



**Sustainable Energy Watch
2007**

Improving Energy Resilience in Uganda



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Summary of Report

This report explores how the strategic design of sustainable energy policies and management approaches and the investment in corresponding technologies can be used to build up the resilience of vulnerable communities in Uganda to cope with climate change impacts. Recommendations include: accounting for regional disparities in energy policy and planning; examining the potential for sustainable bio-fuel production to reduce the burden on the country's dwindling biomass base; and, increasing the visibility of energy in the country's poverty reduction strategy.

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Preface

Climate change is now a certainty and we must plan for the reality that dangerous changes in weather patterns will disrupt economic activity. The impacts will be worse in developing countries, where existing capacity to manage disasters is still very low, further impeding progress towards achieving the Millennium Development Goals. The costs of weather-related events are rising rapidly around the world. There is need for a new integrated approach which optimizes the response of key actors like business, government and civil society in dealing with weather related disruptions. Such an approach should coordinate adaptation, disaster management, and sustainable economic development more systematically.

The aim of this report is to contribute to the identification of vulnerabilities to climate change and ways through which communities in Uganda, especially at risk, poor groups, may be assisted to adapt to climate change impacts. Adaptation to climate change in this instance 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 opportunities.

This report explores how best sustainable energy investment can be employed in building the resilience of vulnerable communities to cope with climate change impacts in Uganda. The report makes specific policy recommendations on how energy systems can be made more resilient in order to fully support Uganda's development needs.

Executive Summary

While Uganda's climate offers great potential for food production, prolonged droughts and frequent famine in many parts of the country, particularly the northeast, have brought increasing public attention to the long-term economic ramifications of climate variability. For instance, the percentage of people living below the poverty line fell from 56% in 1992 to 35% in 2002. This figure recently increased to 38% apparently due to climate variability. In 1997/1998 an estimated 525 people died and over 11,000 were hospitalized and treated for cholera triggered by the El Niño induced floods and land slides; and damage to trunk and rural roads infrastructure was estimated at US\$ 400 million.

Uganda's low level of income as shown by a low per capita income (approx. US\$300) and its heavy dependence on rain-fed agriculture make it very vulnerable to climate change. A large part of the population is self-employed in agriculture. A negative change in climate patterns directly affects the performance of the agricultural sector and consequently the livelihoods of many people. This situation is exacerbated by Uganda's high external debt of over US\$ 3.2 billion which reduced funds available to finance initiatives that could assist the poor to cope with climate change impacts.

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. Among other things, Government has developed a comprehensive National Adaptation Program of Action (NAPA). The NAPA is a prescription of urgent and adaptation needs for Uganda. It also signed and ratified the United Nations Convention to combat desertification (CCD) in 1994 and 1997 respectively. A National Action Program for Dry lands has been elaborated. The NAP aims at the sustainable development of dry areas by focusing on the alleviation of poverty, food security and sustainable environmental management.

Additionally, the Government has established a Department of Disaster Preparedness under the Prime Ministers Office.

Uganda adopted its energy policy "Energy 21" in 2002. This policy recognizes the strong linkage between energy and poverty eradication. However in spite of several initiatives in the energy sector, the lack of access to clean and efficient energy services—fuels, electricity, and motive power—is a major factor in contributing to rural poverty especially in the dry lands. Biomass resources—wood, charcoal and agricultural residues—constitute about 93% of the country's total energy consumption which in turn contributes to the decimation of the country's forest resources is accelerating the desertification in Uganda's dry lands. Increasing desertification makes poor rural communities ever more vulnerable to the vagaries of climate.

Petroleum imports consume a considerable portion of Uganda's total export earnings, approximately US\$ 120 million and equivalent to 20% of the country's total export earnings. The high cost of petroleum products discourages its use for activities such as irrigation and other initiatives that

would increase rural incomes, helping to build up resilience to climate change impacts.

At US\$ 0.24/KWh, Uganda's electricity tariffs are one of the highest in Africa. Because of this the majority of the population cannot afford the cost of being connected to the grid. Grid access in rural areas is a paltry 2.0 %. The electricity supply system in Uganda is highly centralized which requires huge infrastructure for the distribution of the power across the country. This system is highly vulnerable to disruptions and entails high costs for distributing the power across the entire country.

Understanding local needs and resources is crucial in choosing the energy technology to use. As a precondition for successful energy investment, training communities to operate and maintain the system is key to ensuring sustainability of energy systems. It's also vital to expand the boundaries of the energy system beyond the technology to incorporate secondary job creation, community consultation, local community participation in decision making, and capacity building. Recognition of appropriate local system of governance is also important. Decentralization government policy in Uganda provides a fertile policy environment to take advantage of decentralized energy planning that is sensitive to regional disparities.

The report concludes with a series of policy recommendations aimed at reducing vulnerability to climate change. Particular focus is on making the energy sector more resilient. These recommendations include:

Recommendation 1

Design a means of decreasing costs of modern fuels—particularly electricity and diesel—to make them more affordable for economic production. Tax reductions or exemptions on capital equipment for electricity generation; the reduction of taxes on certain petroleum products such as diesel are some of the options.

Recommendation 2

New renewable energy sources—solar energy, wind, modern bio-energy, geothermal and small hydropower—should be given special priority via government incentives to encourage investment in this area. These energy sources would help to lift burden currently on Uganda's forests. It could also provide much needed power for irrigation, hence supporting coping potential of communities to climate change impacts in dry lands.

Recommendation 3

Energy policy and planning should take into account significant, regional variations. Current energy policy does not seem to recognize that different parts of the country have differing energy needs. The current policy structure in Uganda offers a good opportunity to implement decentralized energy planning that caters for regional disparities and constraints. It's therefore a suggestion of this paper that districts should become more actively involved in energy planning.

Recommendation 4

Sustainable bio-fuel production is another option that could be used in complementing Uganda's dwindling biomass resource base. Biomass based industries could be a significant source of jobs in rural areas, and sustainable land management activities can promote biomass re-growth, allowing more carbon dioxide to be absorbed from the atmosphere.

Recommendation 5

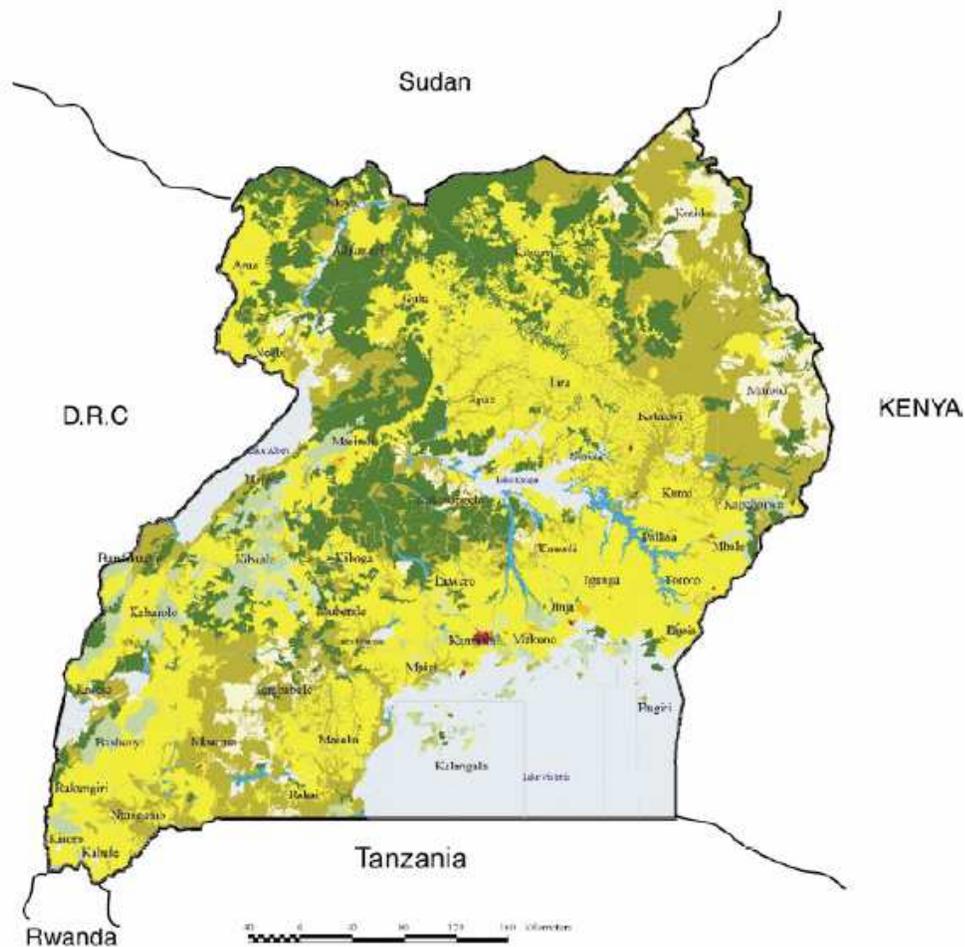
There is a need to increase visibility of energy in the PEAP; the country's poverty reduction strategy. The PEAP provides the over-arching framework to guide public action to eradicate poverty, including the formulation of sector-wide and district development plans. But issues of how energy can be used to drive rural development are weak in the PEAP. This issue needs to be strengthened in the next PEAP review.

Overview

Country Background

Uganda is located in Eastern Africa and occupies an area of 241,038 square kilometers of which open water and swamps constitute 43,941 square kilometers and represent 18.2% of the total area. The 2002 census estimated that Uganda's population had grown up to 24.7 million people and had an annual average growth of 3.4%. Population growth is highest in the dry areas averaging 9.7% in Kotido and 6% in Moroto, both which are extremely vulnerable ecosystems. The population annual growth rate is higher than the average Sub-Saharan rate of 2.1%¹.

Figure 1: Location of Uganda



The country is endowed with a considerable amount of natural resources that include fertile soils, and a favourable climate for agriculture.

¹ Uganda National Adaptation Programmes of Action (NAPA), November 2005

Uganda has achieved strong economic growth and macroeconomic stability over the last two decades, owing largely to the implementation of an ambitious program of macroeconomic adjustment and structural reforms. Overall, the economy has been growing at a rate of 5-7% over the past decade. As a result, a number of government service parastatals in sectors such as energy and health were privatised. To some extent this has negatively impacted various income groups with the poor finding it increasingly difficult to access basic services such as energy and water. Economic growth has been accompanied by sustained shifts in the economy. Agriculture, which accounted for 68% of GDP in 1985, now accounts for only 31.8% while the contribution of industry and services has steadily risen².

Table 1: Summary of Country Characteristics

| | 2003 | 2004 | 2005 | 2006 |
|--|-------------|-------------|-------------|-------------|
| Real GDP growth | 4.7 | 4.0 | 5.3 | 5.6 |
| Tax revenue as % of GDP | 11.3 | 12.2 | 12.8 | |
| Value of exports (\$ M) | 563.0 | 629.7 | 659.7 | 663.3 |
| Value of imports (\$ M) | 1255.9 | 1318.2 | 1492.5 | 1620.0 |
| Current account balance (\$ M) | -377.4 | -361.5 | -462.8 | - 507.8 |
| Balance of payments (\$ M) | 178 | | | |
| External Debt (\$) | 3.9 | 3.8 | 3.7 | 3.6 |
| Incidence of absolute poverty % | 38 | 38 | | |
| HIV /AIDS prevalence | | 6.1 | 5.6 | |
| Life expectancy | 42 | 43 | 47 | |

Source: Uganda Sustainability Watch Report, 2005

For a country where over 85% of the population lives in rural areas and depends on agriculture, this drop in agricultural growth has had some negative impacts among the rural poor. The percentage of people living below the poverty line fell from 56% in 1992 to 35% 2002. However, in 2004 it increased to 38% apparently due to climate variability and conflicts in the northern and eastern parts of the country.

² UNDP (2004) Human Development Report

Climate Change in Uganda

Current Climate Patterns

Uganda experiences moderate climatic conditions throughout the year. Its location across the equator gives it two rainy seasons annually although these two seasons merge into one long rainy season as you move away from the equator. The first rainy season is from March to June, while the second one is from August to October. The mean annual rainfall varies from 750 to 2000 mm³. Rainfall is the most sensitive climate variable affecting social and economic activities.

Despite the generally favourable climatic conditions, the frequency and severity of droughts in many parts of the country is on the increase. Seven droughts were experienced between 1991 and 2000. Traditionally the cattle corridor, stretching from the northeast to the southwest is the most prone to droughts. However over the years, drought-like conditions have broken out in totally new parts of the country.

Impacts of Climate Extremes

The prolonged and severe drought of 1999/2000 caused severe water shortage which led to loss of animals, severe famine and a drop in the local economies of this area. Severe drought was responsible for the escalation of social conflicts among the different Karamajong clans as they competed for scarce water and pasture resources. Over the last few years, severe drought conditions have caused massive rural to urban migration of the traditional Karamajong pastoral communities on to the streets of Kampala (capital city). Increasing climate change is escalating food insecurity in the country with malnutrition rates being the highest in the dry lands.

Climate change which manifests itself through the increased frequency of extreme weather events such as droughts, floods and landslides is already posing a serious threat to economic development as shown in the table below.

³ First National Communication on Climate Change

Table 2: Impacts of the 1997/98 El Niño rains

- An estimated 525 people died and over 11,000 were hospitalized and treated for cholera triggered by the El Niño induced floods and land slides;
- An estimated 1,000 people were reported to have died in flood related accidents;
- About 150,000 people were displaced from their homes;
- Damage to trunk and rural roads infrastructure was estimated at US 400 million;
- In Kapchorwa district about 300 hectares of wheat were destroyed;
- Tea estates were flooded making tea picking difficult;
- Coffee exports dropped by 60% between October and November (disrupted transport system);
- Infiltration of water resources and flooding of some pumping stations (submerging of pumping stations); and,
- Monetary value of the losses in the agricultural sector and inaccessible markets were not estimated. The total cost could run into hundreds of millions of US dollars.

Source: First National Communication on Climate Change for Uganda, 2002.

Drought also affects the power supply and water availability to urban areas, which is a problem for the country as it is heavily dependent on hydroelectric power for its industrial performance.

National Response to Climate Change

On the whole, the issue of climate change and its influence on national economic performance has not yet been appreciated. Many of the country's development plans have not accounted for climate change impacts and as such little or no resources have been provided. There is an increasing need to raise the level of awareness of climate change and its importance to success of national development.

The country has however undertaken a number of positive steps to address the problem of climate change at both the national and international front. For instance, Uganda signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) on June 13th, 1992 and September 8th, 1993 respectively. And in compliance to the convention's provisions, a number of activities have been undertaken at the national level. Most of these are geared to building national capacity to implement the convention and include:

- Designation of the Department of Meteorology as the UNFCCC Focal Point;
- Compilation of a national inventory of sources and sinks of greenhouse gases;
- Carrying out vulnerability, adaptation and mitigation assessments;
- Carrying out capacity building activities on the UNFCCC in general and the CDM in particular;
- Compilation and submission of the First National Communication to the COP; and,
- Carrying out several public awareness activities.

In November 2005, Uganda completed the development of its National Adaptation Program of Action (NAPA) on climate change.

Uganda also signed and ratified the United Nations Convention to combat desertification (CCD) in 1994 and 1997 respectively. A National Action Program for Dry lands has been established and aims at developing dry areas sustainable by focusing on poverty alleviation, food security and sustainable environmental management.

Integrating Disaster Risk Management in National Policy

The 1997-98 El Niño struck Uganda at a time when the country had a very unfavourable policy climate to respond appropriately to flood-related disasters. The government was totally overwhelmed by the magnitude and diversity of the impact. In addition, the lack of coordination between the various response centres resulted in slow interpretation and action.

The Government responded by establishing a Department of Disaster Preparedness to coordinate serious emergency efforts. Climate forecasting was strengthened and improvements were made to the coordination of early warning, and communication between government and donor agencies, e.g. especially for the management of strategic food security reserves.

The Department of Disaster Preparedness is coordinated by the Office of the Prime Minister. But even so, long-term disaster management has not been adequately integrated across all sectors. Prevention is only a limited component of the PEAP⁴ and other development plans.

The Government's Department of Meteorology is responsible for the provision of weather and climate data services to different sectors, including the private sector, civil aviation authority, radio stations etc. The regional Climate Outlook Forum established in 1998 generates seasonal forecasts which are used by the department of meteorology and other users.

Energy Sector in Uganda

The National Energy Policy

Uganda's energy policy "Energy 21" was adopted in 2002 and recognizes the strong linkages that exist between energy and the other sectors such as environment, water, agriculture, health, transport and education. The goal of the policy is "to meet the energy needs of the Ugandan population for social and economic development in an environmentally sustainable way".

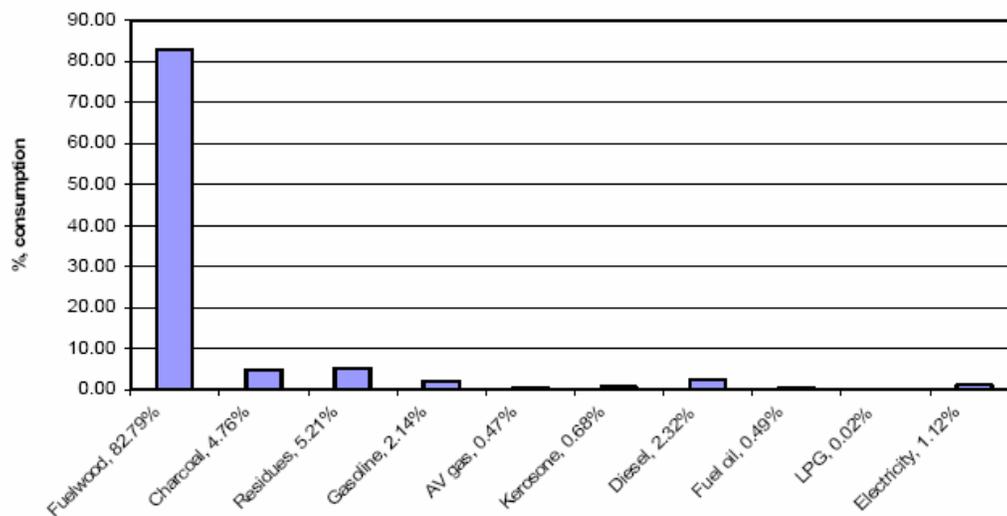
With a per capita energy consumption of 0.3TOE or 12.72 GJ, Uganda's energy consumption is among the lowest in the world. Biomass resources—wood, charcoal and agricultural residues—constitute about 93% of the total energy consumption. The daily per capita consumption of woody biomass for

⁴ Poverty Eradication Action Plan, in other countries this is the poverty reduction strategy paper

energy was about 4 kg (NEMA⁵ 2001/2002). By 1998, the wood-fuel demand was estimated to be about 18.5 million tones (0.88) TOE, according to the Forestry department. This increase in consumption is greatly contributing to the decimation of the country's forest resources, and fastening the rate of desertification in Uganda's dry lands. Increasing desertification is expanding the vulnerabilities of poor rural communities, particularly women and children.

Figure 2: Energy Consumption in Uganda, 2001

Figure 1: Energy consumption in Uganda, 2001



Source: MEMD 2002

Uganda's per capita consumption of 62kwh/year is very low compared to its neighbouring countries. This is because of high electricity tariffs—US \$ 24 cents per KWh—brought about by high distribution costs. Because of a highly centralized supply system from the main hydro power dam in Jinja, distributing power across the country is very expensive. Because of these exorbitant costs, poor people in rural areas can not afford to pay for the power with a result that only 3.0% have access. The majority of the communities both urban and rural largely depend on fuel wood and charcoal for their energy needs.

Over the years, the annual per capita consumption of petroleum products in Uganda has increased partly due to a rise in the number of vehicles and industries. Between 2004 and 2006 the number of businesses operating on thermal electricity increased even further as the country's electricity supply dwindled due to a devastating drought that lowered the water levels of Lake Victoria.

⁵ National Environment Management Authority

Uganda's annual importation bill for petroleum products is very high and continues to rise. This cost is estimated to be more than US\$ 212 million which represents about 15% of the total export earnings. This removes a considerable percentage of the country's per capita income, drawing resources away from pro-poor development programs.

Between 1990 and 1998, Uganda's total carbon emissions increased by 57% compared to the 10% average for sub-Saharan Africa⁶. Within the same period, the per capita CO₂ emissions shot up by 133%. Although, Uganda's contribution to global carbon dioxide remains negligible, these drastic increases are a clear indicator that the country's current energy path is very unsustainable. The upward trend in emissions is attributed to increasing fossil fuel consumption in the country; and the increasing importation of used vehicles and cheap obsolete technologies as the economy continues to grow.

Reforms are already underway that have seen the liberalization and unbundling of the power sub-sector, with the creation of a regulatory agency to oversee full and fair private sector development in anticipation of investment.

⁶ <http://earthtrends.wri.org>

Anticipated Areas of Vulnerability and Associated Consequences

Country Context

Based on macro level indicators that measure a weak institutional capacity, limited resources for disaster management, low levels of income—as shown by a low per capita income, approx. US\$300—and the heavy dependence on rain-fed agriculture, Uganda can be assumed to be very vulnerable to climate change.

A large part of the Ugandan population is self-employed in agriculture. A negative change in climate patterns directly affects the performance of the agricultural sector and consequently the livelihoods of many people. This will lead to hikes in food prices, lower domestic revenues and a widening of the current account deficit due to lower export earnings coupled with increased inflation and external debt. Crop sensitivity to climate variability and change in Uganda varies by ecological zone. In particular, the uncertainty of the 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.

Uganda's over dependency on natural capital appears to be the country's biggest weakness because of the difficulty in increasing production and consumption without depleting natural resources, some of which are irreplaceable. Overdependence on natural capital is therefore something that raises the country's vulnerability.

Uganda's high external debt of over US\$ 3.2 billion means that increases in GDP are eroded by the high debt service ratio (about 2.6); this reduces the impact of any improvements in the economy and increases poverty as much needed funds that would support initiatives to build pro-poor resilience to climate change impacts are diverted to service debt.

Insecurity has been identified as one of the most important reasons for the increasing levels of poverty in Uganda's northern region. The twenty year old conflict in this region, has prevented people from making long-term investments and has restricted economic activities. In areas like Gulu, where people have been living in internally displaced camps for over twenty years social networks and safety nets have been totally destroyed leaving communities extremely vulnerable to the impacts of climate variability.

The HIV/AIDS pandemic is an increasing burden to many households. Because AIDS often eliminates the economically most productive members of the family, the disease has reduced agricultural productivity. Productivity is further compounded with remaining household members having to spend substantial amounts of time and money caring for the sick. Furthermore, assets such as land and livestock have had to be sold off to pay for medical and funeral expenses of those infected by HIV/AIDS.

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. This is further compounded by dwindling government financial allocations.

Large economic changes are exposing the agricultural sector to fluctuations in world market prices and affecting the poor's access to basic health and education services. These further compound the poor's vulnerability to climate change.

Vulnerabilities by Sector

Agriculture

Agriculture is the backbone of Uganda's economy. It constitutes about 42% of GDP, comprises over 90% of export earnings and employs over 80% of the labour force. The major factors that influence agricultural production include soils, climate, agricultural implements, management practices and access to markets.

Uganda's agriculture is subsistence, rain-fed and therefore extremely vulnerable to climate variability and change. Although it is predicted that climate change will lead to increased rainfall in Uganda, its distribution during a season is critical to agricultural performance. Any increase in extreme events associated with climate change may cause significant loss of life and substantial damage to property. The cyclic and increasing frequency of droughts will have an adverse effect on agricultural production. Some of the negative effects of this will be on the national economy include:

- Increases in food prices leading to an unstable macro economy and resulting into inflation, which discourages foreign investment;
- Low incomes leading to poor health and decreased standard of living; and,
- Increased external debt.

Poor seasons and occurrences of droughts will therefore exacerbate poverty.

Water Resources

Even though 15 percent of Uganda's total area is covered with water, the distribution is highly geographically differentiated, meaning that large parts of the country, especially the semi-arid areas in the north, face problems of water scarcity. A large proportion of the population depends on streams for their water which tend to dry up during droughts causing serious water stress. The cyclic and increasing frequency of droughts will have an adverse on both the quality and quantity of water. Prolonged and severe droughts lead to low water levels in rivers, underground aquifers and reservoirs, affecting the hydrology and water supply. The severe drought of 2004/05 contributed to the reduction of the Lake Victoria and Nile River waters and had a serious impact on power generation at Uganda's biggest dam in Jinja. Climate change will exacerbate water scarcity problems as well as pollution of

water supplies, particularly in urban centers. Floods will increase the contamination of drinking water and lead to outbreaks of water borne diseases like cholera, typhoid and dysentery, particularly as a large proportion of the rural poor do not have toilets.

In the drier Northern parts such as Karamoja, there is a high likelihood that there will be an increase in social conflict stirred by growing competition for pastures and water. In the process, as the burden of providing for these resources at the household level expands, marginalization of certain groups such as women will increase. The continuing privatization of water resources presents a trend that will impact negatively on access rights.

Forests

Forestry currently contributes about 6 per cent to the national GDP and creates employment opportunities that are estimated at about 1 million jobs. But the high destruction of forest resources, mainly for charcoal production, is posing a big threat to the sustenance of forests in the country. Increased utilization of fuel-wood, privatization of access rights and changing climatic conditions are negatively impacting communities living in Uganda's dry lands. The combination of high levels of charcoal production and grazing in the forests is contributing to loss of biodiversity and forest cover, and may potentially threaten future access to forest products as drought coping strategies are implemented.

Additionally, the out break of fires is increasing, particularly during the dry seasons. This is leading to the destruction of large chunks of forestland with serious consequences to vital ecosystems.

Road Infrastructure

Uganda has abundant natural resources, but its effective and economical exploitation depends largely on a well-functioning road infrastructure. Rapid economic growth through private investment and stimulating domestic production, requires good infrastructure such as roads, telecommunications, power and access to markets and education and health services. The rail network in the country has deteriorated over time. This has put substantial pressure on trunk roads many of which were destroyed during the 1997 El-Niño rains.

Health Sector

Climate change will be accompanied by an increase in the incidences of diseases like cholera, malaria. El Niño rains will increase the incidence of land slides as shown by the 1997/8 rains when about 1,000 people died in flood related accidents and 150,000 were displaced from their homes. In Mbale and Kapchorwa, 60 people were injured and 33 died in the 1997/98 floods and land slides. In Rakai, the hailstorms of 2005 resulted into three deaths and displacement of 2,800 people.

Country Assets to Support Resilience and Adaptation to Climate Change

Renewable Energy Resources

Uganda has a very high level of renewable energy resources, including geothermal, biomass-based cogeneration, small hydro and wind. Most of these resources have never been fully developed, while others are only partially developed. The country's geothermal and cogeneration potential can play a vital role in offsetting the energy balance in the country and create employment opportunities for the population.

According to Karekezi et al. (1997), small hydro projects in Uganda have proved to be an important engine of development in most rural areas. Small hydro holds a tremendous potential in the country and hold the promise of improving rural productivity.

These resources offer a great potential in supporting interventions that will reduce dependency on natural vegetation for the provision of energy services. Decentralized energy sources based on renewable supplies are more promising in promoting the emergence of micro businesses and health services necessary in helping communities cope to climate change impacts.

In addition, the country is heavily endowed with forests, rivers and lakes which although threatened by the current unsustainable levels of consumption are of great social and economic value to Uganda and other East African states

Rich and Diverse Biodiversity

Uganda has a rich ecosystem that forms the foundation of the economy. The country is ecologically, agriculturally, culturally and climatically diverse. The majority of people draw their livelihood from these natural systems. The diversity of its ecologies and of its cultural practices has given rise to the use of a wide range of species. The wide genetic diversity existing within agricultural crops helps poor farming communities to cope with drought and salinity. The richness of biodiversity resources is also a source of traditional medicines for the treatment of disease for many resource-poor farmers.

Farmers use genetic diversification of crops as a form of insurance against rainfall variability and pest 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.

Social Networks and Informal Farming Associations

Social networks are the links and connections that individuals and households have with family, neighbours and friends. These networks are always very strong in Uganda, particularly in the rural areas. They are often used as basis for collateral or insurance in micro financing arrangements. A common

feature is “traditional forms of non-cash bartering”, such as the exchange of labour.

By working in groups, villagers are able to spread the risk of new practices and technologies. This is especially important for poor households as it enables them to share some of the production costs and risks, thus increasing their overall resilience to both droughts and floods.

Farming associations have become the focus of innovation and experimentation. The associations are popular with women which helps to strengthen the position of women in the community.

Indigenous Knowledge

Before the advent of complex climate models, indigenous communities have used changes in their environments to predict fluctuations in the weather and climate. Harnessing traditional knowledge about environmental observations will turn out to be extremely useful in complementing scientific understanding of future changes in the climate.

There is vast traditional knowledge about crops, such as types, uses, cropping systems handed from generation to generation that could be tapped to increase community’s resilience and adaptive capacity to climate change impacts.

Micro-financing and Insurance

Uganda has a fast growing micro financing and insurance sector that has been successful in reaching out to rural remote areas. Formal insurance is provided through private or public schemes and is mostly concentrated in the more urban areas. On the other hand, informal insurance—which is provided through micro credit and savings schemes—is concentrated in the poorer areas of the country. In areas that are prone to drought, farmers often invest in “liquid” saleable assets such as livestock that can be sold easily to trusts run by social networks. Community seed banks are also used as insurance against loss of community bred crop genetic materials necessary in drought resistance.

This informal insurance is very useful in reducing community vulnerability and aiding short-term recovery. For the government, this insurance will help in offsetting costs of reconstruction.

National Policies and Measures

Having signed and ratified the UNFCCC, Uganda has put in place a number of supportive policies and measures to effectively implement the convention and other protocols. These policies and measures contribute to the long-term strategic framework for national development with a strong focus on poverty eradication.

Some of these policies include:

Poverty Eradication Action Plan (PEAP)

PEAP is Uganda's Comprehensive Development framework, which has guided the formulation of government policies since 1997. Under PEAP Uganda is being transformed into a modern economy in which agents from all sectors can participate in economic growth. The government envisages that poor people can benefit from economic growth only if the following conditions are met under PEAP:

- Implementation of structural transformation, including modernization of agriculture and the development of industries which build on the demand and supply linkages from agriculture;
- Ensuring the participation of the poor in growth, both by expanding smallholder agriculture and employment in industry and services including rural non-farm enterprises; and,
- Achievement of sustainable economic growth.

Plan for Modernization of Agriculture (PMA)

PMA is a holistic, strategic framework for the eradication of poverty through multi-sectoral intervention enabling people to improve their livelihoods in a sustainable manner. It is perceived that modernizing agriculture will contribute to increasing incomes of the poor by raising farm productivity, increasing the share of agricultural production and creating on-farm and off-farm employment. The poverty focus of the PMA is based on poor people's perspectives that are contained in various poverty studies in Uganda.

Uganda is in the process of developing a number of specific policies for the agricultural sector. The key policy areas will include:

- Agricultural research;
- Agricultural advisory services;
- Farm power and agricultural mechanization;
- Dairy sub-sector;
- Beef sub-sector; and,
- Fisheries sub-sector.

With respect to food security, Uganda has considered several options. These options include:

- Extensive irrigation;
- Publicly held grain resources;
- Compulsory retention of reserve of designated food crops by farmers; and,
- Improved productivity through intensive agriculture.

Population Policy

The Population Policy for Uganda was developed in 1994 with overall goal to influence the future demographic trends and patterns in desirable directions

in order to improve the quality of life and standard of living of Ugandans. This policy encourages sustainable development through, the harmonization of population growth with the country's natural resources such as water, land, forests and climate. This is being done through:

- Expansion of the Primary Health Care (PHC) especially maternal and child-care;
- Promotion of a comprehensive family planning delivery system;
- Education and awareness, inter alia family size, health and welfare; and,
- Integration environmental concerns into population and development issues.

Among the many strategies highlighted in the population policy, the strategy on environment aims at:

- Increasing awareness about impact of population change on the environment;
- Reviewing, enacting and enforcing laws relating to forest conservation, game parks, wildlife, and environmental management in general; and encouraging afforestation programmes;
- Promoting proper waste management in both urban and rural areas; and,
- Promoting research in use of alternative sources of energy and energy saving devices.

Health Policy

The Health Policy and Sector Strategic Plan were developed within the context of the provisions of the Constitution of the Republic of Uganda (1995) and the Local Government Act (1997), which decentralized governance and service delivery. The Health Policy further derives guidance from the National Health Sector Reform Programme and the Poverty Eradication Action Plan (PEAP). The overall policy goal is the attainment of a good standard of health by all the people in Uganda, in order to promote a healthy and productive life. To achieve the goal, the principles of PHC, equitable distribution of health services, good quality health care, efficiency and inter-sectoral co-operation between different health-related sectors and authorities are being followed.

Uganda is committed to addressing the increasing burden of disease resulting from poor environmental health by placing greater emphasis on rural areas where the population has low access to safe water and poor latrine coverage. Key components of the minimum health package, which are directly relevant to the UNFCCC, include:

- Malaria prevention and control;
- Integrated management of childhood illness;
- Public health interventions;
- Health education and epidemics; and,
- Environmental health and disaster prevention.

Disaster Management and Preparedness Policy

Uganda has put in place a comprehensive policy for the effective and practical management of disasters. The overall policy goal is to promote prevention, preparedness, mitigation, response and recovery such that disaster management is integrated with development planning. A Department of Disaster Preparedness has been established in the prime minister's office.

Forestry Policy

The current trend in Uganda has the loss of forest cover and degradation of the remaining forest resource base. For this reason, there has been a need to plan a new direction for forestry development in Uganda. The Policy Goal of the Uganda Forestry Policy (2001) is to establish an integrated forest sector that achieves sustainable increases in the economic, social and environmental benefits from forests and trees by all the people of Uganda, especially the poor and vulnerable.

Environment Policy

The National Environment Management Policy promotes the use of economic instruments, public participation and environment information and education to improve the environment. The overall policy goal is "sustainable social and economic development which maintains or enhances environmental quality and resource productivity on a long term basis that meets the need of the present generations without compromising the ability of future generations to meet their own needs".

National Water Policy

The National Water Policy of 1995 sets out water supply and sanitation policies as well as sustainable provision of accessible clean safe water and hygienic sanitation. The policy promotes a new integrated approach to manage the water resources in ways that are sustainable and most beneficial to the people of Uganda. The overall policy objective for the Water Resources Management is "to manage and develop the water resources of Uganda in an integrated and sustainable manner so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations with full participation of all stakeholders.

Energy Policy

The main policy goal in the energy sector is "to meet the energy needs of Uganda's population for social and economic development in an environmentally sustainable manner". Among other things, the policy intends to guide increase access to modern affordable and reliable energy services as a contribution to poverty eradication.

Table 3: National Mode of Resilience

| | Moderate Climate Warming | Maximum Resilience |
|--------------------|--|--|
| Agriculture | <ul style="list-style-type: none"> ▪ Rains delayed for a number of weeks causing extension of the dry spell. ▪ Low production and productivity of crops and animals ▪ Rains extended for a few weeks causing delay in planting | <ul style="list-style-type: none"> ▪ No rains for a period of over six months which causes a severe drought leading to loss of animal and human life. ▪ Heavy rains causing floods and land slides as well as outbreaks of waterborne diseases as well as extreme flooding |
| Investment | <ul style="list-style-type: none"> ▪ Introduce drought resistant crop varieties ▪ Increase off-farm livelihood opportunities ▪ Diversify the type of crops grown in the area ▪ Train farmers in soil and water conservation technologies ▪ Improve range-land management by planting drought resistant pastures | <ul style="list-style-type: none"> ▪ Build water dams reservoirs for storage of human and animal water ▪ Establish irrigation infrastructure ▪ Elaborate policy environment linking drought preparedness into disaster management Early Warning System. |
| Water | <ul style="list-style-type: none"> ▪ Drop in water levels in streams, rivers and lakes | <ul style="list-style-type: none"> ▪ Water streams, rivers and lakes dry up because of severe drought ▪ Low reservoirs levels reducing the potential for hydropower generation leading to power rationing in the domestic and commercial sectors |
| Investment | <ul style="list-style-type: none"> ▪ Scaling up of water and sanitation using appropriate technologies ▪ Promote community best practices of collaborative water management ▪ Promote appropriate and sustainable water harvesting technologies ▪ Disseminate weather and climate information | <ul style="list-style-type: none"> ▪ Water dams reservoirs for storage of human and animal water ▪ Establish irrigation infrastructure and expand access to water ▪ Climate information |
| Health | <ul style="list-style-type: none"> ▪ Increasing incidences of certain pests and diseases | <ul style="list-style-type: none"> ▪ Massive outbreaks of diseases such as malaria, diarrhoea and cholera |
| Investment | <ul style="list-style-type: none"> ▪ Support local and | <ul style="list-style-type: none"> ▪ Improvement and |

| | | |
|--|---|---|
| | <p>traditional health services</p> <ul style="list-style-type: none">▪ Study and promote traditional food preservation technologies | <p>expansion of health infrastructure</p> |
|--|---|---|

Vulnerability of Energy Systems in Uganda

High Dependence on Biomass Energy Resources

Of the total primary energy supply in Uganda, electricity contributes 1.3%, fossil fuels 4.1% with 92% coming from biomass resources. This high dependence and escalated harvesting of biomass puts a lot of stress on the country's natural vegetation and has resulted in massive deforestation in many parts of the country. This pattern of energy consumption is a major threat to the country's economic development. FAO estimates that Uganda is losing 50,000 ha (0.8%) of its forestland per year, most of which occurs in woodlands outside the protected areas.

Hydro Power Generation Sensitive to Rainfall

Because Uganda's hydropower generation is highly dependent on the amount of water in the rivers, seasonal changes in the amount of rainfall often affect the amount of power generated. In many cases, this causes load shedding and in certain instances has completely power cut off. Electricity production in Uganda is therefore highly vulnerable to climate variability.

Highly Centralized Energy Infrastructure

Until recently, the electricity industry in Uganda was a monopoly with the main supply point located at Jinja at the Owen Falls Dam. This system depended on a highly centralized supply structure that required a large infrastructure for the distribution of the power across the country, making distribution costs high and the system highly vulnerable to disruptions. This form of centralised energy production explains, in part, the low rates of electricity access, especially in the rural areas where access is under 3.0%.

High Investment Costs for the Large-Scale Conventional Energy Sector but Low Population Outreach

While the large scale conventional energy sector—electricity and petroleum—receives the bulk of energy investment in Uganda, it is paradoxical that this sector serves only a small proportion of the population. This sector caters largely to the urban middle and upper income groups and to the formal commercial and industrial sectors.

In spite of substantial investment, the conventional energy sector in Uganda is characterized by an unreliable supply flow, low access levels and capacity utilization, deficient maintenance and high transmission and distribution losses.

High Energy Costs

Uganda has a per capita energy consumption of 0.3 TOE or 12.72 GJ which is considered to be among the lowest in the world. The energy consumption rate stands at about 5 million TOE per year of which approximately 93% is biomass—wood, charcoal and agricultural residue. Few people have access to

modern energy supplies such as electricity and petroleum products. The grid electricity access rate is 6% for the whole country and about 3% for the rural areas. The majority of the population today cannot meet the cost of being connected to the grid. NAPE (2003) noted that as a result of lack of affordability, the majority of Ugandans have resorted to illegal connections, leading to large losses for the power companies. Other than biomass, most of the other available energy sources are beyond the financial reach for the majority of the population. The cost of hydro electricity in the country is one of the highest in the region and continues to rise.

Uganda's low rate of energy consumption is a disincentive to attracting private sector investment in the energy sector. Where investment has occurred rates have been exorbitantly high and pay back periods are short.

High Petroleum Import Bill

Petroleum products are an important source of energy in the country, especially paraffin which is mainly used for lighting in rural communities and poor urban households. A number of diesel and petrol generators are also run by individuals and businesses to meet electricity needs in areas where there is no grid connection and in cases where the supply is rationed. In addition to privately-owned generators, the government operates diesel generators to meet the energy needs of some rural towns not connected to the grid.

In the last few years, the volume of imported petroleum products has increased considerably. All these products are imported and consume a considerable portion of Uganda's total export earnings. The total importation cost for petroleum products is about US\$ 120 million, equivalent to approximately 20% of the total export earnings. The cost of petroleum products is very high primarily due to the high tariffs levied on these products. Because Uganda is a land-locked country, the cost of transportation of oil products from the sea port is high, thus increasing the overall cost of oil products in Uganda.

This high import cost of petroleum makes Uganda highly vulnerable to external price shocks and has obvious implications for the country balance of payments.

Highly Complex Energy System Architecture

The current energy infrastructure, particularly in the electricity sector, is highly complex and requires immense expertise and equipment for its maintenance, most of which is often sourced abroad. This creates delays in repair and increases costs of operation of power plants. Apart from this, many of the large fuel depots are located in the same area in the city making them highly vulnerability in case of a fire outbreak or terrorist attack.

Table 4: Pre-conditions for Successful Sustainable Energy Investment

| | BEFORE | DECISION TIME | DURING | AFTER |
|-----------------------|--|---|---|---|
| Local level | <ul style="list-style-type: none"> ▪ Mobilize and facilitate the active participation of both men and women in technology choice and siting ▪ Consumer education and appropriate information to stimulate informed choices ▪ Consider environment and climate issues ▪ Affordability, and exploration of the “user pays” option ▪ Consideration of long-term maintenance costs ▪ Availability of renewable energy resources / limitations ▪ Understand social economic context and local skills ▪ Energy conservation will reduce the volume of imported primary energy sources. This will increase robustness of Uganda’s energy security | <ul style="list-style-type: none"> ▪ Using participatory approaches, conduct consultations taking into account traditional structures, local priorities and preferences, cultural factors, the context and local institutions, social and environment impacts of technology. | <ul style="list-style-type: none"> ▪ Equip and train local communities for the operation, maintenance and management of energy systems. This would greatly reduce the costs of operation ▪ Create local employment through installation, operations and maintenance | <ul style="list-style-type: none"> ▪ Local level monitoring on whether the energy service reflects true demand |
| National Level | <ul style="list-style-type: none"> ▪ Legislation allowing for | <ul style="list-style-type: none"> ▪ Ensure compliance | <ul style="list-style-type: none"> ▪ Train local expertise | |

| | | | | |
|--------------------------------|--|--|---|--|
| | <p>independent power generation and connection to national grid etc.</p> <ul style="list-style-type: none"> ▪ Energy subsidies and how they discourage or support sustainable energy development ▪ Provide financing for sustainable energy development and risk guarantees ▪ Institute a flexible pricing policy regime for electricity services ▪ Integral revenue collection and control system | <p>with Uganda's poverty reduction strategy (PEAP), MDG and other development targets. Energy should be an important consideration of these strategies</p> | <p>working in partnership with research institutions and other stakeholders like NGOs</p> <ul style="list-style-type: none"> ▪ Reliable systems and components | |
| <p>Investment Level</p> | <ul style="list-style-type: none"> ▪ Assess overall life-cycle cost to the owner ▪ Ensure that choice of energy delivers planned level of service to consumers with minimum need for external services or capital | <ul style="list-style-type: none"> ▪ That the project creates commercial opportunities particularly in rural areas | <ul style="list-style-type: none"> ▪ Supplier requirement for environmental protection | |

Recommendations for Policy Makers

This section presents some recommendations for policy makers based on the vulnerabilities in the energy sector that have been identified and outlines how the sector could be made more resilient in the face of increasing climate change. Each of these policy recommendations is evaluated by identifying possibilities and constraints in institutions and management, legal frameworks, economic/financial context, human resources and technical capabilities in the country.

Recommendation 1

Design a means of decreasing costs of modern fuels—particularly electricity and diesel—to make them more affordable for economic production. Today the costs of electricity and petroleum products are too high relative to the incomes or urban population, especially the urban poor. One option could be to give tax reductions or exemptions on capital equipment for electricity generation. Another option could be to reduce taxation on certain petroleum products such as diesel which is used in rural areas to power small for agro-processing and irrigation facilities. This would greatly support the performance of small businesses that are crucial in coping to climate change impacts especially those located in the dry lands.

Recommendation 2

New renewable energy sources—solar energy, wind, modern bio-energy, geothermal and small hydropower—should be given special priority by government. Incentives should be provided to encourage investment in this area. These energy sources would help to lift off burden on Uganda's forests. It could also provide much needed power for irrigation, hence supporting coping potential of communities in the dry lands to climate change impacts.

These energy systems need to be sensitive to the needs of smaller income generating activities, which are mostly owned by the poor, and are often useful in building local resilience to climate change impacts.

Recommendation 3

Energy policy and planning should take into account current significant regional variations. Because there is significant variations in the way energy is used in the different parts of the country, energy policy and strategies need to take this into consideration if they are to succeed. Current energy policy does not seem to emphasize this aspect.

The decentralization energy policy in Uganda offers a good opportunity to implement decentralized energy planning which caters for regional disparities and constraints. It's therefore a suggestion of this paper that districts should get actively more involved in energy planning.

Recommendation 4

Sustainable bio-fuel production is another option that could be used to complement Uganda's dwindling biomass resource base. Biomass-based industries can be a significant source of jobs in rural areas, and sustainable land management activities can promote biomass re-growth, allowing more carbon dioxide to be absorbed from the atmosphere.

However it is important that these fuels are grown with a focus to providing energy needs of the rural poor. Moreover, bio-fuel production should not cause social and environmental problems.

Recommendation 5

There is a need to increase visibility of energy in the PEAP (country's poverty reduction strategy). The PEAP provides the over-arching framework to guide public action to eradicate poverty, including the formulation of sector wide and district development plans. However issues of how energy can be used to drive rural development are weak in the PEAP and needs to be strengthened in the next PEAP review.

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