MAINSTREAMING ADAPTATION TO CLIMATE CHANGE IN THE DEVELOPMENT PROCESS IN UGANDA

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Capacity Strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)

The CLACC fellowship programme aims to build the capacity of civil society organizations in Least Developed Countries (LDCs) on issues relating to adaptation to climate change. As part of the activities, country reports for Sudan, Tanzania and Uganda have been prepared through reviewing their respective national communications, poverty reduction strategy papers, plans for combating desertification and other relevant reports on environment and development. The programme aims to contribute to strengthening of the capacity of civil society in LDCs to help the most vulnerable groups adapt to climate change. The report will also help in establishing an information and knowledge system to support countries to deal with the adverse impacts of climate change. All the three countries have ratified the framework convention, signifying their commitment to the global environment and principles of sustainable development. It is important that civil society and other stakeholders are prepared well to effectively contribute to climate change initiatives in their respective countries and regions.

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1. Introduction

The aim of this report is to contribute to the identification of ways through which communities, especially vulnerable groups, may be enabled to adapt to climate change. Adaptation to climate change refers to adjustment made in natural or human systems in response to actual or expected climate stimuli or their effects in order to moderate harm or make use of beneficial opportunities.[1] This may be achieved through addressing the current sources of vulnerability among the different groups. By virtue of being a party to the United Nations Framework Convention on Climate Change (UNFCCC), the government of Uganda recognizes and supports the need to address climate change. It also signed and ratified the United Nations Convention to combat desertification (CCD) in 1994 and 1997 respectively. A National Action Program for Drylands has been established and aims at developing dry areas sustainably by focusing on poverty alleviation, food security and sustainable environmental management.[2] This paper focuses on vulnerability to climate change in Uganda and possible adaptation strategies.

In this paper, we review national and local level documents, including the initial National Communication on Climate Change, and Plan for Combating Desertification, in order to identify how efforts to achieve climate change adaptation can be mainstreamed into development policies. We take current local adjustments to climate stress such as drought and floods and constraints to making such adjustments as a starting point for analysis. Existing understanding regarding potential climate change impacts and socio-economic trends are reviewed in order to identify critical areas for adaptation. Using lessons from studies of past or current livelihood adjustments, we explore how technical and infrastructural climate adaptation measures can be complemented with more comprehensive measures to reduce vulnerability. Section one of this report presents the country profile in terms of physical and socio-economic factors and how they relate to vulnerability of various population groups. Local level coping strategies that communities have used during extreme climatic events like drought and floods are outlined in section 2. The different approaches used in defining vulnerability are presented showing how they influence the choice of activities to be carried out in managing the impacts of climate change. In section 3, we describe anticipated impacts of climate change in Uganda. Section 4 describes different options for complementing sectoral adaptation strategies with measures aimed at strengthening current livelihood and climate responses, thus mainstreaming adaptation to climate change in the

development process. We suggest that addressing current sources of vulnerability and strengthening the livelihood strategies that are already being used by households and communities represent adaptation measures that could potentially prove less costly and target the poor and vulnerable groups more effectively than many larger scale, technological or infrastructural adaptation measures.

Developing countries may find it difficult to implement large-scale technical measures such as dams and introducing new agricultural technologies due to limited resources and technical capacity. Strengthening local livelihood security can be considered an integral part of adaptation, however. This implies that adaptation to climate change may not be limited to technical measures. Adaptation could incorporate elements of equitable resource access and use, good governance, participation in decision-making processes and gender equity. This would entail, for example, recognizing and incorporating traditional rights and systems of management in laws and policies as part of the adaptation process, in order to reduce both present and future vulnerability. We assess the implications for Uganda of integrating adaptation to climate change into the development process rather than treating it in a sectoral manner.

Country profile: The physical and socio-economic conditions

Uganda is a land-locked country in Eastern Africa with an area of 241,038 square kilometers, of which open water and swamps constitute 43,941 square kilometers or 17 per cent.[3] Most parts of the country lie at an average altitude of 1200m above sea level. By virtue of its location across the equator, two rainy seasons are experienced annually although the two seasons merge as you move away from the equator.[4] Mean annual rainfall varies from 750 to 2000 mm between different parts of the country, shaping the geographic distribution of social and economic activities that are carried out. In recent years, Uganda has experienced frequent and severe droughts in most parts of the country, especially the northern and western parts. These parts were seriously affected in 2001, leading to food insecurity and social conflicts as people searched for pasture and water for animals across local borders.[5] Mean daily temperature is 28 ^{o}C but temperatures below 0 ^{o}C are experienced on higher mountain ranges like the Ruwenzoris that has a permanent ice cap. This ice cap is senstive to global warming.[6]

Uganda is endowed with a considerable amount of natural resources including fertile soils, minerals and vegetation. More than 40 per cent of the 25 million plus population derive economic benefits from Lake Victoria in the form of fishing, water supply, transport, hydro energy and tourism.[7] The population is largely rural (88.7 per cent) and depends primarily on land resources. Women constitute the majority of the rural population.[8] Poverty levels are high; by the year 2000, 35 per cent of the population was living below the poverty line. Poverty was more concentrated in the north and east of the country, partly due to the persistent civil strife in those areas.[9] Agriculture is the backbone of Uganda's economy, contributing about 42 per cent of GDP, over 90 per cent of export earnings and employing 81 per cent of the labour force.[10] The widely varying altitude and climatic conditions makes the country rich in biodiversity that is important for tourism, food and cash crops, forestry and medicinal plants.

Uganda's contribution to global warming in terms of fossil fuel consumption is low. The energy sector is heavily dependent on bio-mass resources, accounting for more than 90 per cent of the national energy needs.[11] Households, small-scale industries (like lime, brick and tile making) and a number of agro-based industries (tea, tobacco and fishing) also depend on biomass energy. Continued heavy dependence on biomass may contribute to the loss of vegetation cover and land degradation, worsening an already precarious situation. Diminishing forests and decreasing vegetative resources have led to increased difficulties in accessing forest products.

Inadequate supply of safe water and sanitation facilities, especially in rural and poor urban areas is a major problem that is contributing to poverty and poor health. Women, who are usually charged with the responsibility of collecting water for household use, spend a lot of time and energy collecting water from distant sources that are often unsafe.[12] This leaves them with limited time for other household chores and income generating activities. Health provision and medical services are also inadequate, burdening people's quality of life and ultimately reducing their productivity.

Large economic changes have taken place in Uganda in the recent past as a result of implementation of the structural adjustment programmes.[13] A number of government employees were laid off and new management systems put in place including liberalization of markets, cost sharing and greater involvement of the private sector in service provision. Implementation of these measures has impacted differently on various income groups with the poor finding it increasingly difficult to access basic services like education, health and resources such as water. The fact that the economy is largely based on export of primary products, including coffee, makes it vulnerable to fluctuations in world market prices.

2. Climate change and vulnerability

Climate refers to "average weather" and represents the state of the climate system over a given time period. Climate changes over time may be due to natural variability or as a result of human induced increases of greenhouse gases in the atmosphere[14] and is reflected in the variation of the mean state of weather variables including temperature, precipitation and wind. The anticipated impacts of human-induced climate change will affect people differently, depending on their livelihood strategies and asset base. Hence, some groups are said to be more vulnerable than others.

Vulnerability refers to the potential to be adversely affected by an event or change. The UN Intergovernmental Panel on Climate Change (IPCC) considers vulnerability to be a function of three aspects of a system: its exposure; sensitivity; and adaptive capacity. [15] Exposure refers to the physical hazards or changes that a system experiences due to global warming. The sensitivity of a system and its economic activities to particular climatic changes, such as reduction in rainfall, also shapes vulnerability. The existent state or performance of individuals, groups or systems in terms of ability to secure livelihoods or basic needs like health, education, food and income is emphasized by some authors as the most important aspect of vulnerability, however.[16] A system that is already performing poorly in these aspects may find that the additional stress of a climatic change triggers severe effects in terms of loss of lives, health, income and welfare. In addition, the ability to cope with or recover from impacts, as well as the capacity to adapt to longer term changes, may be poor. Vulnerability may be considered at many levels, including individual, household, village and national levels.

Adaptation to climate change refers to responses to actual or expected climate changes or their effects. [17] According to the IPCC, [18] such responses include changes in processes, practices or structures either voluntarily or planned to minimize potential damages or to take advantage of opportunities associated with changes in climate. Effective adaptation strategies imply reducing present and future vulnerability to climate change[19] and include coping strategies or changes in practices and processes in light of the perceived climatic change.[20] Such actions can be taken by individuals, households, governments and other stakeholders. Adaptation may include policy measures that reduce vulnerability and enhance adaptive capacity, or the ability of people and systems to adjust to climate change.[21]

The capacity to adapt depends largely on the assets (natural resource, human and social, physical and financial capital) that one has or can access and how well these are utilized. The adaptive capacity of human systems in Africa is generally considered to be low due to lack of economic resources and technology. Similarly, vulnerability is considered high due to the heavy reliance on rain-fed agriculture, frequent droughts and floods, and poverty in many African countries.[22] Populations have developed a number of coping mechanisms in order to live with climatic variations and uncertainty, such as diversification of crops and sources of income, migration, reliance on remittances and social networks of support. These adjustments largely take place within informal economic sectors, however, and most poor people have little access to formal support or investments. Instead, poor populations may find livelihood options threatened by social and economic changes such as privatization and commercialization of resource rights and loss of access to land, forest and water resources. Increasing urban unemployment is leading to decline in access to urban jobs and remittances as a coping option. Greater and even more rapid changes in the local climate as a result of global warming present an additional challenge to local adaptation mechanisms. The poor are therefore considered among the most vulnerable to impacts of climate change. Increasing inequality among a group of people can heighten collective vulnerability. Strong links exist between inequality and a lack of diversification of income sources as well as with poverty, placing further constraints in the response options.[23] It is therefore as important to look at the social and economic processes causing vulnerability as the possible direct sectoral impact of climate change based on changes in climate parameters.[24]

Different coping strategies may be considered an integral part of the adaptation process of a country. In the *social vulnerability approach* vulnerability is viewed as a state resulting from multiple social, economic and environmental processes that constrain livelihood security and which is exacerbated by climate change.[25] Most *National Communications on Climate Change* publications that try to identify possible climate change impacts and adaptation strategies have, however, taken scenarios of climate change rather than existing adjustments and sources of vulnerability to climatic changes as a starting point for analysis, leading to a lack of emphasis on local coping and adjustments. A weakness in this approach is the tendency of viewing vulnerability to climate change as static and dependent on changes in climate parameters rather than social conditions,

leading to an emphasis on solutions that are technical and often expensive. Consideration is seldom given to how such measures can strengthen the livelihood strategies of households and the fact that they can also be difficult to implement considering the limited resources of developing countries. The livelihood approach that involves present vulnerability assessments helps identify policies or measures that reduce vulnerability and increase adaptive capacity through understanding the distribution and causes of vulnerability.[26]

How vulnerable is Uganda?

On the basis of macro level indicators outlining weak institutional capacity, limited skills and equipment for disaster management, limited financial resources, low level of income reflected in per capita income (about U$300) and heavy dependence on rain-fed agriculture, Uganda can be assumed to be very vulnerable to climate change.[27] An examination of the social, economic and environmental conditions and processes that constrain livelihood security in the face of climate stress may indicate critical aspects of vulnerability in Uganda.

A large part of the Ugandan population is self employed in agriculture. A change in climate may reduce Uganda's agricultural sector performance which contributes up to 40 per cent of GDP.[28] This could result in higher food prices, lower domestic revenues and widening of the current account deficit due to lower export earnings together with increased inflation and increased external debt. Crop sensitivity to climate variability and change in Uganda varies with the ecological zone. In particular, the uncertainty in onset and cessation of rainfall seasons, which is high in northern Uganda, affects agricultural production. Agricultural performance not only fluctuates with changes in weather conditions, it is also adversely affected by poor market conditions, storage and infrastructure. Timing of rainfall in relation to cropping calendars is crucial for farmers. Robertshaw and Taylor[29] found, for example, that the El-Nino induced high rainfall in 1997/98 destroyed many crops in Kitara region, contrary to the common belief that increased rainfall necessarily results in greater crop yields. The El-Nino rains also resulted in the death of 1,000 people from flood-related accidents; displacement of 150,000 people from their homes and damage to trunk and rural road infrastructure estimated at US$400 million.[30] Rasmusson and Carpenter,[31] quoted in Schreck III and Semazzi [32] stated that El-Nino–southern oscillation (ENSO) remains the most dominant mode of

interannual climate variability in eastern Africa. Any increase in extreme events associated with climate change may cause significant loss of life and substantial damage of property in Uganda.

Even though 15 per cent of Uganda's total area is covered with water, the distribution is highly geographically differentiated, which means that large parts of the country, especially semi-arid areas in the north-east, face problems of water scarcity.[33] These areas face severe water shortages particularly during drought periods. The cyclic and increasingly frequent periods of drought have had an adverse effect on both the quantity and quality of water resources. Increased competition in the drier areas where perennial rivers are lacking is likely to escalate, especially during dry periods among the different livelihood groups. In the process, some groups may be marginalized and find it difficult surviving in such environment. Inequality, marginalization and exclusion from access water resources may be critical to determining vulnerability among population groups in these areas. Access rights are a particular pertinent issue in determining vulnerability given the process of privatization of water resources currently taking place.

Forestry currently contributes about 6 per cent to the national GDP and creates employment opportunities estimated at about 1 million jobs.[34] Any threats to forests from increased utilization of forest resources,[35] privatization of access rights and changing climatic conditions may lead to negative socio-economic impacts. The combination of high levels charcoal production and grazing in the forests is contributing to loss of biodiversity and forest cover,[36] and may potentially threaten future access to forest products in drought coping strategies among poor population groups. The wildlife based tourism sector, which contributes a significant proportion of the foreign exchange, may be negatively impacted by the loss of forests.

Insecurity, economic decline and the HIV/AIDS pandemic have also burdened households.[37] AIDS often eliminates the economically most productive members of the family and has raised the dependency ratio, increased the number of child-headed households, led to a drop in school attendance and reduced agricultural productivity because remaining household members have to spend substantial amounts of time caring for the sick. In addition, assets such as land and livestock are sold off to pay for medical and funeral expenses of those infected by HIV/AIDS.[38] Extension services which are important for dissemination of information on new farming and livestock technologies have also been affected by HIV/AIDS as some of the trained and experienced staff are also infected.[39] The large economic changes taking place, exposing the agricultural sector to

fluctuations in world market prices and affecting access by the poor to basic health and education services, are likely shape patterns of vulnerability to climate change.

Insecurity has been identified as one of the most important reasons for the increasing poverty in the northern region of the country[40] and involves cattle raiding, theft, damage of property, displacement of people and loss of lives in extreme cases. Insecurity prevents households from long-term investments and also restricts the types of economic activities they may be engaged in. Under situations of insecurity, farmers are restricted to planting only around homesteads as people fear venturing into more productive, but distant and unsafe, farmland. Destruction of property and loss of lives during conflicts may drive households into destitution and reduce their resilience, critical to their ability to adapt to climate change.[41] Social networks and safety nets that exist within communities are also destroyed during conflicts leaving communities more vulnerable to shocks than the pre-conflict period.

Local level coping strategies

Households adopt various strategies when faced with difficult circumstances. Coping refers to actions and activities used by households to survive when confronted with unanticipated livelihood failure.[42] Adaptation frequently involves changing the social and economic framework within which livelihood and coping strategies take place,[43] that is, adjustments to improve long-term livelihood security. Local level coping strategies to shocks such as drought and floods differ among households and communities depending on the types of resources, economic activities and social networks that they can access. Activities may range from collection of wild fruits, depending on remittances, switching to non-farming activities, migrating to other areas, or in extreme cases, sale of assets.

Among dryland pastoral groups like the Karamojong, mobility is critical to the viability of survival strategies. Through livestock mobility, using different grazing areas in the wet and dry seasons, pastoralists avoid overgrazing and try to ensure that grazing areas remain productive. The appropriations of wetter areas and water sources for permanent cultivation by farmers, coupled with loss of drought grazing areas due to government creation of environmental conservation areas, are developments that undermine this mobility and put pressure on subsistence herders, increasing their vulnerability to extreme climatic events. Some pastoral groups have adopted crop farming when faced with the problem of decreasing grazing

areas. Of late, sedenterization, driven by the need for social amenities and individualization of tenure has reduced mobility, productivity and drought resilience.[44]

Other strategies adopted by livestock keepers include splitting of stock, seeking employment during droughts and engaging in petty trade.[45] Households distribute their livestock among relatives and friends in other places as an insurance against total loss in case of a raid or drought. This enables them to restock after a bad event, ensuring recovery and continued survival.

Farmers use mixed cropping and diversification of crops as a form of insurance against rainfall variability and pests attack. The risk of complete harvest failure due to a climatic event such as drought, intense rainfall or high or low temperature spells, is reduced by having different crops in the same field or various plots with differing crops since not all crops and fields are affected the same way by such climate events. Irrigation, providing crops with water from rivers and streams, is another strategy to compensate for unreliable rainfall conditions. Irrigation may allow the growing of crops such as vegetables in areas of low rainfall as well as during the dry season and droughts. These may form an alternative source of food and income when rainfed crops fail. In some areas, flood waters are trapped and used for growing crops after the floods have receded.

Currently, a number of changes are being carried out in the water sector in the east African region aimed at formalizing water rights and involving the private sector in provision of water services. Such changes also affect the ability of rural populations to access water for small-scale irrigation. Many such reforms are being instituted as part of aid conditionalities and are often implemented without adequately considering implications on water access for low income groups. For example, small scale subsistence users often find the process of applying for water rights too bureaucratic and costly. This sometimes leads to subsistence farmers losing their right of access to water while wealthier and more influential groups benefit. Van Koppen et al [46] found that in neighboring Tanzania, the very poor may not be able to pay even what may be considered basic costs for water. Reforms that curtail rights of certain groups to a basic and productive resource like water severely limit their livelihood options and may make their production systems less diverse and resilient.

While agriculture is important to the Ugandan rural economy, households also engage in diverse non-agricultural livelihood strategies.[47] Households increase their reliance on wild fruits during drought, for example. Indigenous fruits are regarded as highly important because they do well in drought conditions while any household member can harvest them.

Collection of forest products (including honey, fuelwood) for sale has also provided households with the badly needed cash for use during such difficult times.[48] Remittances from family and relatives working in urban areas help households survive harvest failure. It has been observed in other areas of East Africa that people who receive remittances tend to be less affected negatively during drought in terms of access to food, health services and school attendance.[49] Other strategies for coping with seasonal food shortages include starting petty business, changing the quality of the diet, reducing the number of meals and taking loans from traders.

Other alternative sources of income during drought used by some people, especially men, include carpentry, brick making, bicycle repair and construction as well as establishment of retail shops and restaurants. Smith[50] found these activities to be important secondary sources of income for village farmers in Kumi and Rakai Districts in eastern and central regions of Uganda respectively. Such income is used for purchase of essential food and non-food commodities and paying for medical services and school fee.

Recovery after drought sometimes involves selling household goods, including crop harvests, in order to repay debts incurred during the drought. In other instances, assets like land are sold to pay off debts. Such coping strategies erode the asset base and compromise the household's longer term livelihood security and future ability to cope with drought. Such last resort strategies can make households descend into a state of destitution. While migration to urban areas in search of paid employment increases during hard times, the growing numbers of urban migrants are also finding that it is becoming more and more difficult to get a job and secure an income for their family. Such migration to urban areas reduces the labour availability in rural areas as those who migrate are mostly the strong and relatively young members of households. Low household labour availability severely affects household's ability to secure food and income during drought; in addition, remittances from migrant household members are often unreliable and unable to compensate for the loss of labour. The situation is particularly precarious for women because it is mostly males who move in search of off-farm employment. Women are often left behind overburdened with responsibilities of farming, looking for alternative sources of income, as well as domestic duties. Although the benefits of initiating labour intensive development activities in rural areas, including creation of employment opportunities, have been highlighted,[51] such initiatives need to consider the rural labour shortage. Some of the most vulnerable households may not have sufficient labour time available to invest in labour intensive additional activities and may require less labour intensive and more flexible alternatives. In order to avoid that such development efforts disadvantage

vulnerable gender and livelihood groups further, it is critical that access to income opportunities are increased.

Rapid socio-economic changes taking place together with the threat of climate change represent huge challenges to existing coping strategies. In order to reduce present as well as future vulnerability, measures aimed at strengthening livelihoods and coping strategies may be necessary. In particular, existing livelihood and coping options may be restricted by socio-economic developments; in addition, these household adjustments may be inadequate in addressing new types of climatic changes. Most coping strategies are aimed mainly at responding to known extreme or seasonal events like floods and drought; however, fewer strategies may exist that are aimed at dealing with longer term changes brought by global warming. A starting point to strengthening adaptation may be to identify ways in which current climatic adjustments can be improved, taking into account likely impacts from climate change, as well as addressing present sources of vulnerability, such as declining water rights among the poor, rising unemployment, insecurity, and the spread of HIV/AIDS. As observed by Phillips:[52] "improving our ability to respond to seasonal and event-based climate variability is likely to have payoffs in terms of longer term adaptation to climate change". The next section presents an overview of the anticipated impacts of climate change in Uganda.

3. Climate change projections and impacts

Mean global temperatures are expected to increase by between 1.4 and 5.8°C over the next 100 years.[53] The large range in the expected rise in average global temperature is due to uncertainties inherent in climate scenarios, including inadequate understanding of feedback processes in the climate system (i.e. modification of clouds, snow cover, ocean currents, vegetation responses) and uncertainty about future emission levels.[54] There are likely to be considerable differences among regions in terms of temperature changes, distribution of rainfall, frequency and intensity of extreme events such as storms, floods and droughts resulting from rising global average temperatures.[55] The vulnerability assessment carried out in Uganda identifies change in precipitation as the most important climate change impacts, some areas of the country likely to receive more rainfall while other areas less. These changes are likely to affect water and other natural resources as well as economic activities. Climatic changes may exacerbate the constraints on current livelihood activities created by socio-economic

trends of declining water rights, insecurity, rising unemployment, and the spread of HIV/AIDS.

Anticipated impacts of climate change

The majority of farmers practice rainfed agriculture which is sensitive to fluctuations in weather conditions. Food insecurity arising from occurrences of drought and floods may worsen with climate change. Declining and unreliable rainfall may lead to crop failure in some areas. Other areas may experience enhanced crop potential with increased rainfall, although any increase in rainfall intensity and flooding may destroy both crops and property. High yielding dairy cattle found in montane zones like Kabale (south western highlands) are potentially vulnerable to climate change. These exotic dairy cattle are more susceptible to heat stress compared to the indigenous low yielding breeds and an increase in mean temperatures is likely to lead to heat stress. Increased temperature is likely to reduce the total optimal area where high yielding dairy cattle can be economically reared, thereby decreasing the output from this sector.

As mentioned in section 2.1, the distribution of water in Uganda is geographically uneven, some parts of the country being semi arid.[56] The cyclic and increasingly frequent periods of drought have had an adverse effect on both the quantity and quality of water resources. Increased temperatures and reduced rainfall could lead to scarcity of water for human consumption and watering of livestock. This may result in increased conflicts among different groups over water particularly in drought prone areas. Fodder for livestock may also become scarce with drier conditions. On the other hand, heavy rainfall expected in the medium and high altitude areas may accelerate soil erosion and land degradation and also cause damage to communication infrastructure. The vulnerability assessment carried out in Uganda[57] recounts problems of frequent flash flooding by mountain streams of Mt. Elgon and Ruwenzori in the lower valleys areas in Kilembe stretching to Kasese airfield by the river Namwamba and lower Mbale area by Manafwa River. Other areas may also experience floods due to changing land use increasing runoff.

In addition to flooding, droughts, soil erosion and siltation are expected to become more frequent and severe with the impending climate change. Results from hydrological vulnerability assessment using three river basins indicate a 10-20 per cent increase in runoff for most of the country, although

runoff may decline in semi-arid areas.[58] Increased rate of soil erosion and deposition not only reduces water quality for domestic and economic uses but also increases the cost of water treatment and reduce the lifespan of water reservoirs. Prolonged droughts, floods and rapid change in climate may adversely affect biodiversity because of drastic changes in habitat conditions, such conditions becoming unfavorable for survival of certain species. A decline in biodiversity will negatively affect livelihoods of those who depend on tourism as a source of income. Tourism is also a major foreign exchange earner for Uganda. Additionally, drier conditions may lead to a decline in forests, resulting in reduced timber and fuelwood availability. This development is particularly dramatic because biomass remains the most important source of fuel for the majority of rural and poor urban households. Outbreak of diseases such as malaria, dengue fever, water borne diseases (for example cholera and dysentery) associated with floods, and respiratory diseases associated with drought, are also likely to negatively affect household welfare as well as exert an additional burden on the national economy.

Weak and inadequate infrastructure (weak buildings, seasonal roads) makes the country susceptible to floods as observed in the extent of damage caused by the El-Nino rains of 1997/98 (see section 2.1). Low lying areas could be cut off from the rest of the country by floods, preventing agricultural produce from being transported to markets in urban areas in time as well as processed goods reaching the rural areas. This is likely to reduce the ability of rural households to sell agricultural produce leading to plummeting prices at the same time as the cost of basic consumer goods rise, severely threatening rural household food security. The cost of transport and consumer goods are likely to increase under such circumstances. Because traders are not willing to operate in areas of poor infrastructure, income from selling farm produce is likely to be low since farmers will be forced to absorb such costs. In addition to economic losses, such developments may be a disincentive to farming, and people may try to enter other economic sectors.

Table 1: Summary of anticipated impacts and adaptation strategies

(a) Anticipated impacts of Climate change	**(b) Measures Suggested in the National Communication**	**(c) Comprehensive measures (addressing reasons for vulnerability) that could be included.**
• Decreased rainfall, increased temperature and evaporation • Frequent drought spells leading to severe water shortage especially in semi-arid areas • Decrease in forest area and area under cultivation • Increased heat stress on cattle • Increased risk of food shortage and famine • Reduction in ecosystem integrity and resilience, and decline in biodiversity • Landslides in mountainous regions • Increased potential of malaria transmission and burden on the country's health care system	• Modernization of agriculture • Introduce drought resistant crops • Develop capacity to tap water • Development of new dam sites • Diversify crops grown in the locality • Reduction of water loss through water conserving technologies • Encourage water harvesting through constructing permanent houses • Reduction of animal population • Use of appropriate pesticides to control new pests and diseases • Institute policy mechanism to control unsustainable forest clearing and forest consumption (plans for reforestation and afforestation projects with a primary concentration on trees) • Promote use of LPG for cooking and solar cookers instead of inefficient woodstoves and charcoal stoves • Step up Malaria control	• Strengthen traditional local level coping strategies. • Support and incorporate traditional laws and institutions regarding land, water and forest resource use and management into formal systems • Developing water pans in drylands as well as watering points in grazing lands • Strengthen indigenous knowledge and improve access by the poor to new farming technologies • Address the causes of conflicts and promote peace among neighboring communities • Tackle factors that currently prevents people from accessing or using available malarial control methods • Address the spread and adverse effects of HIV/AIDS • Strengthen access to safe water and hygiene as well as health and education services • Address the issue of cost of alternative energy sources like LPG, solar and others • Strengthen disaster related insurance and credit schemes • Food reserves for emergencies • Improve rural infrastructure • Involvement and representation of vulnerable groups in development and implementation of adaptation measures

4. Mainstreaming adaptation to climate change in the development process

The inclusion of climate change and vulnerability considerations in sectoral and development planning and policies is an important way through which adaptation may be promoted. The potential damage from anticipated impacts of climate change could be reduced and society be prepared to take advantage of the opportunities presented. When interacting with other stressors (such as HIV/AIDS or economic changes), climate change could trigger adverse consequence and contribute to more people descending into destitution. This makes it particularly important to ensure that appropriate and timely measures are put in place to cushion the vulnerable groups against such shocks. The Ugandan national communication on climate change has highlighted a number of activities that may be carried out as part of the adaptation process. The identification of these activities is largely based on impacts derived from climate scenarios (see Table 1, second column). Accordingly, some of the options presented, such as the development of new dam sites and modernization of agriculture, are focused on climatic rather than socio-economic constraints to livelihoods. As a result, many of the suggested measures focus on technological solutions to particular changes in specific climate parameters and require high technological and capital investments. Some of these investments may be constrained by the unavailability of such resources. In contrast, it is likely that strategies that will be of benefit to the vulnerable groups are those that they can easily access and adopt and which have much lower technological and capital investments. It is therefore important explore how strategies that households and communities have used to adjust to climatic changes in the past can be strengthened. As observed by Phillips[59] in Uganda, adaptation to long-term change will be driven by responses to individual events.

The first and second columns in Table 1 show some of the anticipated impacts and possible adaptation strategies. Adaptation to climate change need not focus on entirely new activities but can also strengthen livelihood strategies and incorporate development initiatives that may create and diversify opportunities for earning a living. The third column in table 1 represents an effort to identify such options, labeled comprehensive measures. This list does not represent an exhaustive investigation into all adaptation measures but serves to illustrate the types of measures that may be appropriate in strengthening adaptation. An in-depth study of existing climatic adjustment strategies and the socio-economic and environmental

trends that constrain or facilitate local livelihood security would be necessary to adequately identify the measures that need to prioritized for adaptation in Uganda. Such comprehensive adaptation measures would be aimed at increasing resilience in a changing environment and represent important adaptation measures. Building resilience into the system ensures that extremes are buffered irrespective of the direction of climate change. No such studies have been carried out to date.

It is worth noting that Uganda has adopted an integrated approach in identifying possible adaptation strategies. A number of proposed activities may be carried out and benefit the poor who are among the most vulnerable; but as explained above, some may need to be re-examined in light of the limited financial and technical capacity. Agriculture presents a great opportunity for poverty eradication because it employs over 80 per cent of the labour force. Enhancing sources of livelihood in this sector would significantly improve local people's resilience in a changing environment. Because the majority practices rainfed agriculture, availing water for small scale irrigation could reduce the risk of crop failure and contribute towards improving crop production. Sustainable supply and access rights of water for human, livestock and irrigation purposes could be pursued in the dry areas where drought and lack of water access constrain livelihood options. The National Communication proposes medium sized dams in each parish, especially in the cattle corridors, which would greatly improve pastoral activities, although the financial requirements may be high and difficult to meet for local governments alone. Cheaper options like water pans could be considered as they are more easily constructed with limited finance. These are water sources that local communities and households may both be able to contribute to in kind (providing labour during construction) and which may be more easily managed locally to secure access to vulnerable groups.

Vulnerability and poverty in pastoral areas may be exacerbated by inappropriate policies and development interventions that undermine pastoral institutions and strategies for responding to environmental stresses.[60] The specific vulnerability conditions created by poverty, conflict and frequent droughts in pastoral areas calls for specific policy attention to these issues and in particular pastoral representation and involvement in the policy formulation process. For example, an issue that may be particularly pertinent to pastoralist adaptation to climate change may be the provision of watering points that are well planned in relation to available grazing areas. Adequate spacing of water points in pastoral areas is important to make larger areas available for grazing cattle during dry spells (water availability for cattle rather than lack of grass often being the main factor constraining

grazing in many dryland areas). Such development also reduces the need to concentrate animals in smaller areas, which potentially causes overgrazing, poor cattle health and degradation around watering points. Appropriate development of water points can only be achieved when such groups are involved in planning and implementation of such initiatives. Other important elements include improving efficiency and accessibility of veterinary services to reduce the disease burden that may worsen with new climatic conditions.[61]

Reducing animal population has been suggested as an adaptation measure.[62] While reducing pressure on grazing lands, however, this measure may actually increase pastoral vulnerability. Sale of livestock is the most important drought coping mechanisms among pastoralists. A policy aimed at reducing livestock numbers fails to recognize the fact that the high number is used as a form of insurance against bad events like extended drought periods. Attempts at making the Karamojong pastoral community in Northern Uganda practice 'modern' agriculture and 'controlled' grazing failed because they were in direct conflict with the long held tradition of transhumance in most parts of Karamoja.[63] This case illustrates that it is important to recognize the traditional systems of resource management and livelihood strategies. It should be noted that the concept of 'carrying capacity' for example varies in relation to the composition of the herd and its movement; hence the absolute number of animals grazed may be less important than the way they are grazed.[64] The complexity of ensuring good grazing during drought may be more usefully handled by incorporating traditional land holding systems that allow pastoralists freedom of movement in search of pasture. Laws and regulations could recognize traditional systems of land ownership and use and integrate these systems in formal laws as far as possible. Pastoral groups have, for example, been able to survive in the dryland areas using a combination of strategies like migration, rotational grazing and communal land ownership which should inform the adaptation measures being promoted in any national policy.

The proposed modernization of agriculture is expected to increase incomes of the poor by raising farm productivity, increasing the share of agricultural production that is marketed and creating on-farm employment.[65] In order to strengthen livelihood security, important issues that need to be addressed include the cost of such methods to farmer households and whether the proposed or introduced methods are accessible to poor people and other vulnerable groups. Some of the new technologies may be expensive and unaffordable to the poor. Growing hybrid crops for example is more often associated with use of agrochemicals (like fertilizers) which

poor farmers may not afford. Other risks associated with hybrid crops, including the weakening of crop diversity and resistance to diseases and pests need to be addressed when such crops are introduced. Acceptability of a new technology to the intended beneficiaries also needs to be assessed. In order for technologies to benefit women who are overburdened with domestic and economic activities, for example, the demand of a technology on time and energy needs to be low. As Eriksen[66] observed in Kenyan and Tanzania dry-lands, farmers may be unwilling to adopt new crops developed without their involvement.

Adoption of appropriate farming techniques may be achieved by improving the delivery of advisory services to farmers in rural areas especially those in the drylands by strengthening the National Agricultural Advisory Services (NAADS). Dissemination of appropriate technologies that may help farmers overcome some of the bottlenecks experienced is welcome. Incorporation of indigenous knowledge into such development is critical because the survival mechanism adopted by a community usually takes into consideration the resources and constraints within their environments. The NAADS could take a more active role in propagating more drought resistant crops[67] as this may increase incomes and improve the quality of life of poor subsistence farmers.[68] As explained above, it is important that this is done in consultation with the intended users to ensure that measures reach the targeted beneficiaries. Other measures that may benefit the agricultural sector include having publicly held grain resources and compulsory retention of reserves of designated food crops by farmers. These reserves assist people in surviving periods of poor harvest or long droughts.

Good infrastructure allows farmers to access markets for their produce as well as develops alternative economic activities, thus strengthening and diversifying local livelihood options. Improving infrastructure therefore forms part of measures aimed at strengthening local livelihoods. Good infrastructure could also attract foreign investment in a country with the possibility of creating more opportunities for employment. Electrification of rural areas can facilitate development of agro processing and other non-farm employment in rural areas in addition to the fact that it is one of the cheapest sources of energy. Fishermen, for example, are often exploited by middlemen partly because they lack cold storage facilities and have to sell their catch quickly. This constraint could be addressed by improving or extending electricity coverage in such areas. The poor infrastructure connecting landing beaches and markets also reduce their profit by increasing transportation costs and therefore need to be given priority in the

development process to increase income for such areas. It is important, however, to take climatic changes into account and locate such development in areas that are not at risk from flooding, for example.

Diseases such as malaria, water-borne diseases and HIV/AIDS reduce the household labour available to engage in farming or in drought coping strategies such as casual labour. Poor health of a family member also requires labour and financial resources spent on care, medicines and hospital visits for that person. Measures to reduce the spread of HIV/AIDS, provision of health care and medicines to reduce the symptoms of the disease are important to reduce the financial burden, labour shortage and vulnerability of households. Poor accessibility to good health facilities among rural populations is an important source of vulnerability in Africa. Improving accessibility and reducing the cost of medical care is critical to improving the livelihood security and strengthening adaptation to climate change; in addition, the sources of poor health such as lack of safe water and hygiene need to be addressed.

In Uganda, more than 75 per cent of the life years lost due to premature death are as a result of 10 preventable diseases.[69] Addressing the increasing disease burden arising from poor environmental health is critical to reducing vulnerability. This can be achieved by placing greater emphasis on rural and poor urban areas where the population has low access to safe water and latrines. Systems that ensure accessability and affordability of water are essential to targeting the most vulnerable. Access to water could be improved by having an efficient distribution network, avoiding wastages (through leakages) and conserving "unimproved water sources" for the rural areas. Safe water delivery could be achieved by having public private partnerships in water supply and distribution where government may not have the financial resources to cater for all the services; however, any such measures by the government should ensure that prices of basics such as water are kept within the reach of the poor. The involvement of private sector in water service provision has resulted in price increases in many areas. Affordability could be achieved through the use of cross-subsidies (for example, government profits from public-private ventures can be used to subsidize costs and expand the infrastructure in rural and poor urban areas).

Equally important is the conservation of unimproved water sources (springs, streams, swamps and ponds), which are the water sources on which the rural population mostly depends. Pollution control legislation should therefore be enforced to ensure that such sources remain usable and safe healthwise. In the past, it has been found that fines or penalties against water

pollution were lenient and did not function as an effective incentive to control pollution. It was cheaper to pollute than to oblige with the regulations.[70] Strengthening the management of wetlands using a decentralized community based approach where district wetland action plans are developed and integrated into district development plans[71] will become particularly important because of the numerous benefits from wetlands to drought coping strategies. Making technologies and management systems available to communities neighbouring wetlands and identifying equitable systems of access rights could be an important step towards improving management of wetlands, reducing land degradation and enhancing local livelihood security.

Adaptation measures to promote environmental health include malaria prevention and control (draining of stagnant water around houses), integrated management of childhood illness through immunization, and health education. Malaria incidences may increase especially in those areas that experience increase in rainfall. Investigations of why currently available control methods are not effective have found that cost is an important factor. Most of the poor households cannot afford using available methods. Some of the methods, such as using insecticides, have side effects like killing unintended organisms and being poisonous, in addition to being costly. Making mosquito nets affordable is not only an effective strategy to enhancing the health status of the household, but is also environmentally friendly and cheaper in the long run. Evaluating the existing methods and make adjustments to these where necessary may be a more effective adaptation measure in the short term than carrying out new studies on malaria control.

Deforestation has been rampant in Uganda, threatening continued access by the poor to forest products used in coping strategies. The degradation of water catchments also reduces the reliability of springs. The new forest policy aims at turning this trend around through encouraging development and sustainable management of natural forests on private land, encouraging tree growing on farms, and developing innovative mechanisms for the delivery of forestry extension and advisory services. Collaborative partnerships with rural communities could be developed for sustainable management of forests. Ensuring continued access by rural households to the forest during drought is an important climate change adaptation priority for any such management. Through these efforts, watershed protection forests will be established, rehabilitated and conserved and biodiversity managed to support local and national socio-economic development. Innovative mechanisms for the supply of high quality tree seed and improved planting stock can also enhance access to forest products. Private

investment in commercial forest plantation and fuel wood plots concentrated in peri-urban areas may assist in satisfying the demand for biomass energy. Tree nursery establishments by local communities, control of bush burning and formation of forest management committees in partnership with the forestry department may boost forest development. Reforestation will also be very important in reducing the risks of landslides in the mountainous areas. As a precautionary measure, human settlements and economic activities need to be sited away from such areas. Land tenure changes, privatization of resources and replacing customary rights to forest and trees on access to forest products are all likely to affect resource access by different social groups. Assessing such effects is critical to designing any policy measure aimed at enhancing adaptation among the most vulnerable households. Lack of access to forest products due to tenure changes and privatization may in some cases constitute a larger threat to forest access than deforestation per se.

Nevertheless, high dependence on fuel wood in rural and poor urban areas due to a lack of alternative energy sources is one of the factors contributing to deforestation and related problems in some areas.[72] Improving rural quality of life and promoting rural non farm income is probably the most important measure that could reduce vulnerability as well as deforestation. Such improvement could be achieved through accelerated rural electrification, for example by designing strategies that overcome the financial barriers experienced by rural households. Developing a rural electrification fund allowing provision of grants and subsidies is one such measure.[73] Use of alternative sources of energy and technologies, efficient utilization of energy and promotion of private sector participation in the development of both conventional and renewable energy sources could also improve quality of life. Alternatives like solar and LPG have remained too expensive for poor people and the price is an obvious constraint to their wider adoption. Efficient energy use in households and industry is necessary because they heavily depend on biomass which is rapidly declining, partly due to the high demand. Within households, wider adoption of energy conserving ceramic stoves and improvement in charcoal burning methods to improve efficiency and energy conservation could be good starting points. Use of ceramic stoves, for example, has double advantage in that households' energy expenditure reduce as well as demand on forest.

The National Communication recommends the incorporation of disaster preparedness and management action plans at various levels of socio-economic development planning including national, district, and local levels. Some of the major disasters occurring in Uganda are associated with famine resulting from prolonged drought in dry areas.[74] The severe effects of these could be avoided if households, organizations and government

departments put in place measures to prepare, anticipate and manage the impacts. Local disaster management committees should therefore be strengthened. Strengthening of the District Environmental Action Plans which borrows from both Sub-county and Parish plans is suggested in order to ensure that needs and aspirations of local people are adequately taken care in the sustainable development activities. Such plans are a product of the devolution in governance system that has taken place in Uganda.

Several institutional issues need to be addressed as part of any effective adaptation policy. Weak institutional collaboration and coordination is a key constraint in planning and implementation of sectoral development activities. Duplication of activities sometimes limits the output. Local governments are also constrained by limited financial resources and therefore not able to invest in long-term environmental concerns such as desertification or climate change because they are forced to prioritize to immediate and urgent concerns like health and education.[75] Lack of institutional collaboration and coordination currently constraining implementation of most plans could be strengthened through sensitization of sectors and local level government planners and implementers on their roles. Governance systems may also give more autonomy to the lower level institutional structures that are closer to the people and are likely to be more responsive to their needs.

Decentralisation of power is an important entry point for adaptation and in particular representation of vulnerable groups in the development of adaptation measures. Capacity development to address the related problems of poverty, desertification and climate change is needed both within the government and civil society. This may entail building human resources for the enhancement of environmental management systems, increase level of awareness on climate change issues and mainstreaming adaptation to climate change strategies in development plans. Improvement of popular participation in the decision-making process under a decentralized administration as enshrined in the Local Government Act (1997) is another entry point for adaptation. Ensuring adequate representation and effective participation by households or local communities in the decentralized governance system may increase sustainability of development initiatives. There is a need to delineate the role of state vis-à-vis those of private sector and civil sector to make them efficient and responsive people's needs.

Reliable weather and climate monitoring for provision of accurate and timely weather and climate information forms part of disaster preparedness schemes to support adaptation activities. Early warning systems in Uganda could be strengthened to reduce the scale and magnitude of disasters. Improving data collection, processing and archiving to enhance the country's capacity to develop early warning systems are all activities that

require additional financial resources. Another important aspect of disaster preparedness is the dissemination of information. Merely collecting information about future climate is not sufficient in order for that information to be used; in addition, the information collected has to be translated to an easily understandable format and disseminated to as many people as possible using the appropriate means. Public awareness must be an integral part component of national programmes to address climate change and its adverse impacts. Disaster preparedness and health programmes should pay attention to local knowledge about trends in risks and sources vulnerability as older people remember how weather patterns have changed over the years, the developments that have left communities more vulnerable, as well as the coping mechanisms that have worked well in the local context.[76] Box 1 below shows what can be achieved with enhanced information dissemination at community level.

Box 1

The Radio and Internet Project (RANET) implemented in Nakasongola district by World Vision and the Department of Meteorology enhanced collection and dissemination of early warning and climate information at the local level through radio and internet. The project provided timely information on climate and other development information for the people in the district. The equipment, which consisted of a computer, a modem, receiver and antenna, downloaded the required information. The project successfully collected and disseminated climate information to local farming communities in a timely manner. Local communities in 17 parishes of the district benefited from this effort. This was possible because of easy access to weather information through the internet and established local structures for interpretation and dissemination of information. The information enabled local population to improve the state of drought preparedness and food security. The project also improved the efficiency of planning by enabling the taking into account of more accurate forecast. More farmers in Nakasongola started preparing their land for cropping in advance banking on predictions received through RANET compared to the past when almost all farmers waited for rains before starting land preparation. This change improved productivity of crops and livestock. Local communities were better prepared for disasters with availability of information through established grass root structures which reduced their vulnerability as shown by minimal damage to life and property in the El-Nino predicted for 2002.

Source: Waiswa, 2003.

The feasibility of disaster or climate related insurance schemes can be considered as a way of strengthening the recovery process after disasters where governments do not have the money for providing relief and helping households. Money or credit from such schemes may help households restart their lives after disasters, for example by purchasing seeds and/or restock animals. As reported elsewhere in the text, households having access

to cash (remittances) during hard times are usually least affected and are able to recover from climatic events faster. Little is known about the potential accessibility and feasibility of such insurance schemes for poor people, however.

5. Conclusion

This paper has reviewed the potential impacts of climate change on Uganda and illustrated possible adaptation measures taking into consideration social, economic and environmental trends and sources of vulnerability. Agriculture remains the backbone of the economy and in order to contribute to climate change adaptation, its development should take place in such a way as to improve livelihood security, in particular among the poorest. However, it is important that other livelihood strategies including pastoralism are also given adequate attention. Due to the relatively limited information on adaptation to climate change in Uganda, an in-depth look at the traditional coping strategies and livelihood adjustments to climatic changes could offer some insights on how adaptation to extreme climate events and long-term climate change may best be promoted among the various livelihood groups.

The Ugandan National Communication suggests several adaptation measures based on expected changes in temperature and rainfall and resulting impacts on various sectors. The communication has thus largely focused on climatic constraints to development. In this paper, we have focused on socio-economic constraints to livelihood security in Uganda and attempted to exemplify types of comprehensive measures that address these constraints and enhance livelihood security as part of adaptation efforts to climate change. These measures complement the measures outlined in the National Communication, thus addressing, at least partly, developing countries' constraints in meeting the high technological and capital investments required in implementing technological solutions targeted at particular changes in specific climate parameters. In addition to having lower capital and technological requirements, comprehensive type measures illustrated in this paper are specifically targeted at the poor and most vulnerable, strengthening their present livelihood security as well as reducing their vulnerability to future climate change. Such measures are critical to adaptation to climate change because poor groups who are vulnerable to impacts of climate change may not be able to access expensive

technologies, such as hybrid crops. An appropriate adaptation approach therefore seems to be building community resilience through strengthening the existing livelihood and coping strategies so that they can cope better with any adverse impacts in future and take advantage of opportunities presented. Comprehensive adaptation measures focus on addressing current sources of vulnerability. For example, measures to address the spread of diseases, such as improving access to health services, safe water and hygiene, are critical to strengthening household labour availability and ability to cope with climatic events. Addressing insecurity in pastoral areas is also likely to strengthen local resilience in the face of climate change. Access to water resources emerges as a critical constraint to future adaptation among vulnerable households. Uganda has instituted a number of reforms in economic management and service provision in line with global trends including liberalization of the economy and greater involvement of the private sector in service provision. In order to reduce current and future vulnerability, it is important that the changes being instituted do not threaten the resource rights and access of the poor to basic resources. In order to strengthen adaptation, reforms in resource access and governance should encourage equitable access to basic resources. Institutional changes, including devolution of governance, privatization of natural resources, and tenure changes are critical in shaping local management, access and control over resources used in livelihood strategies. Such changes may determine the success or failure of any adaptation measure aimed at benefiting the poor or vulnerable.

Finally, adaptation and strengthening of livelihood security are necessarily cross-sectoral, since diversification is a key household strategy to cope with climate stress. Livelihood options are also affected by developments in a number of sectors, including forestry, agriculture, water, infrastructure and health. Development of effective adaptation policies entails coordination between sectors, ministries and institutions. In particular, it is important that vulnerable groups are well represented in the development and implementation of such measures. Involving local communities and their experiences is a first step towards ensuring that any technological or institutional changes to promote adaptation to climate change are appropriate to the intended users.

It is important to note that this paper represents a preliminary review of adaptation issues in Uganda; in order to develop comprehensive adaptation policies in Uganda, in-depth studies of sources of vulnerability and current constraints to livelihood security in the face of climate stress need to be carried out.

Notes

1. IPCC, 2001a.
2. MAAIF, 2002.
3. MAAIF, 2002; MLWE, 2002.
4. Waiswa, 2003; MLWE, 2002.
5. MLWE, 2002.
6. MLWE, 2002.
7. MLWE, 2002.
8. MAAIF, 2002.
9. MLWE, 2002.
10. MLWE, 2002.
11. MLWE, 2002.
12. Thompson and Caincross, 2002.
13. Odhiambo and Hesse, 2002.
14. AfDB *et al.,* 2003.
15. IPCC, 2001a.
16. Kelly and Adger, 2000; Eriksen, 2000.
17. AfDB *et al.,* 2004.
18. IPCC, 2001a.
19. Huq *et al.,* 2003a.
20. DFID, 2004.
21. *ibid.*
22. RCRCCC, 2003.
23. Kelly and Adger, 2000.
24. O'Brien *et al.,* 2004.
25. O'Brien *et al.*, 2004.
26. O'Brien *et al.,* 2004.
27. MLWE, 2002.
28. MLWE, 2002.
29. As Robertshaw and Taylor, 2000.
30. MLWE, 2002.
31. Rasmusson and Carpenter, 1982.
32. Schreck III and Semazzi, 2004.
33. MLWE, 2002.
34. MLWE, 2002.
35. Naughton-Treves, 1997.
36. Moyini, 2004.
37. Smith *et al.,* 2001.

38. Haslwimmer, 1996.
39. Shapouri and Rosen, 2001; Haslwimmer, 1996.
40. MFPED, 2001.
41. Phillips, 2003, pg. 3.
42. Ellis, 2000.
43. Adger, 1996.
44. Western and Nightingale 2004.
45. Smith *et al*., 2001.
46. Van Koppen, Sokile, Hatibu, Lankford, Mahoo and Yanda, 2004.
47. Smith *et al*., 2001.
48. *ibid*.
49. Eriksen, 2005.
50. Smith *et al*., 2001.
51. for example in Smith, *et al*., 2001.
52. Phillips, 2003.
53 IPCC, 2001b.
54. IPCC 2001a
55. *ibid*.
56. MLWE, 2002.
57. MLWE, 2002.
58. MLWE, 2002.
59. Phillips, 2003.
60. Hesse and Odhiambo, 2002.
61. MAAIF, 2002.
62. MLWE, 2002.
63. Moyini, 2004.
64. *ibid*.
65. MLWE, 2002.
66. Eriksen, 2000.
67. MAAIF, 2002.
68. MFPED, 2001.
69. MLWE, 2002.
70. UNEP/UNDP, 1999.
71. MAAIF, 2002.
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