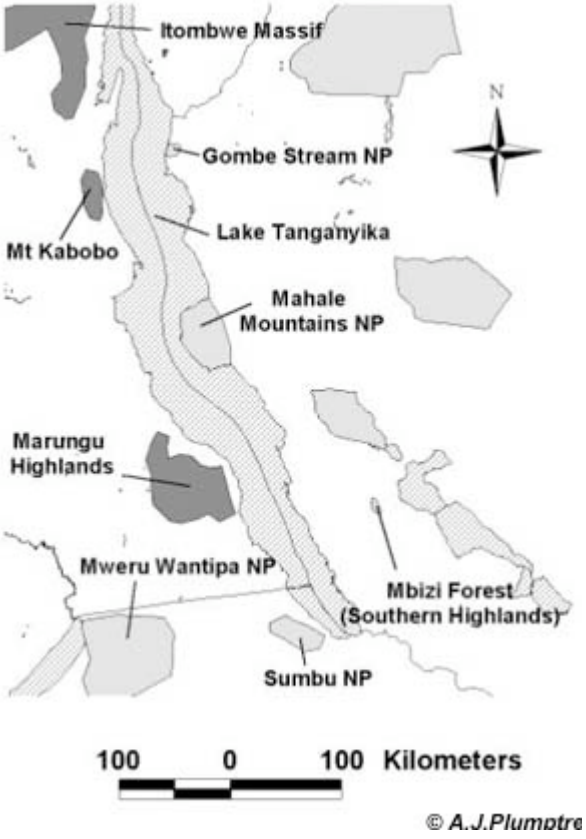
Appendix 2: The Northern, Southern and Central Portions of the Albertine Rift Region

(a): The Northern Part of the Albertine Rift



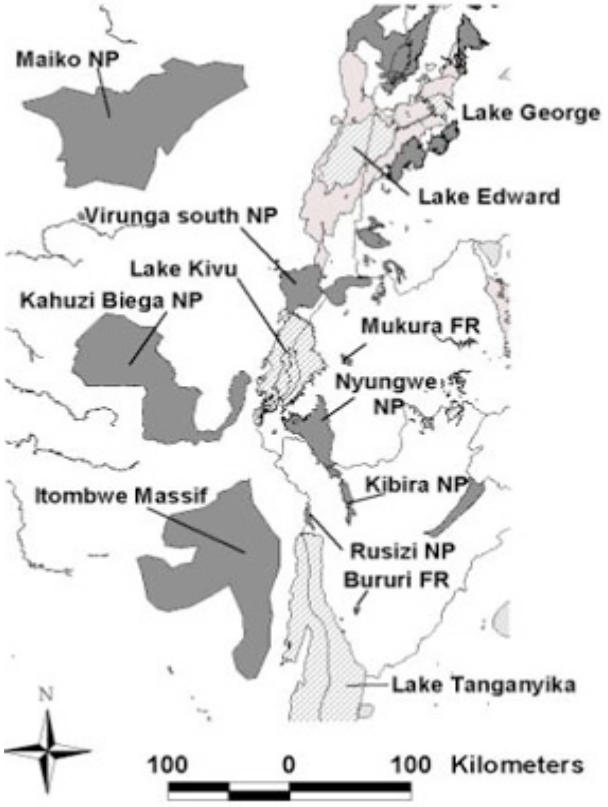
(Source: Plumptre et al, 2003)

2(b): The Southern End of the Albertine Rift Including Tanzania and the Democratic Republic of Congo.



(Source: Plumptre et al, 2003)

2(c): The Central Part of the Albertine Rift, Including Rwanda and Burundi



NB: NP=National Park, FR=forest Reserve, WR=Wildlife Reserve

(Source: Plumptre et al, 2003)