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Abstract

Africa boasts remarkable biodiversity, including the many endemic and endangered mammals and plants. However, species abundance and diversity are in decline and the threats to species diversity are increasing. Climate change is one of the major threats to biodiversity and ecosystem services in the region (Lepetz et al.; Guo, Desmet, and Powrie; Sonwa et al.; Matata and Adan). The United Nations Framework Convention on Climate Change recognize that climate change is one of the greatest threats to biodiversity. Recent studies also have shown the impacts of climate change on biodiversity in Africa. For instance, Midgley et al. (2002) studying the potential impact of climate change on plant diversity in the Cape Floristic Region in South Africa have shown that 11% of the species studied are at risk of extinction, and a reduction in the modeled range sizes of 42% of the species, with the projected climate-change scenario. A study published in Nature (Thomas et al.) reveals that climate change could result in the extinction of more than a million terrestrial species in the next 50 years. Rare species, fragmented ecosystems, and areas already under pressure from pollution and deforestation are the most vulnerable. Fire is a major cause of biodiversity loss in Africa. As global warming increases, these fires are likely to get more intense and extensive and may result in significant ecosystem changes that would affect biodiversity through species loss or changes in species composition (Bellard et al.; Foden et al.; Akcakaya et al.; Bland et al.; Pacifici et al.). Similarly, the broad conclusions of the review outputs showed that direct and indirect effects of climate change have posed potential major threats to biodiversity in Africa.

Direct effects include those arising from increased temperature and increased carbondioxide CO2 levels associated with global climate change (Adler, Leiker, and Levine; Andrew et al.; Dawson et al.). These direct effects result in several potentially major indirect effects, such as changes in hydrologic cycles (evaporation and precipitation) and an increasing magnitude and extent of extreme weather events and frequent fires that destroy the ecosystem. These changes can affect biodiversity in many ways, including altering life cycles, by shifting habitat ranges and species distribution, changes in abundance, changes in migration patterns, and changes in the frequency and severity of pest and disease outbreaks.

One of the other important pathways by which climate change affects African

biodiversity is by reducing the amount and availability of suitable habitats and by eliminating species that are vital for the species in question (Lovett, Midgely, and Barnard; Hély et al.; Doak and Morris; Dawson et al.). A loss of species from an ecosystem not only affects the species that is lost but also the interactions with other species as well as the general ecological functions, which are expected from these interactions. Despite growing awareness that biodiversity is one of the most vulnerable to climate change, Africa is one of the least studied region in terms of biodiversity dynamics and climate variability (Getahun and Shefine ; Sonwa et al. ; Matata and Adan). Therefore, understanding how climate change affects African biodiversity is important, both for examining status or trends, responses, and identifying biodiversity that are sensitive to climate change system and to provide valuable insights to avoid or mitigate climate-induced effects.

As a contribution towards more sustainable development, USAID/Uganda has developed a six-year integrated strategic plan (ISP 2002-2207) for Uganda (USAID 2001). A key ingredient in the ISP 2002- 2007 is the merging of the economic growth and environment Strategic Objectives (SOs) in a new SO7, Expanded Sustainable Economic Opportunities for Rural Sector Growth. The SO7 will “assist Uganda to reduce rural-based poverty and sustain economic growth by expanding economic opportunities and increasing employment, income, and the viability of enterprises” while halting environmental degradation and biodiversity loss (Ibid: 36-39). The key strategy to achieve this objective is the integration of economic growth, agriculture, and environment and natural resources interventions (Ibid). The three core investment programs under the SO7 are: Productive Resource Investments for Managing the Environment/Western Region (PRIME/WEST); Agricultural Production Enhancement Program (APEP); and Uganda Trade Revitalization and Diversification of Exports (U-TRADE).

Preface

Uganda being a landlocked country that lies astride the equator between 4°N and 1°S and stretches from 29.5°W – 35°W (Figure 1). It is one of the smaller states in Eastern Africa covering an area of 236,000 square km comprising 194,000 square km dry land, 33,926 square km open water and 7,674 square km of permanent swamp (Langdale-Brown et al 1964, Langlands, 1973).Agriculture remains the backbone of the economy and in order to contribute to climate change adaptation. According to predictions, Uganda will continue to experience rising temperatures, which will increase by more than 2 °C by 2030 (Tetra Tech ARD, 2013). The economic situation in Uganda has continued to improve, and today the country is characterized by a relatively liberal, open and market driven economy. In 2022 Uganda had a GDP growth raised from 6.5 percent to 7.5 percent. National income continues to be dominated by agriculture, with crops, livestock, fisheries and forestry together contributing just under half of GDP. The agricultural sector is still dominated by smallholder production, and food crops that contribute over 85% of the total value of arable output.

Industrial and service sectors have however grown substantially, and are playing an increasingly important role in the national economy, with construction, manufacturing and commerce registering especially high growth rates over the last five years. Despite an overall positive and much improved situation, the national economy faces structural problems. Domestic savings are still low and there is a negative real interest rate, Uganda continues to rely heavily on external borrowing and foreign debt has increased substantially. Rates of urban and rural poverty are high and many areas of the country and sectors of the population lack access to basic services and infrastructure. It is now widely recognized that climate change and biodiversity are interconnected. Biodiversity is affected by climate change, with negative consequences for human well-being, but biodiversity, through the ecosystem services it supports, also makes an important contribution to both climate-change mitigation and adaptation. Consequently, conserving and sustainably managing biodiversity The research argues that the spatial consequences of depleting finite environmental assets mean that “the burden of guaranteeing sustainable development must be shared locally, nationally, and globally.” Environmental and social stresses reflect the failure of institutions to manage and provide public goods,

to correct spillovers and broker differing interests. Because the spatial extent of spillovers from the degradation of environmental assets varies by problem, appropriate institutions are needed at different levels, from local through national to global.

This research looks at how the term 'sustainable development' has been used in the process of regional plan making over the past decade. In terms of how sustainable development has been used to justify different types of approach in different parts of the country. This paper argues the need to see regional planning as a part of a multi-scalar governance system, whose importance should not be underestimated. KAMPALA, December 15, 2022 — as the shock of the COVID-19 pandemic recedes and Ebola outbreak, Uganda is returning to its pre-pandemic path to growth, with economic recovery boosted by the strong performance of the services and industrial sectors, buoyant private consumption, and an uptick in private investment is critical to addressing climate change.

Uganda has mostly a tropical climate characterized by stable rainfall patterns. However, the effects of climate change have turned the seasons around with the country experiencing shorter or longer rains and harsher droughts – especially in the eastern and north-eastern Uganda.

Uganda is rich in biodiversity because of its geographical location and altitudinal variation. Uganda has an altitudinal range of between 600 m above sea level (Nimule) to more than 5,000m (Mt. Rwenzori). It is home to species of world-wide importance and contains a globally recognized biodiversity of species and habitats that are distributed throughout the country's vast wetlands, lakes, protected forests, and savannah grasslands. The study also aims to increase the capacity of government officials to use the evidence on the economic impacts of climate change in development and investment planning.

Keywords; Climate change (CC), Biodiversity, Policies and strategies.National Environmental Management Authority(NEMA)

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Chapter One: Introduction

1.1 Background

Uganda covers a land area of some 241,500 km^2, of which between 17% (Ogutu-Ohwayo et al 1998) and 27% (Kigenyi et al 1998) is comprised of lakes, rivers and swamps. It has an estimated population of just over 21 million people (MFEP 1998, Table 17 in Data Annex), of which 90% live in rural areas and the majority are concentrated in the more fertile lands of the southern, central and western parts of the country. The Ugandan economy is based on agriculture, which contributes over half of GDP and forms the major livelihood of over 90% of the population (NEMA 1996). Since the early 1990s, after widespread civil unrest, economic stagnation and breakdown of basic infrastructure and industry over much of the 1970s and 1980s, the country has been undergoing a period of economic adjustment and reconstruction, and rapid urban, industrial and infrastructural development has taken place.

Uganda is a landlocked country that lies astride the equator between 4°N and 1°S and stretches from 29.5°W – 35°W. It is one of the smaller states in Eastern Africa covering an area of 236,000 square km comprising 194,000 square km dry land, 33,926 square km open water and 7,674 square km of permanent swamp. Climate impacts are already harming health, through air pollution, disease, extreme weather events and forced displacement, pressures on mental health, and increased hunger and poor nutrition in places where people cannot grow or find sufficient food.

1.2 Statement of the problem

With the increasing population each day that passes by, there has been increase in climate change and biodiversity. Both seen causing positive and negative impacts. This study is intended to identify them and policies on how to solve it.

1.3 Objectives:

The overall aim of this study is to study and analyze the effects of climate change and biodiversity on sustainable development in Uganda. Specifically, this research aims:

i. To enhance the knowledge of climate change as regards to sustainable development

ii. To find out the causes and effects of climate change on sustainable development in Uganda.
iii. To identify the impact of climate change and biodiversity on sustainable development
iv. This study will provide the insight how sustainable development has been affected by climate change and biodiversity.

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Chapter Two Design/ Methodology/ Approach

2.1 Design Approach

An exploratory approach through gathering of research data from different sources and an extensive review of related literature and case studies was adopted for this study

2.2 Summary of the results

Sustainable development is basically the livelihood of people that can be drown from poverty,well-being of people in terms of food supply ,standards of living and so on.However it is seen that sustainable development is impacted by so many things which may include,climate change and biodiversity,and due to this harsh conditions that could have been caused by different activities such as afforestation,clearing of swamps causes drastic change of climate that my later lead to droughts and flooding and since Uganda being an Agricultural country country where moost of its peoples livelihood taking the biggest percentage depending on Agriculture for survival.In this research looks at the impacts of both climate change and biodiversity being the major threat to sustainable development in Uganda.

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Chapter Three Biodiversity in Uganda

3.1 Overview and Status of Biodiversity in Uganda

Biodiversity is a fundamental element of the earth's life support system and is the basis for all ecosystem services and thus plays a fundamental role in maintaining and enhancing the world's population as it supports many basic natural services for humans for example fresh water, fertile soils and clean air. Biodiversity includes diversity at the genetic level, the diversity of species, and the diversity of ecosystems.

Uganda's biodiversity has a high economic value, locally, nationally and globally. Biological resources supply goods for consumption and production, as well as providing ecosystem services which provide the underlying support for human settlement and economic activity. Maintaining biodiversity also allows for the possibility carrying out new economic activities in the future, and has an intrinsic value irrespective of its current or potential uses. These economic benefits can be at least partially valued. Based on available data, the quantifiable economic benefit of Uganda's biodiversity can be calculated to have a value of at least USh 1,112 billion a year. Including the unquantifiable benefits of biodiversity - which are likely to be worth at least as much as this figure - the total economic value of biodiversity is far in excess of this, including.

Table 1: Recorded flora and fauna species in Uganda

Taxon	Total number of species	% of global species	No. of globally threatened spps
Amphibians	86	1.7	10
Birds	1,012	10.2	15
Butterflies	1,242	6.8	-
Dragon flies	249	4.6	-
Ferns	389	3.2	-
Fish	501	2.0	49
Flowering plants	4,500	1.1	40
Fungi (poly pore)	173	16	-
Liverworts	275	46	-
Mammals	345	7.5	25
Molluscs	257	0.6	10
Mosses	445	3.5	-
Reptiles	142	1.9	1
Termites	93	3.4	-
Other invertebrates	-	-	17

Uganda is richly in biodiversity with different research sources reporting occurrence of over 18,783 species of flora and fauna. Sources of the species present is confined to the more known taxa such as birds, mammals, butterflies, higher plants, reptiles, amphibians and fish as shown in the table above. This is because of their relative conspicuousness and economic importance.

3.2 Biodiversity loss

All ecosystems are losing biodiversity, but analysis suggest that losses from natural and seminatural ecosystems are the most serious (Nachuha & Pomeroy, in prep.). however, there are schemes such as the Poverty Eradication Action Plan (PEAP) and the Plan for the Modernization of Agriculture (PMA) whose aim is to boost production. If they are successful soon, it may be possible for the line to be held. Meanwhile, there is increasing awareness of environmental issues. Recent government decisions to degazette two small Forest Reserves (Namanve, Mabira and Butamira), and the experimental trading in Uganda's wildlife, have met heated and vocal opposition. Nevertheless, if the rate of habitat loss is to be reduced or reversed many non-agricultural activities need to be created. Possibly even more important for conservation and even harder to measure than habitat loss – is the

degradation of the remaining areas of natural vegetation.

3.3 Characteristic of ecosystem types

There are several potentially useful ways of characterizing ecosystems, as discussed below.

i. Conservation importance in regards to ecosystems are important if they support lots of species. But their importance in terms of needing conservation action is greater if they are under threat, and particularly if they are small in area and inadequately represented.

ii. Wildlife. A further aspect of an ecosystem's overall conservation importance is the particular species of wildlife that it supports. Species of global conservation concern examples include gorillas and chimpanzees, for instance. Others may have national significance such as Uganda's national bird, the Grey Crowned Crane Balearica pavonina.

iii. Goods and services. All ecosystems provide environmental goods and services, including water and carbon. The nature of the vegetation which largely defines ecosystems reflects water availability in the ground. At the same time, a range of vegetation types are indicated to have well-drained soils. Vegetation cover is crucial in the regulation of the water supply deriving from hills and mountains.

The existence of life predominantly depends on the evaporative power of the atmosphere, along with solar radiation, carbon dioxide level, ambient temperature, and the availability of water and inorganic nutrients. However, those important parameters upon which the existence of life depends are affected by human induced and natural factors. Consequently, over the last century, the rapidly expanding human population and economies place increasing demands on biodiversity resources. One third to one half of the world's terrestrial surface has been substantially altered by human activity. Species existing both at the Arctic and Antarctic environments are tainted by pollutants transported thousands of miles through the atmosphere. Thus, man is modifying the functioning of the entire planet, changing the earth's atmosphere through the industrial release of carbon dioxide which may dramatically change the earth's climate and diminishing the ozone layer through the production of chlorofluorocarbons. Therefore, humans have endangered terrestrial and aquatic

ecosystems, enhanced the survival of some species, and affected many organisms to adapt towards climate change （CC). Though there are a number of goods, and services derived from biodiversity (such as, pollination, soil biodiversity, biological control, and nutrient cycling), expansion and intensification of agriculture continue to be major causes of biodiversity loss.

3.4 The impact of man on biodiversity

Exploitation, land degradation, nitrogen deposition, pollution, introduction of invasive or alien species, water diversion, landscape fragmentation, urbanization, and industrialization. However, recently the interaction of CC with pre-existing threats to the biota is the most serious and pressing problem above all. Habitat fragmentation, invasive species, pollution, overexploitation, and global CC are among the direct threats to the biodiversity. On the other hand, the causes of biodiversity loss are more complex and interrelated with many other factors. Among which are overpopulation and overconsumption. This is compounded by social, economic, and political forces. Furthermore, socioeconomic structures, policies, weak governance, and legislation, corruption, and lack of enforcement, often intensify the threats to biodiversity.

3.4 Overview and status of Uganda's climate

Climate is defined as the average weather conditions, characterized by long-term statistics for the meteorological elements in a given area. Uganda has mostly a tropical climate characterized by stable rainfall patterns. However, the effects of climate change have turned the seasons around with the country experiencing shorter or longer rains and harsher droughts especially in the eastern and north-eastern Uganda. Uganda's climate is naturally variable and susceptible to flood and drought events which have had negative socio-economic impacts in the past. Human induced climate change is likely to increase average temperatures in Uganda by up to 1.5 ºC in the next 20 years and by up to 4.3 ºC by the 2080s. Such rates of increase are unprecedented. Changes in rainfall patterns and total annual rainfall amounts are also expected but these are less certain than changes in temperature. The climate of Uganda may become wetter on average and the increase in rainfall may be unevenly distributed and occur as more extreme or more frequent periods of intense rainfall. Regardless of changes in rainfall, changes in temperature are likely to have significant implications for water resources, food security, natural resource management, human health, settlements and infrastructure. In Uganda, as for the rest of the world, there are likely to be changes in the frequency or severity of extreme climate events, such as heat waves, droughts, floods and storms.

Kampala, as one of the most populated areas in Uganda, is experiencing climate changes mostly with increased temperatures and more intense rainy seasons which are less predictable and more erratic leading to flooding and food insecurity. Recorded temperature has increased by 1.50 over the last 50 years. Although the precipitation levels have not changed significantly, the patterns have become more erratic.

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Table below showing temperature differences caused due to different climatic changes.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	22.1 °C (71.7) °F	22.7 °C (72.8) °F	22.3 °C (72.1) °F	21.6 °C (70.8) °F	21.3 °C (70.4) °F	20.9 °C (69.7) °F	20.7 °C (69.3) °F	20.8 °C (69.4) °F	21.1 °C (70) °F	21.2 °C (70.2) °F	21.1 °C (70) °F	21.4 °C (70.5) °F
Min. Temperature °C (°F)	18.7 °C (65.7) °F	19.3 °C (66.7) °F	19.3 °C (66.8) °F	19.2 °C (66.5) °F	18.7 °C (65.7) °F	18 °C (64.4) °F	17.7 °C (63.9) °F	17.8 °C (64.1) °F	18.2 °C (64.8) °F	18.5 °C (65.4) °F	18.4 °C (65.1) °F	18.4 °C (65.1) °F
Max. Temperature °C (°F)	25.4 °C (77.8) °F	26 °C (78.8) °F	25.2 °C (77.3) °F	24 °C (75.3) °F	23.9 °C (75) °F	23.8 °C (74.8) °F	23.8 °C (74.9) °F	24.1 °C (75.4) °F	24.5 °C (76.2) °F	24.3 °C (75.8) °F	24.1 °C (75.3) °F	24.5 °C (76) °F
Precipitation / Rainfall mm (in)	111 (4)	110 (4)	172 (6)	225 (8)	196 (7)	119 (4)	86 (3)	115 (4)	127 (5)	159 (6)	185 (7)	142 (5)
Humidity(%)	78%	76%	81%	85%	85%	82%	80%	82%	84%	86%	86%	83%
Rainy days (d)	14	14	18	20	20	16	13	16	18	20	19	18
avg. Sun hours (hours)	9.3	9.3	8.7	7.4	7.5	8.6	9.0	8.4	8.3	8.2	7.8	8.5

The consequences of climate change mean the city is more exposed to certain risks and disasters such as floods and heat hotspots as temperatures rise. Without control and protection mechanisms for land use and built environment will worsen. The city will be exposed to severe climate change shocks and stresses that will impact on its functioning and the livelihoods of residents, particularly the vulnerable urban poor. The flood map opposite shows how services and communities will be affected by increased water surface runoff from climate change if no action is taken.

3.4.1 The Six Mass Extinction

There have been several mass extinctions in which many species were wiped out because of catastrophic climate change, volcanic activity, the impact of an asteroid or other reason that may not yet be discovered.

Plants and animals that currently live on Earth have continued to evolve over the 65 million years since the last mass extinction. Many scientists consider the huge reduction in biodiversity since the emergence of humans is now on the scale of another mass extinction. This is known as the *sixth mass extinction*.

Further research estimates that a loss of *68% of all vertebrate wildlife*

populations since 1970. That's more than half of all birds, mammals, reptiles, amphibians and fish gone in just 50 years. During that time, the population has more than doubled, increasing from 3.7 billion to over 7.9 billion today. Invertebrates, while understudied, aren't faring any better. A German study found that flying insect populations (including pollinators) have crashed by three-quarters since 1989, reflecting similar trends around the world.

3.4.2 Habitat Destruction

Damaging human activity continues to encroach on natural environments, thereby destroying the habitats of countless species. As numbers rise, cities, infrastructure and crops are growing and merging into each other, fragmenting the remaining habitat and leaving isolated "islands" of natural populations of plants and animals too small to survive.

3.4.3 Over Exploitation

Humankind's relentless consumption of resources such as timber, oil and minerals is continuing to destroy natural habitats around the globe. We are also putting enormous pressure on populations of wild species, both by bush meat hunting in the developing world and by large-scale industrial fishing in our seas. Wildlife poaching and trafficking still present a huge threat to many species, including rhinos, tigers and pangolins.

3.4.4 Climate Change

The planet is on the verge of a climate crisis due to endless production of greenhouse gases including carbon dioxide and methane. The country is headed for a 3-4 °C warmer world by the end of the century if nations' current climate ambitions are delivered on. Species are already seen declining due to global temperature increase. Every half degree of warming has a huge effect on ecosystems, with mobile species running out of areas to migrate to and temperature-sensitive organisms like corals undergoing massive die-offs.

3.4.5 Pollution

As populations increase, the disposal of waste from households, agriculture and industry, becomes an increasingly serious issue. Our oceans are becoming choked with plastic waste which is killing millions of animals, from sea turtles to whales. The Ellen MacArthur Foundation estimates that by 2050, there will be more plastic than fish in the sea. As well as affecting the lives of humans, noise, light and

chemical pollution all damage the health of wild species.

3.4.6 Agricultural Intensification

Agriculture is a primary driver of habitat destruction, climate change and pollution. Agriculture takes up 50% of all habitable land on Earth, 80% of extinction threats to mammal and bird species are due to agriculture, and our modern food systems are also the biggest contributor to climate change, responsible for around a third of all greenhouse gas emissions, with more than half of these coming from animal agriculture. In order to meet the unsustainable consumption humanity has developed agricultural systems which rely on monoculture, artificial fertilizers and pesticides. Monocultures are increasingly susceptible to disease so require widespread pesticide use which destroys insect populations. Intensive farming leads to soil depletion and runoff from farms pollutes water bodies and causes harmful algal blooms and the collapse of fish stocks.

3.4.7 Invasive Species

Human travel across the world has very large emissions but it has also allowed the spread of invasive species, both accidental and intentional. As a consequence of the introduction of non-native species to some areas, such as rabbits and cats in Australia, goats on St. Helena, we have put many vulnerable ecosystems at risk, threatening native species and diminishing biodiversity.

Table 1 Summarized actors and impacts of biodiversity

actors	Impacts on biodiversity
Habitat loss and fragmentation	Decrease in natural habitat, homogenization of species composition, fragmentation of landscapes, and soil degradation
Invasive alien species	Competition with and predation on native species Changes in ecosystem function Extinctions and Homogenization
Over exploitation	Genetic contamination Extinctions and decreased populations Alien species introduced after resource depletion
Climate change	Homogenization and changes in ecosystem functioning Extinctions Expansion or contraction of species ranges

Pollution	Changes in species compositions and interactions Higher mortality rates Nutrient loading and acidification
Anthropogenic threats	species extinction Habitat loss and conversion Degradation and fragmentation Over Harvesting

3.5 Economic instruments

Economic instruments to encourage biodiversity conservation in commercial and industrial sectors. These Economic instruments include such measures as pricing, taxes, subsidies, property rights, loans, grants, deposits and bonds.

They aim to influence people's economic behavior, and promote particular sectors or economic activities, by making it more or less profitable to produce or consume particular goods. Economic instruments have long been used by the Ugandan government as tools for broad macroeconomic management and to pursue sectoral economic strategies. Despite their potential to promote environmental goals, and their particular suitability for use in commercial and industrial sectors, economic instruments have rarely been used for biodiversity conservation in Uganda. Working primarily through market and price mechanisms, economic instruments can be used to overcome the market, policy and institutional failures which constitute the underlying root economic causes of biodiversity loss and to ensure that the full benefits of conservation and costs of degradation are reflected in economic decisions and activities. They aim to make it more profitable for commercial and industrial producers and consumers to conserve biodiversity in the course of their economic activity than to degrade it. A wide range of economic instruments have relevance for commercial and industrial sector biodiversity conservation, include:

i. Market creation and charge systems: A major reason why biodiversity is overconsumed, depleted and converted is that it is free or cheap to use, and that the people who degrade it bear few private costs as a result of their actions. For example

    - Industrial polluters do not have to bear the costs that their activities cause, the royalties that commercial loggers pay to obtain timber are well below market prices.
    - Agricultural producers gain less by employing sustainable land use and cultivation practices,

    Market creation and charge systems can provide important tools for biodiversity conservation in Uganda. There is great potential for establishing prices and markets for biodiversity goods, or rationalizing existing charges, as a means of regulating their use and allocating them efficiently. Many existing

extractions and use fees - including commercial water and power charges, biological resource royalties and user fees, tourism prices and land development permits are underpriced or not priced at all. Other markets do not allocate biological resources in the most efficient, equitable or sustainable way for such as the allocation of fishing activities, timber concessions and rights over forest and wildlife areas through fixed fees and licenses. These charges could be improved so as to reflect the full values associated with the consumption of biodiversity, and products allocated in ways which would incorporate scarcity and sustainability concerns, for example through auctions, bidding and tradable permits. There is also potential for charging for damage caused to biodiversity and ecosystem services, for example through pollution and waste clean-up fees. All of these economic instruments provide a means of making sure that commercial and industrial producers and consumers take the full value of biodiversity into account when they make economic decisions.

ii. Fiscal instruments: Another way of overcoming market distortion which make biodiversity depleting technologies and products cheap to consume and biodiversity easy to degrade is through the use of fiscal instruments such as taxes and subsidies. These can be used to raise the relative price of biodiversity degrading technologies and products in line with the costs of the damage they cause and discourage people from using them, and to lower the relative price of biodiversity conserving products and technologies in line with the benefits of conservation, and encourage people to use them.

iii. Tax and subsidy systems are already used in Uganda as economic tools to encourage the consumption or production of certain products or to stimulate investment in particular sectors and activities. The manipulation of existing fiscal instruments has great potential for biodiversity conservation. For example measures such as relatively higher product taxes on indigenous timber or biodiversity-depleting technologies and products, and tax relief or reductions on sustainable land uses or sustainably harvested products, clean technologies, efficient product processing equipment and water and energy-saving production processes can all make it more profitable for commercial and industrial consumers to conserve biodiversity than to degrade it. They encourage industries to switch away from

biodiversity-depleting production and consumption and promote the use of biodiversity-conserving products and production processes.

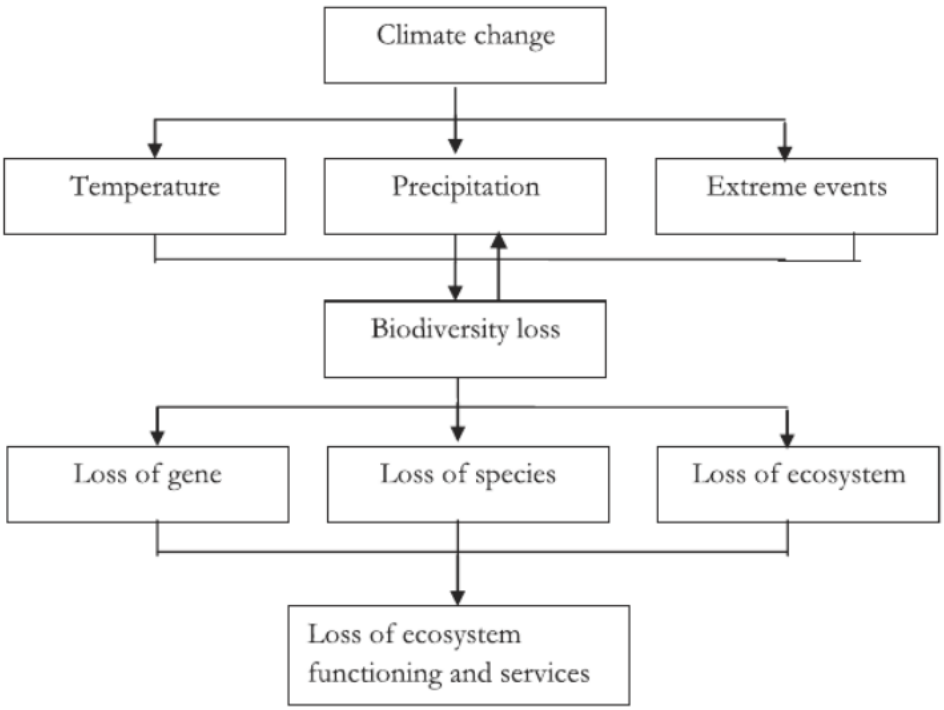
iv. Financial instruments: Few funds are available to commercial and industrial producers for investing in biodiversity-conserving equipment, technologies and production processes. Financial instruments provide a means of mobilizing and channeling funds, and include loans, grants and investment facilities earmarked specifically for biodiversity conservation. The provision of credit and loans on easy terms is already used by the Ugandan government as an incentive for industrial investment. Such arrangements could, if targeted at particular industrial processes and commercial activities which currently harm biodiversity, be used as an effective tool for biodiversity conservation.

v. Bonds and deposits: Commercial and industrial producers have no incentive to minimize harm to biodiversity in the course of developments and economic activities because they incur no cost, and may be able to generate more profits, by doing so. Bonds and deposits are product charges which shift the responsibility for biodiversity conservation to private producers, consumers and developers. They are levied on processes or products which run the risk of degrading biodiversity, and require the person carrying out these activities to pay an advance bond or deposit against the possibility of this harm occurring. They mean that the costs of biodiversity degradation appear as a private cost to commercial and industrial producers, and presents incentives for them to avoid damage and reclaim their deposit or bond.

However, there is limited understanding of the impact of climate change on multiple component of African biodiversity, and their functional or interactive role in ecosystem integrity and stability, how the system will respond to biodiversity loss induced by climate change, and ultimately affect the societal benefits they support. Thus, this comprehensive synthesis considers the connection between climate, biodiversity, and biodiversity-based ecosystem services in Africa. Here, I used information gleaned from different studies and databases to show the status and identify biodiversity and biodiversity-based ecosystem services that have been and will continue to be affected by climate change and their impending impact on human well-being in Africa.

The impact of climate change on the well-being of human is described in

terms the change in ecosystem services caused by climate-induced change in biodiversity. In this review, the categories of ecosystem services are those applied in the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment.



3.6 Impacts of economic activities on biodiversity

1. Direct economic impacts on biodiversity in Uganda include:

Economic activities which utilize biological resources as primary inputs: Economic activities impact directly on biodiversity when they consume biological resources as their primary inputs. In Uganda four major sets of economic activities rely on the consumption of biological resources as raw materials thus utilizing wild plant and animal products for household income and subsistence, including the use of natural vegetation for pasture and fodder; fisheries; forest industry including both

timber and non-timber products; and commercial trade in wild plant and animal products. Although there is little detailed information about the level at which these activities are being carried out, many are known to be unsustainable both in their overall volume and in terms of the species and ecosystems they exploit. Grazing pressure (Mbuza et al 1998a, NEAP 1995, NEMA 1996), over-exploitation of fisheries Uganda Biodiversity: Economic Assessment 11 (Ogutu-Ohwayo et al 1998), uncontrolled harvesting of forest and plant products (Kigenyi et al 1998, Wasswa et al 1998) and unsustainable utilisation of wetlands products (Mafabi et al 1998) are all widely cited as major causes of biodiversity loss in Uganda.

Economic activities which impact on biodiversity through their production processes: Economic activities also impact on biodiversity as indirect or knock-on effects when;

- they employ destructive or damaging methods to utilize biological resources,
- convert or modify ecosystems or introduce wastes, effluents and pollutants into the natural environment. Five major sets of economic activities in Uganda impact on biodiversity through their production processes – agriculture, fisheries, forestry, urban and industrial production.

Nevertheless, the Loss of natural vegetation and conversion of ecosystems to agriculture is one of the most pervasive causes of biodiversity depletion in Uganda (Howard 1995, NEAP 1995, NEMA 1996). In both high potential and marginal areas, as well as in wetlands, biodiversity is also being degraded as a result of the increased use of agro-chemicals and poor agricultural practices (Rwakaikara and Nkwiine 1998). Both forestry and fisheries activities impact on biodiversity because they use damaging harvesting methods and production technologies. There is widespread concern about the impact of small mesh nets and other destructive fishing practices on the resource base (Ogutu-Ohwayo et al 1998) and the effects of damaging harvesting techniques on forest biodiversity (Kigenyi et al 1998, Rwakaikara and Nkwiine 1998). Rapid industrial and urban development, often implemented in the absence of proper planning and controls, have all introduced sewage, solid wastes, pollutants and other untreated effluents into land and water ecosystems (Mugoya et al 1998, NEAP 1995, NEMA 1996)

3.7 Option and existence benefits

Although none of the option and existence benefits associated with Uganda's biodiversity can be quantified on the basis of available data, their value is likely to be extremely large. Maintaining a diverse range of biological resources and ecosystems allows for possible future uses and developments for recreational, pharmaceutical, industrial and agricultural purposes and is thus likely to have a high commercial option value. The local option value of biodiversity is also great in terms of the contribution of wild resources, and their diversity, to livelihood choice and security in times of stress and uncertainty. Existence values include both the local cultural values associated with indigenous biological resources and their diversity and the value of biodiversity in terms of national heritage and bequest for future generations of Ugandans, as well as global appreciation and interest in Uganda's biodiversity. These existence values are significant overall, and for particular species and areas.

Chapter Four Impacts of Climate Change in Kampala

In Kampala the impacts of climate change are manifested in the following forms:

Floods: As many of the poor of Kampala live in flood plains and reclaimed wetlands, they are exposed to frequent flooding during the rainy season resulting in loss of lives and property. The impacts of the floods are exacerbated by poor city planning as these neighborhoods have no drainage systems. The frequency and intensity of floods are expected to increase with climate change.

Decreased Water Availability: Most of the slum dwellers in Kampala do not have access to running water; their main source of water is natural springs.

During flooding, most of these water sources get contaminated due to the poor sanitary conditions, thus putting the lives of these poor communities in danger.

Health: Floods cause frequent outbreaks of water borne diseases like cholera. The urban poor are affected most by these waters borne diseases and the frequency of the outbreaks is expected to increase with climate change.

Sanitation: Most of the slum dwellers use pit latrines which are shallow due to

the height of the water table in the flood plains where they live. These sanitary facilities get flooded and become inaccessible during the rainy season, leading to contamination of water sources. It should therefore be noted that if urban poverty is reduced, the disasters brought on by climate change will be greatly offset.

Food security will be maintained when access to food by all people at all times is adequate for an active and healthy life. If biodiversity is negatively affected by CC it goes to show that the world food security is greatly threatened stemming from an imbalance in the natural ecosystem. Therefore, concerns over species extinction are warranted because of the goods and services provided by species such as pollination, natural pest control, food, and medicine. CC is affecting those goods, services, and ecosystem resilience through hurricanes, blizzards, heat waves, drought, and extreme weather events. For example, rainfall and Elinio events between 1996 to 2003 produce high amounts of precipitation in parts of equatorial, East Africa, and resulted in flooding, reduction of crops, and agricultural yields. Therefore, change in climatic effects has immediate impacts on food production and distribution. Moreover, changes in mean temperatures and rainfall will affect the suitability of land for crops, pasture, and productivity of marine resources. It will also increase the incidence of pests and diseases; loss of biodiversity, a decline of ecosystem functioning; reduce the availability of water for crop, livestock, and inland fish production, groundwater depletion, and sea-level rise.

Globally, CC is expected to reduce cereal production by 1 to 7% by 2060. Besides, 22% of the cultivated area under the world's major crops is likely expected to practice adverse impacts due to CC by 2050. Accordingly, CC is expected to lead to 5–170 million additional people being at risk of hunger by 2080. Therefore, CC through its extreme and unpredictable weather will affect food security and crop yields too. It is estimated that agricultural yields in Africa alone could decline by more than 30 percent by 2050. Such yield reduction will largely distress the poor people who are less capable of absorbing the global commodity price changes that characterize a reduction in supply. Three of the most recent famines in sub-Saharan Africa were exacerbated by unexpected weather patterns that pushed already vulnerable livelihoods into major food insecurity and famine. Furthermore, CC through extreme weather events can have a devastating effect on crops as the recent droughts in Russia and China, and floods in Australia, India, Pakistan, and Europe indicated. Therefore, the impacts of rising temperatures will likely hurt the rural poor

too. Furthermore, growing extreme weather events makes it highly likely that asset losses attributable to weather-related disasters will increase. These losses involve loss of life and food security status of millions of people in disaster-prone areas. For example, an average of 500 weather-related disasters is now taking place each year, compared with 120 in the 1980s. Similarly, the number of floods has increased over the same period.

CC affects food security for communities that depend on rain-fed agriculture making food security highly vulnerable to climate variability such as shifts in the growing season. For instance, from the year 1996 to 2003, there has been decline 50–150 mm rainfall per season (March to May) and failure in long-cycle crops (e.g. slowly maturing varieties of sorghum and maize). For example, in Zimbabwe, past Eliño events and warm sea surface temperatures in the eastern equatorial Pacific reduce 60% of agricultural production of maize. If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by CC, large numbers of the rural poor will be vulnerable to food insecurity too. Thus, food processing, distribution, acquisition, preparation, and consumption are affected by CC as well. Moreover, as the frequency and intensity of severe weather increase, there is a growing risk of storm damage to transport and distribution of food items. Therefore, CC affects the four components of food security (food availability, food accessibility, food utilization, and food system stability). In direct and indirect ways, CC variables influence biophysical factors (plant and animal growth, water cycles, biodiversity and nutrient cycling), and the ways in which those are managed for agricultural practices, and food production. Furthermore, CC induced variables have a large impact on physical and human capital (roads, storage, and marketing infrastructure, houses, productive assets, electricity grids, and human health). These indirectly fluctuate the economic and socio-political factors that govern food access and utilization.

Change in climatic variables will alter suitable areas for the cultivation of a wide range of crops. Current and projected climate data for about 2055 under the climate model-based scenarios, indicate the impacts of CC on areas that are suitable for several staple and cash crops. Therefore, there will be losses in a suitable area in sub-Saharan Africa, the Caribbean, India, and northern Australia, and gains in the northern USA, Canada and most of Europe. Consequently, 23 crops are forecasted to gain fit areas while 20 are predicted to lose. Even though similar trends in

sub-Saharan Africa have been predicted, developed nations will perceive a considerable expansion of suitable arable land to higher altitudes and the potential to increase production if those lands are brought under cultivation. Therefore, areas that are currently most food-insecure will be most affected by CC, and have the greatest need for new crop varieties tolerant of extreme climate conditions such as drought, heat, submergence, and salinity.

The impact of CC on food production must take into account the characteristics of the agro-ecosystems. For example, moderate warming (increases of 1 to 3 ºC in mean temperature) is expected to benefit crop and pasture yields in temperate regions, while in tropical and seasonally dry regions, it is likely to have negative impacts on cereal crops. However, warming more than 3 ºC is expected to have negative effects on Agricultural production in all regions. Furthermore, increases in air temperature can accelerate crop growth and consequently, shorten the growth period. Conversely, such changes can lead to poor verbalization and reduced yield. Therefore, CC may pose a threat to food security through erratic rainfall patterns and decreasing crop yields, contributing to increased hunger. Crops have thresholds beyond which growth and yield are compromised for climatic variables such as rainfall, soil moisture, temperature, and radiation. For example, cereals and fruit tree yields can be damaged by a few days of temperatures above or below a certain threshold. Similarly, in the European heatwave of 2003, when temperatures were 6 °C above long-term means, crop yields dropped by 36% in Italy, and by 25% for fruit and 30% for forage in France. Therefore, changing climatic conditions could create crop losses, resulting from contamination with microorganisms and their metabolic products. This could lead to a rise in food prices. Furthermore, it increased the intensity and frequency of storms, altered hydrological cycles, and precipitation. Transport infrastructure is affected by CC too [228]. Heat stress and increased frequency of flood events destroy infrastructure in developing countries. This has an impact on food distribution and influence people's access to markets to sell or purchase food products. Thus, declines in productivity of cropland could occur, with the severest impacts in the currently food-insecure areas of sub-Saharan Africa, which have the least ability to adapt to CC or to compensate through greater food imports.

Poor people will be exposed to greater variability in and uncertainties about food in a changing climate. Non-farming low-income rural and urban households

whose incomes fall below the poverty line because of CC impacts will face similar choices. Most food is not produced by individual households but acquired through buying, trading, and borrowing. CC impact on income-earning opportunities can affect the ability to buy food, and a changing climate or climate extremes may affect the availability of certain food products, which may influence their price. For example, in Cameroon, Haiti, Tunisia, and Egypt, there have been increased prices of basic foodstuffs. The change in seasonality attributed to CC can lead to certain food products becoming scarcer at certain times of the year. These seasonal differences in the food supply, make human life vulnerable at certain times of the year. Many areas will receive less annual rainfall, while others may receive much due to CC. In low latitude regions, moderate temperature increases (1–2 °C) are likely to have negative impacts on yields of the major cereals. Furthermore, warming will have increasingly negative impacts on all regions. In cereal cropping systems, changing varieties and planting times will cause a 10–15% reduction in crop yield corresponding to a 1–2 °C local temperature increase. Consequently, the pressure to cultivate marginal land may increase land degradation. For instance, there was a 5% decrease in the yield of rice as a consequence of warming for above 32.8 °C.

CC may increase extinction risks for underutilized plant species such as species suitable for biofuel production (biodiesel, and ethanol technologies). Species and genetic variety used for food (including wild species) and the direct ecosystem services that support agriculture, including services such as pollination and nutrient cycling are affected by CC too. For instance, pollination is likely to be problematic, as insect response to CC is particularly sensitive. Besides, CC may have profound impacts on the synchronicity between pollinators and crop flowering, resulting in reduced productivity. The projected impacts of CC on wild plant species distribution will affect the composition of plant and animal communities, and biological control organisms as well0. In warmer environments, CC may result in more intense rainfall events between prolonged dry periods, as well as reduced or more variable water resources for irrigation. Such conditions may promote pests and disease on crops and livestock, as well as soil erosion, drought, and desertification. Conflicts over water resources due to CC will affect food production, animals' fodder, and people's food access in affected areas too. Furthermore, drought and deforestation can increase fire risk, with consequent loss of the vegetative cover needed for grazing and fuelwood [242]. For example, droughts increase livestock mortality in African

countries between 1980 and 1999 (Table 2).

Chapter Five Policies & Strategies

5.1 Overview

Several national policies and strategies indirectly and directly focus on biodiversity and natural resources management in Uganda, including the National Action Plan of Adaptation (NAPA), the National Climate Change Policy, the Climate Change Policy Implementation Framework, and the soon-to-be-finalized National Biodiversity Strategy and Action Plan. Since 2009, Uganda has actively participated in Reducing Emissions from Deforestation and Forest Degradation+ (REDD+) processes with support from the Forest Carbon Partnership Facility and is preparing a National REDD+ Strategy. These policies and planning frameworks provide broad strategies and actions for addressing climate change in Uganda. Management plans (e.g., Park Management Plans, Forest Management Plans) for the 12 identified locations complement the frameworks. Overall, the strategies at policy and management levels tend to emphasize knowledge generation, capacity for designing and implementing mitigation and adaptation interventions, and building ecosystem resilience to the effects of climate change.

5.2 Policies and Programs

The following presents some of the national policies and programs that directly or indirectly respond to climate change impacts on biodiversity and ecosystem resources in the 12 selected locations in the Albertine Rift and Karamoja regions.

1. Climate Change Policy Coordination: The government response to climate change is coordinated by the Climate Change Policy Committee that comprises representatives from ministries and government agencies responsible for economic and development planning, environment, agriculture, disaster preparedness, local government, energy, works and transport, health, and justice. The overall mandate of the committee is to provide policy-level guidance, coordination, harmonization, and integration of broader climate change policy initiatives and programs into national and sectoral plans, strategies, and actions, and to monitor their implementation.
2. Institutional Strengthening: The Climate Change Policy (approved in 2014) focused on strengthening institutional frameworks for management and coordination of climate change issues at both the national and district levels

and across all sectors in partnership with non-state institutions such as nongovernmental organizations (NGOs) and civil society organizations. This strategy will provide training, institutional capacity strengthening, and upgrades to meteorology equipment and facilities for better prediction, analysis, and presentation of weather and climate-related information.

3. Mainstreaming Climate Change in Macro-Economic and Sectoral Development Plans: The Uganda Vision 2040 and National Development Plan (2009-2014) prioritize restoration of and adding value to ecosystems (wetlands, forests, rangelands, and catchments), ensuring environmental sustainability, and mainstreaming issues of climate change into macroeconomic and sectoral development plans.

4. National REDD+ Process: Through the Ministry of Water and Environment, the government is coordinating the preparation of the Uganda REDD+ Strategy that will respond to the drivers of deforestation and forest degradation while promoting sustainable forest management and building carbon stocks. The REDD+ process has formulated guidelines for REDD+ demonstration plots, including within gazette forest lands.

5.3 Acclimatization, adaptation and mitigation measures of a changing climate

Acclimatization is a powerful and effective adaptation strategy to live comfortably with a changing climate. While, adaptation refers to adjusting/accommodating to CC induced impacts, such as minimizing negative consequences and enhancing opportunities. Furthermore, CC adaptation includes “initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected CC effects”. Besides, it is comprised of “adjustments in natural or human schemes in reply to the real or expected climatic stimuli and their effects”. Furthermore, CC adaptation focuses on preparing for coping with and responding to the impacts of current and future CC. Therefore, it intends to deliberate adjustments in natural or human systems and behaviors to reduce the risks of people’s lives and livelihoods. Adaptation responses are essentially planned or unplanned policy responses designed to increase the resiliency of our natural, socioeconomic, and built environments. Planned adaptation to CC denotes actions undertaken to reduce the risks and capitalize on the opportunities associated with

global CC. However, adaptation is crucial at present because biodiversity and earth's ecosystems are being more vulnerable to a changing climate.

Mitigation of CC involves actions to reduce greenhouse gases (GHG) emissions and sequester carbon and develop choices that will lead to low emissions in the long term. It is reported that 30% of the world's GHG emissions come from land-use change (deforestation). Likewise, Livestock production (animal digestion, feed production, and manure management), and forest cover loss contribute about 14.5% of GHG emissions. Therefore, half of the emissions globally are because of land clearing. Consequently, the future emission reduction scenarios should focus on improved feed systems, manure management strategies, efficient fertilizer use, deforestation reduction, and degraded land restoration. Changes in land management and land use may also moderate local and regional climate through changes in albedo, evapotranspiration, soil moisture, and temperature. Therefore, it is via landscape management approaches (diverse landscapes) that sustainable food production, biodiversity conservation, and CC mitigations across entire regions are maintained. Moreover, studies noted that options for mitigating GHG emission include improved crop and grazing land management, restoration of soils, and degraded lands. However, mitigation is possible with improved water management, land-use change, agroforestry, and improved livestock management. Soil carbon sequestration has the greatest mitigation potential, with an estimated 89% contribution under adaptive management. The development of new mitigation practices for livestock systems and fertilizer applications will be essential to prevent an increase in emissions from agriculture. Therefore, mitigation is the anthropogenic intervention to shrink the sinks of GHG. Mitigation activities include reducing GHG emissions through the reduction of fossil fuel use, conservation of ecosystems, biodiversity, and increase in the rate of carbon uptake by ecosystems. Depending on the design and implementation of strategies such as land use and forestry (afforestation, reforestation, and land management practices, and use of renewable energy sources (biomass, wind, and solar power)) mitigation strategies can have positive, neutral, or negative impacts. However, these strategies may lead to loss of biodiversity by substituting rapidly growing diversified forests for monoculture plantations for growing biofuel demands. Another prominent mitigation activity for the reduction of fossil fuel use is putting taxes on emissions. Furthermore, tapping tradable permits, implementing laws and regulations to restrict the use of fossil fuel

can be more effective. Lawful provisions of voluntary agreements, technology, and performance standards, support of energy efficiency improvement, and road pricing are other mitigation strategies. Therefore, mitigation policy measures could reduce the atmospheric concentration of GHG to levels that do not dangerously interfere with the climatic conditions. Management of water resources, land rehabilitation, and application of biotechnology are also considered as effective adaptation measures for CC. Consequently, depending on the intended outcomes, mitigation approaches can seek to either maintain the persistence of current conditions or facilitate transitions to alternative states

Chapter Six Conclusion & Recommendation

6.1 Conclusion

African biodiversity currently faces insurmountable problems than in the past due to climate change. There are two major reasons for this: (1) Species habitats are smaller than in the past. Smaller habitats support smaller populations which constitute less genetic diversity and have less evolutionary potential. This evolutionary potential is critical for species' ability to adapt to the changing environmental conditions. (2) Species habitats are more fragmented than in the past. The fragmentation prevents individuals from being able to shift their distribution in response to climate-related impacts as easily as in the past. These are the two fates available to species other than going extinct: adapt to climate change or migrate in response to climate change in order to track environmental conditions favorable for survival. The current rate of climate change is probably unprecedented and would present extreme challenges to the biota of the planet under normal circumstances. However, the combination of the magnitude of change, the extreme fragmentation of habitats, and the fact that there are 180 million people using a very large proportion of Africa's resources means that neither evolution nor migration will be sufficient to allow many species to cope with current rates of global climate change. Thus, the species might be lost, and their value to humans and their beauty will decrease. A changing climate is responsible for dramatic shifts in the range, and geographical distributions of species and ecosystems. For example, the dissemination of species have recently shifted to higher elevations at a rate of 11.0 m per decade, and to

higher latitudes at a rate of 16.9 km per decade. These rates are approximately two to three times faster than previously reported. Likewise, changes in plants' range render many species are unable to follow the climate to which they are adapted. In contrast, climate change-driven species' range shift responses may depend on species types, ecosystem, and altitude. Therefore, adaptation to future climates may require the simultaneous evolution of a number of different traits. However, species range shift is not only because of CC, but also due to intensified grazing, land use change, disturbance, and fire regimes.

Scenarios related to the impact of climate change on biodiversity are made up continuously, often predicting fast paced extinction of species, loss of natural habitats, and shifts in the distribution and abundance of species during the first decade of this twenty-first century. Pressures on biodiversity can shove ecosystems beyond what might be termed "safe functioning space." Once an ecosystem enters the peril zone, it is in danger of crossing a threshold which will tip it into an alternative state. Actions to increase the resilience of ecosystems, that is, by conserving biodiversity, are critical to prevent the "tipping point" being surpassed. Recent "tipping points" analyses indicate that rising atmospheric CO_2 concentrations could lead to major biodiversity transformations (Bellard et al.). Especially in tropical regions, levels near or below the 2°C global warming, are defined as "dangerous" by the. The change eventually becomes self-perpetuating through what is known as a "positive feedback," for example, deforestation may reduce regional rainfall, leading to greater fire risk, further drying, and dieback of forest. As a result of lags in the socioeconomic, biological, and physical systems, these transformations will be irreversible over the next several centuries, creating great difficulties in ecological management. The broad conclusions of the review output showed that climate change have created potential threats to the loss of African biodiversity which basically fundamental for providing ecosystem services to which human well-being. These effects give upsurge to numerous potentially serious negative impacts on key ecosystem services, such as crop and livestock production, and disease and climate regulation as well as reduce human benefits.

In this context, "Climate Change" may be a familiar term by now, but further attention and action is urgently needed. Even a modest and slow warming of the climate will have complex consequences in terms of species numbers and distributions, thus potentially disrupting ecosystem services. This will be

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exponentially severe in highly diverse ecosystems like tropical forests comprising highly specialized organisms. This causality is particularly relevant for developing countries where often the majority of local livelihoods depend on goods and services provided by ecosystems like tropical forests. Drivers of biodiversity loss have not yet been addressed significantly. Furthermore, there is paucity of research dealing with the interaction between different drivers of global change. So far, most studies only focus on particular ones (mostly either climate change or habitat loss) and the mentioned interactions are largely neglected in assessments under global change scenarios. Hence, it is necessary to consider those interactions among different drivers of environmental change in the future.

Biodiversity issues suffer from insufficient integration into broader policies, and stringent strategies and programs at international, national, and local levels are mostly far from being functional. Future initiatives must start to overcome the lack of connections between the relevant sectors. They must be able to adapt in an appropriate way toward increasing knowledge, raising public awareness and responsibility and thus toward changing conditions. The recent establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, which fittingly complements the existent structures, is a step in the right direction for tackling the threat of climate change on biodiversity. The platform could be used to push out the frontiers of knowledge and performance in the area of biodiversity conservation and climate change for sustainable development and improved livelihoods of society.

Uganda is losing its biodiversity rapidly – one estimate is 10% per decade. Fixed carbon is also being lost in all but a very few places. These losses can be reduced by making better use of Uganda's natural resources, for example as recommended in this report: more use in some areas so long as it is sustainable, and improved conservation in others. At the same time, we need considerably better information on biodiversity and – especially – environmental economics to be sure of having the best policies.

6.2 Recommendation

There is an urgent need to devise more innovative ways of using Uganda's biological resources without necessarily converting much more land to agriculture. For example, many desirable plant species can be cultivated to supplement what is

available from the wild. Likewise, opportunities for game ranching, although limited, could be explored more fully. The outcomes of this study will, we hope be useful in considering what and where to be worth following up. And it has left many gaps, such as the very limited extent to which, at present, we can put economic values on various alternative land uses in different vegetation types. For example, what is foregone by allocating land on vegetation type to conservation, rather than to peasant agriculture, tree farming, or some alternative new land use? Some useful data exist, but a detailed study would be a large undertaking.

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