“To understand why people go hungry you must stop thinking about food as something farmers grow for others to eat, and begin thinking about it as something companies produce for other people to buy.

• Food is a commodity. ...

• Much of the best agricultural land in the world is used to grow commodities such as cotton, sisal, tea, tobacco, sugar cane, and cocoa, items which are non-food products or are marginally nutritious, but for which there is a large market.

• Millions of acres of potentially productive farmland is used to pasture cattle, an extremely inefficient use of land, water and energy, but one for which there is a market in wealthy countries.

• More than half the grain grown in the United States (requiring half the water used in the U.S.) is fed to livestock, grain that would feed far more people than would the livestock to which it is fed. ...

The problem, of course, is that people who don't have enough money to buy food (and more than one billion people earn less than $1.00 a day), simply don't count in the food equation.

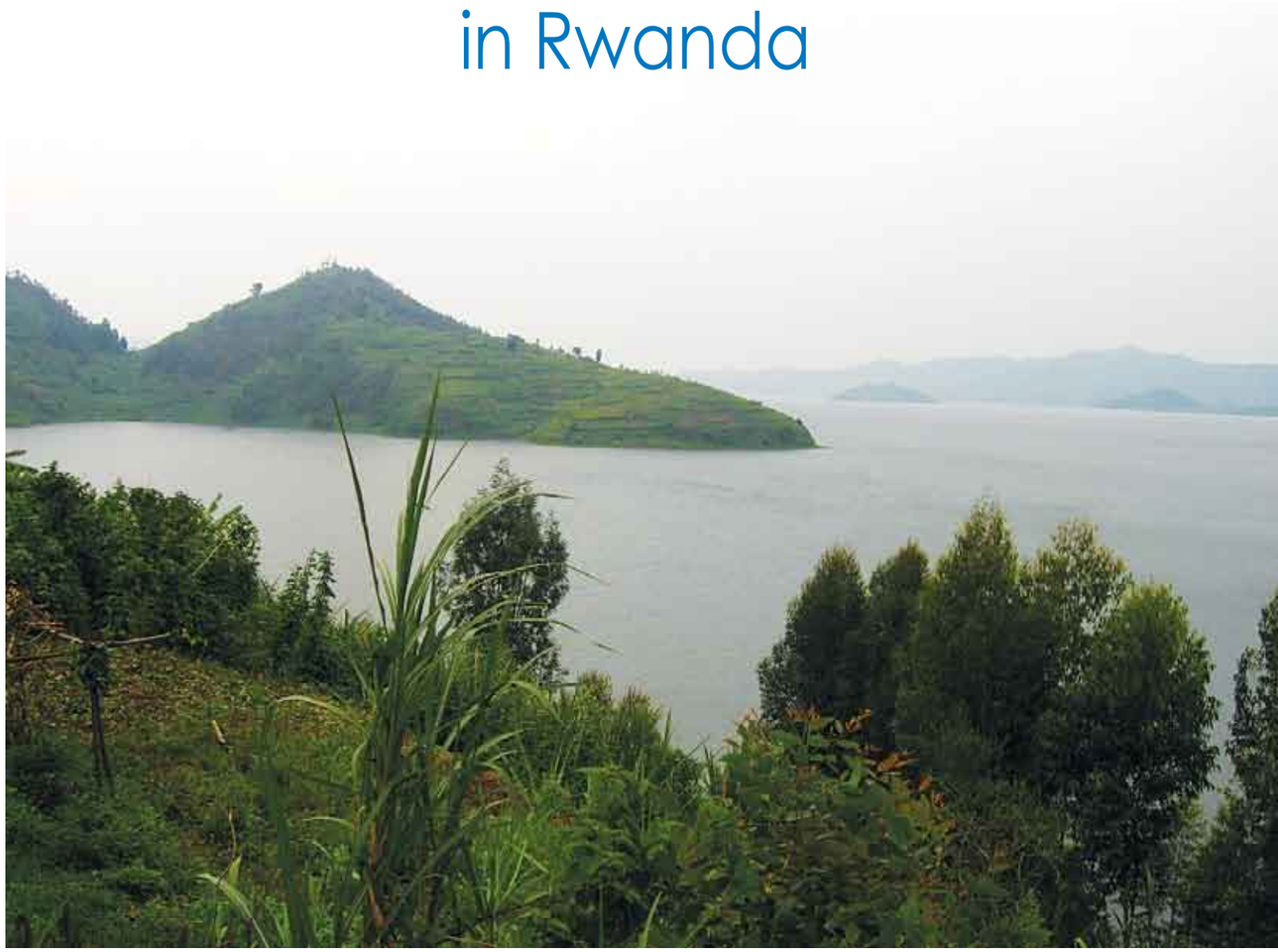
• In other words, if you don't have the money to buy food, no one is going to grow it for you.

• Put yet another way, you would not expect The Gap to manufacture clothes, Adidas to manufacture sneakers, or IBM to provide computers for those people earning $1.00 a day or less; likewise, you would not expect ADM (“Supermarket to the World”) [A large food processing company] to produce food for them.

• What this means is that ending hunger requires doing away with poverty, or, at the very least, ensuring that people have enough money or the means to acquire it, to buy, and hence create a market demand for food.”

— Richard H. Robbins, Readings on Poverty, Hunger, and Economic Development

Economic Analysis of Natuaral Resource Management in Rwanda



UNDP

REPUBULIKA Y'U RWANDA

UNEP

Rwanda Environment Management Authority (REMA)

Foreword

The annual progress reviews for Poverty Reduction Strategy Paper I (PRSP I) consistently highlighted inadequacies in integration of environment into national development planning processes. In the face of growing evidence of the role of environment and natural resources in sustainable development, the Government of Rwanda (GoR) sought partnership to promote the integration of environment into national planning processes and economic development strategies.

These efforts were concretized at a national workshop held in Gisenyi in February 2005 on "Integrating Environment Issues and Rio Multilateral Environmental Agreements (MEAs) into Poverty Reduction Policy and Planning". At the workshop, the Government of Rwanda (GoR) established partnership with UNDP/UNEP Poverty and Environment Initiative (PEI) to develop a strategy to mainstream environment into national development strategies and sectoral plans. This led to the launch of the Rwanda Poverty and Environment Initiative (PEI) programme to support the second generation of PRSP II known as the Economic Development and Poverty Reduction Strategy (EDPRS).

The Rwanda PEI was envisaged to be implemented in two phases over a 4-year period. Phase I would commission studies and develop tools aimed at ensuring that evidence based advocacy tools to primarily inform policy were available to support the formulation phase of the EDPRS. These studies and policy advocacy tools that would be generated under PEI would evaluate the integration of environment into PRSP I with a view to addressing the earlier deficiencies in the planning of EDPRS. Further the studies and advocacy tools would support the formulation of EDPRS and the District Development Plans (DDPs).

The intended outcome of the Rwanda PEI was the integration of environment into national policy and planning processes to implement the EDPRS. One of the studies undertaken to support this objective was the Economic analysis of environmental degradation based on case studies of Gishwati forest and Rugezi wetland (EA I). One of the significant findings of the study was 167% rise in the per capita cost of electricity resulting from the degradation of both Gishwati forest and Rugezi wetland for the 2% of Rwandans who have access to electricity. The results from the study were instrumental in the analysis of existing planning mechanisms and facilitated the identification of priorities within the environment sector during the formulation of EDPRS.

The Rwanda PEI aimed to enhance the contribution of sound environmental management to poverty reduction, sustainable economic growth and achievement of the Millennium Development Goals. The project was coordinated by the Rwanda Environment Management Authority (REMA) in collaboration with the Ministry of Lands, Environment, Forests, Water and Mines (MINITERE). The overall coordination and guidance to the project was provided by a cross Ministerial task team as well as development partners that comprised of MINITERE/REMA, MINECOFIN, MINAGRI, MININFRA, MINALOC, UNEP and UNDP.

I wish to thank the various national institutions which were part of the task team on the project that have provided the necessary support to the project as well as the integration of environment and natural resources in the overall national policy and planning processes.
The inter-Ministerial coordination and the support from the development partners, UNEP and UNDP provided valuable support and guidance that made it possible for the success registered under the project. It was a clear demonstration that true partnership breeds success and all parties are highly appreciated and commendable for the individual as well as collective contribution to PEI, Rwanda.

Sincerely,

Dr. MUKANKOMEJE Rose
Director General
Rwanda Environment Management Authority (REMA)

The Poverty and Environment Initiative (PEI) aims to help countries develop their capacity to integrate the environmental concerns of poor and vulnerable groups into national policy and planning frameworks for poverty reduction and pro-poor growth.

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List of Abbreviations

EDPRS	Economic Development and Poverty Reduction Strategy
ENRM	Economics of Natural Resource Management
GDP	Gross Domestic Product
GEF	Global Environmental Fund
GIS	Geographical Information System
GNP	Gross National Product
GoR	Government of Rwanda
HCLS	Household Living Conditions Survey
IISD	International Institute for Sustainable Development
ENRM	Economic analysis of Natural Resource Management
MINAGRI	Ministry of Agriculture
MINECOFIN	Ministry of Finance and Economic Planning
MINITERE	Ministry of Lands, Environment, Water & Sanitation, Forests and Mines
NPV	Net Present Value
NUR	National University of Rwanda
PEI	Poverty and Environment Initiative
PRSP	Poverty Reduction Strategy Paper
REMA	Rwanda Environment Management Authority
SSA	Sub Saharan Africa
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
WHO	World Health Organisation

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ACKNOWLEDGEMENT

The consultancy work that led to this report was commissioned by UNDP, Rwanda and UNEP for REMA and MINITERE. We are grateful to Honourable Minister Patricia HAJABAKIGA for her inspiration and ideas. We also thank Dr Rose MUKANKOMEJE the Director General of REMA. Despite that REMA is still a young organisation; it is briskly and ostensibly assuming a leading role in fostering national ownership of environmental issues and strategies.

On the technical and financial side we sincerely thank Ms Miko MAEKAWA, Head Sustainable Livelihood Unit in UNDP and Ms Louise Wrist SORENSEN, Technical Advisor to REMA on PEI for their tireless support that has made it possible to have reached this stage of the project. At all stages we received material and professional guidance from Jonathan DUWYN, GEF Associate and UNDP environment focal point based in Kigali and David SMITH at UNEP, Nairobi. We are deeply indebted to their invaluable support and encouragement.

Fieldwork was undertaken in two areas around Gishwati Forest and Rugezi Wetland. We thank the team of data collectors from the National University of Rwanda and not the least the heads of families and respondents who spared their time to answer our questions.

The core team of authors behind this report consisted of three members of faculty of the National University of Rwanda. These were Dr Herman MUSAHARA, Socio-economist and Team Leader: Mme Therese MUSABE, biologist and environmentalist: and Mr Innocent KABENGA, Environmental Economist. They were supported in the analysis by Mr. Manickam JAWAHAR, Mr. Pierre Claver RUTAYISIRE and Mme Veneranda INGABIRE. Any errors in this document are the sole responsibility of the core authors.

Dr. Herman Musahara
Team Leader

EXECUTIVE SUMMARY

The report is structured around two arguments. Firstly, natural resources and ecosystem services in particular have significant contribution to economic growth and poverty reduction. Secondly, failure to manage natural resources, conserve and protect the ecosystem will result in costs of degradation that will compromise medium and long term sustainable development.

These arguments are nested in a context of poverty in Rwanda. While deep levels of poverty in Rwanda are related to a recent genocide, there is ample evidence to show that they are also related to increasing population pressure, degradation of the environment and unsustainable use of land and natural resources in the four decades after independence. Recent official estimates of poverty in 2001 put the number of people below a poverty line of Rwf 64,000 at 60.2 per cent having declined from 77 per cent after the genocide.

It is also noteworthy that genocide besides resulting in wrongful death to about 1 million people pushed down GDP by 50 per cent. It also triggered an unprecedented population movement involving inflows and outflows of more than 40 per cent of the population. The result of fleeing and then returning of families, resettling and giving shelter to new ones and the efforts to rehabilitate the economy greatly severed natural forests and the environment.

A methodology used in this report is beyond orthodox economic analysis of costs and benefits. An ecosystem services approach has been used. This is capable of capturing aspects of the environment and natural resources that are usually neglected either because they do not have market values or they cannot readily be quantified. The approach is supported by Case Studies of Rugezi Wetlands and Gishwati Forest.

The first remark the report makes is lack of data and information on natural resources. The report uses a limited amount of facts based on data, some as old as mid 1990s, to present the case for natural resource management but also for arguing a case for further surveys. Detailed mapping of poverty and the environment is an area that has not received adequate attention.

However the limited amount of information shows serious threats and stresses to the ecosystem in several areas of Rwanda. A UNEP (2005) study shows that while the problem is nationwide, Kibungo in Eastern Province and Butare in Southern Province are two areas where clearly the ecosystem is most threatened and stressed. Components that are surveyed include biodiversity, food production, water supply, energy resources, adequate nourishment, clean water, energy for warming and cooking and earning a livelihood.

Four specific indicators in Rwanda show nationwide linkages between poverty and environment. Natural resource indicators are several. Soil erosion is present in the Southern Province (Gikongoro, Gitarama and Butare), Northern Province (Byumba, Ruhengeri and Gisenyi), and in the Eastern Province (Umutara, Kibungo, Bugesera). Another indicator is access to land. The problem of land is nationwide but more acute in Butare (Southern Province), Gisenyi (Northern Province), Cyangugu (Eastern Province) and Gikongoro (Southern Province). Another indicator under natural resources is lack of access to water. Longest distances to sources of water are found in Kibungo, Mayaga and Bugesera while Kigali Ngali, Bugesera and Kibungo lack access to water for irrigation.

Another indicator under natural resources is those areas in a fragile ecology. These are identified as Umutara, Byumba, Kigali Ngali, Butare and Gikongoro. In these areas medicinal herbs and wild goods have been largely decimated. There are declining fish stocks in Umutara, Cyangugu and Gisenyi.

Another indicator linking environment and poverty is health. Environmental health diseases especially waterborne diseases are nationwide. Kigali City has a problem of access to improved sanitation. Poor housing conditions are nationwide but more pronounced in urban areas. Many areas in Rwanda are prone to natural disasters. Landslides and volcanic eruptions affect Gisenyi, Ruhengeri and Kibuye. Drought is prevalent in Bugesera, Umutara and Kigali Ngali. Some parts of Kigali experience floods during rainy seasons as well as some parts of Kigali Ngali and Byumba.

The report analyses the relationship between natural resources, economic growth and poverty reduction using land and water. The first argument is that soil erosion is due to the topography of Rwanda but it is also due to unsustainable uses in the past including lack of effective anti erosion practices. Erosion affects 50 per cent of all farmers and 1 in 8 of farms. It is the cause of 30 per cent decline in farm productivity. Conservative estimates show that the cost of loss of soil alone may be up to 1.9 per cent of GDP although the report points out the need for more up to date and scientific estimates.

Rwanda is considered as a water scarce economy yet it discharges 5.5 cu.km to the Nile while withdrawing only 0.55. The water flowing from Rwanda carries with more than 14 million tones of humus and top layers of Rwandan soil. If there was effective watershed management in the past less soil would be washed away and more water would be retained in Rwanda. But the case of drying up of Rugezi valley and falling water levels in Lakes Bulera and Ruhondo and the associated energy crisis is a testimony of unsustainable water resource management in the past. More water needs to be harvested. There are 9000 hectares in Rwanda that can be irrigated but only 2000 are in effect under some form of irrigation. There is still a problem of water borne diseases and a lot of water sources especially near urban areas are polluted.

Meanwhile soil conservation alone can raise productivity by 25 per cent. The rate goes up to 33 per cent in areas with low value crops and high erosion. Substantial gains of conservation are imminent from wetlands. As 'kidneys of the landscape' and 'biological supermarkets' their uses are multiple and the benefits are over and above monetary gains. They play an important role in supporting the hydrological and chemical cycles. The functions include flood alleviation, ground water storage and recharge and retention of pollutants. They maintain surface and ground water flows, biochemical cycling. Other functions include nutrient removal and transformation, sediment and toxicant retention, flow water storage, micro climate modification and food web support. They are a source of fish, fuel and can be a tourist attraction. The Rugezi case in the report shows that all wetland functions can be destroyed. Rwanda has about 580.000 hectares of which only 165,000 are cultivated. Authoritative studies show that 15 per cent of growth from agriculture can be ensured from the wetlands. If no sustainable management mechanisms are put in place these valuable ecosystems may not play their role in contributing to economic growth and poverty reduction.

In relation to the role of natural resources in promoting economic growth and reducing poverty, an important aspect is the potentiality of tourism. For 2005 alone the revenue from Virunga National Park amounted to 0.2 per cent of GDP. In neighbouring Uganda gorilla tourism could earn the country between US$ 7 and 33 million.

The potentiality of natural resources in contributing to economic growth and poverty reduction will depend on how Rwanda conserves its natural resources. The report estimates that unless management measures are taken, in 15 years there will be no natural forests in Gishwati, Mukura, Mutara and Virunga. Nyungwe and Akagera will have been depleted by 30,000 and 40,000 hectares respectively. There will be no marshes that are undrained and tragedies like those of Rugezi Wetlands and Gishwati Forest will be common place.

The report has findings on two case studies of Rugezi Wetlands and Gishwati Forest. Rugezi Wetlands shows a case where degradation within the last three decades has resulted in falling water levels and the current energy crisis. By 2004 the water levels in Bulera and Ruhondo usually supplied by Rugezi has fallen by 50 per cent of the average level between 1957 and 1970. The result of the fall in water levels was load shedding of electricity supply that led to escalation of Electrogaz tariff

from RWF 48 to 120. To address the energy problem the government purchased diesel generators. It is indicated by EUI (2006) that these arrangements cost the government US $ 65,000 a day to maintain the generators in operation. But more devastating is the impact of degradation on livelihoods of communities in and around Rugezi.

In the case study it was found out that wild goods have diminished or disappeared. Wild animals and medicinal herbs have disappeared while fish is on the verge of being decimated. Average kilograme per year of thatching grass has declined from 4.2 tonnes to 0.4, while woven goods have declined from 6.2 tonnes to 0.09 and leaf litter from 1.6 tones to 0.10 of a tone. Clay works for making pots common among the Batwa has disappeared from an estimated 7.6 tonnes and livestock browse from 3.1 to 0,8 of a tone. After degradation Rugezi area is experiencing floods because of loss of water regulation. Distances to water sources have gone up. Reeds an important cultural and economic good in the wetland has disappeared. Life around Rugezi is no longer the same. Well being has been negatively affected.

A second case study is that of Gishwati Forest. The forest had been degraded by 1980s. Major causes of the degradation were a World Bank cattle project, serving as a military zone, resettling returning Rwandese in 1995 and a hideout of militias in late 1990s. The paper shows how Gishwati was an important source of goods and services ranging from wild fruit, wild vegetables, wild animals, foods and medicinal herbs. Agricultural loss due to degradation was estimated by peasants to be about RWF 120,000 per season. Degradation has led to more floods in Gishwati and electricity shortage in Cyangugu due to siltation of Sebeya River. as well as the rehabilitation and remediation cost of Gishwati has a budget of US$ 3,571,428. Of tragic significance is the impact of degradation on livelihoods of communities near and around Gishwati. About 72 per cent of respondents used to get stakes for supporting crops from Gishwati now stands at only 7 per cent. Before degradation 40.3 of residents used to get grass to feed livestock from the forest and has now dropped to only 3.5 per cent. Wild fruits have declined by 93.3 per cent, wild vegetables by 99.6 per cent animals by 99.7 per cent wild medicine by 79.9 per cent. Thatching grass collection was estimated to have been about 1.4 tones before degradation but is about .035 of a tone a fall of 93.7 per cent. Woven goods that were estimated to be about 2.8 tones have declined to 0.335 of a tone after degradation. Almost all these goods will have disappeared within a few years.

Rwanda has a formidable challenge of reversing the trends. The case of natural resource management has to be argued and advocated for, including collecting more evidence to support the effort. At policy level NRM has to be part of the efforts to achieve the aspirational goals embodied in Vision 2020 to reach Millennium Goals and to ensure natural resources, land use and environment gain adequate policy attention in the Economic Development and Poverty Reduction Strategy (EDPRS) of Rwanda

1. INTRODUCTION

The study is grounded in the role of natural resources in economic growth, poverty reduction and sustainable development of Rwanda. It is based on a two tier set of hypotheses. Firstly, natural resources and the environment in particular, have significant contribution to economic growth and poverty reduction. Secondly, failure to manage resources, protect and conserve the environment will result in costs of degradation which in turn will compromise the medium and long term achievement of sustainable development in Rwanda.

The hypotheses are tested using a number of arguments, addressing of which should shape current and future policies. Firstly, there is need to evolve a methodology that can capture the true nature of the environment and natural resource management issues which also take into account the contextual nature of the Rwandan economy and policy making process. Section 2 and 3 give a background of the study and methodology respectively.

The second argument being discussed is focusing on the proposition of an existence of a link between the environment and poverty, which has not been fully analysed and acknowledged in Rwanda. While the linkage is theoretically sensible to perceive, it is only recently in Rwanda that it is being analysed in terms of deteriorating ecosystem services which directly affects peoples' well-being. Section 4 summarises the limited evidence now available on Rwanda.

Establishing the linkage is one task and estimating the potential contribution of the environment and natural resources to economic growth in Rwanda is another. A third argument is that policy has not appreciated the significant contribution to economic growth and poverty reduction natural resource management will have in the economic trajectories of Rwanda. Section 5 presents an economic analysis of the contribution of natural resources to economic growth and poverty reduction and the contribution that can be made by minimising costs of degradation.

A fourth argument is that unless there is a deliberate policy reorientation, current trends of taking 'business as usual' will result in scenarios worse than the situation we see now. Using estimates based on recent trends Section 6 shows that in two decades most of the natural resource bases such as forests will have disappeared and most marshlands dried.

A fifth argument is that policy makers are aware of the significance of cost of environmental degradation in stagnating economic growth in Rwanda. However, they lack empirical evidence which can influence their decisions in changing time preferences for specific environment policies which influence the long term economic decisions, including current resource allocations to natural resource management. Section 7 and 8 are presenting and discussing the two case studies. The chapters use Rugezi Wetlands and Gishwati Forest, respectively to provide empirical evidence on the cost of environmental degradation.

Section 9 focuses on prioritisation and policy recommendations for future use of environment and natural resources in the Economic Development and Poverty Reduction Strategy as well as other planning policies and strategies.

2. BACKGROUND

In this section is a brief background of Rwanda. The basic premise of this study is that Rwanda is poor. Its poverty however is not a result of the recent genocide alone. There is evidence to show that past disregard of structural problems related to population, environment and natural resource management have contributed to current levels of poverty. It is imperative to show that future economic growth and poverty reduction should involve change of policies towards better management of natural resources.

Rwanda is a Central African country, situated South of the Equator, between 1o 4' and 2o 51'S and 28o 53' E. It is bordered to the north by Uganda, to the east by Tanzania, to the West by the Democratic Republic of Congo and to the south by Burundi.

Rwanda's relief is hilly, with average altitude of 1700 meters. The highest point on Mt Karisimbi is 4507 meters above sea level. Bordered by volcanoes to the north and rolling hills in a large part of the central plateau, it has earned the name of a 'country of a thousand hills'. To the east, it is however relatively flat with altitudes well below 1500 meters. Consequently, the climate of Rwanda, which according to her location is supposed to be tropical, is mild and cool due to the altitude. Average annual temperatures are about 18.5o C and average rainfall is about 1250 mm per annum.

The land surface of Rwanda is 26,388 km2 and has a population of slightly more than 8 million (GoR 2003). It is a small country. The density of population is 377 one of the highest in Sub Saharan Africa.

About 91% of the population is in the rural sector with about 90% depending on agriculture. The agricultural sector is the backbone of the economy and contributes about 41% of GDP and more than 72% of all exports. Traditional cash crops are coffee and tea. Coffee, tea and minerals earn more than 80% of all foreign exchange (GoR 2006). New products for export, particularly fruit, potatoes and flowers are being promoted in a bid to diversify the export sector (GoR 2002a). There are little if any data on the contribution to the economy of other natural and environmental resources, although it is knowledgeable that in the past two decades tourism was the third earner of foreign exchange (Waller 1996).

Rwanda became a republic in 1962 and has in decades been one of the poorest countries in the world. GNP per capita was as low as US $ 60 in 1969. By 1985 before the economic crises it was still below US$ 300. GDP was actually estimated to be US $ 270 (Europa Yearbooks). Current estimates put GNP per capita at $250, population growth rate at 2.8 percent, life expectancy at 41 years and literacy rates at 48.3 percent (GoR 2002a). Other indicators related to poverty are access to portable water which 44 percent of the population has access to, primary school enrolment rates (gross) 97.1 percent of all eligible children, secondary school enrolment rate 7 percent (GoR 2002b), and HIV/AIDS prevalence of between 3.4 and 7.6 in rural and urban areas respectively(WHO 2005). Infant mortality rate per 1000 is estimated to be 123. The rate of poverty is 60 percent under a new national poverty line (GoR 2002b). As stated at the beginning, Rwanda is one of the poorest societies in the world.

Recent poverty indicators are partly attributed to the most recent genocide that was committed in 1994. In the same year GDP declined by about 50%, approximately one million people were killed and more than 30 percent of the population then in Rwanda were displaced. Poverty became a problem that involved multifaceted and complex social problems as well (UNDP 1999). Poverty in terms of income and consumption was up to 77 percent on the head count index of poverty by 1995 (World Bank 1995). Later our analyses will, among other things, show that the displacement and movement of population following the genocide brought on new pressure on the different ecosystem services and prime natural resource bases like Gishwati Forests, Virunga and Akagera National Parks. The events in 1994 must have surely diverted policy attention from sustainable natural resource management to more emergency issues like resettlement, shelter and food security.

Nonetheless, there is evidence indicating that for more than four decades population pressure was bearing negatively on the stock of natural resources and land in particular (Clay 1996, Ohlson 1999). There is also evidence of environmental scarcity and discrimination during the same period (Bacchler 1999 and Percival and Homer Dixon 1996). Instead of polices to oversee sustainable use of natural resources there is also evidence that there was competition among the elite groups to access and exploit the limited natural resources that were available (Musahara 2005). These sets of evidence demonstrate the need to evolve polices for sustainable use of natural resources in Rwanda. The report provides some evidence that link natural resources with growth and poverty reduction. It also shows that unsustainable use of natural resources in the past have resulted in unprecedented rates of environmental degradation that are a threat to economic growth and poverty reduction now and in the near future.

3. METHODOLOGY

3.1. Introduction

The methodology of this study has been made comprehensive and flexible to permit application of several other disciplines than economics. While the study is on economic analysis, we have noted that poverty is not only income and consumption quantities. Poverty is also about low or stagnating human development (UNDP 1990). It is also about diminishing ecosystem services that usually sustain well beings of poor groups depending more on them (UNEP 2005). Cost and benefits of natural resource use and management require both quantitative and qualitative data. Moreover most environmental goods that form a considerable stock of the natural resource base for most of the poor do not have market values. In this section we outline the problem, hypothesis, objectives of the study and how primary and secondary data were collected and analysed.

3.2. Problem

Rwanda is one of the poorest countries in the world. It is ranked as 159th out of 177 countries (UNDP 2005). About 60 percent of the population are living below the national poverty line of RWF 64,000 a year (~ $ 115). More than 75 percent of these (the poorest) live in rural areas and depend on agriculture for the livelihoods (GoR 2002b). Reducing the levels of poverty and improving their livelihoods depend on how the agricultural production is organised and how environment is harnessed for improved welfare without damaging it.

At national level Rwanda is seeking rapid economic growth to reach the objectives enshrined in Vision 2020 of removing Rwanda from the list of poor countries. A major source of growth is agriculture. But agriculture is a narrow perspective of the broader concept of natural resources. There is no detailed and coherent demonstration of the contribution of environment and natural resources to economic growth in Rwanda. The contribution can be direct in relation to the services that the ecosystems provide to the economy. It can be complementary in relation to how e.g. land use, water, air and forests contribute to the sustainability of the sources of economic growth.

Economic growth is important for poverty reduction. However it will become even more important if it is pro-poor. That is, if the rate of poverty reduction is equal or more than the rate of growth of the economy. Pro-poor growth paths can be ensured if more of the growth is sourced from where the poor live, using their skills and producing goods they use (Pasha 2003). In Rwanda the sources of growth are not as pro-poor as they would be expected (Kade and Musahara 2005). Sustainable use of the natural resources and particularly ecosystem services is pro-poor since most of the poor in rural areas depend on them.

The importance of the link between the environment and growth has not been adequately included in policy making processes (GoR 2006). In PRSP I it was not possible to monitor the role of environment in all the sectors in which it appears. The role of ecosystem services in growth and poverty reduction has not been operationalised in policy, national income accounting and budget allocations. The basic premise is that ecosystem services will ensure growth with poverty reduction if the well being of poorest groups in Rwanda is enhanced.

In relation to the last problem, current analysis of MDGs and PRSP, the role of the environment has been narrowly defined. The role of the environment in poverty reduction towards MDGs is viewed as programming MDG number 7 only. There is lack of understanding that environment is intimately linked to each of the MDG in Rwanda. Being dominantly agrarian, halving poverty, promoting universal education, gender equity, reducing infant mortality and even fighting Malaria and HIV are all at the mercy of the environment and natural resource management in Rwanda.

3.3. Hypothesis

The hypothesis is a two-tier compression of the problem.

1. Plans for rapid economic growth rates that do not take into consideration management of natural resources and the environment will not be sustainable and pro-poor
2. The costs of taking the current status of the environment as 'business as usual' will be so high that long term welfare and livelihoods of Rwandans will be compromised.

3.4. Objectives

The overall objective is to identify the importance of natural resources and environment in economic growth, poverty reduction and sustainable development. At a specific level objectives are as follows;

1. To take stock of existing information on poverty-environment linkages and related activities in Rwanda
2. To identify the contribution of environment to economic growth and poverty reduction in Rwanda
3. To present findings of primary data collected on Rugezi Wetland and Gishwati Forest to provide evidence of costs of environmental degradation and use of natural resources and how they are linked to livelihoods
4. To identify gaps in data, information and analysis in decision-making related to achieving sustainable and pro -poor long-term growth.
5. To construct a natural resource supply scenario if no policy reorientation is undertaken.
6. To identify and recommend strategic priority actions to maximise and maintain sustainable ecosystem services for inclusion in the Economic Development Poverty Reduction Strategy.

3.5. Approach

a) An Ecosystem Services Approach

Poverty reduction and growth studies have tended to give priority attention to monetary incomes and consumption. Studies on environment often consist of rigorous analyses with complex scientific nuances. To capture the real value to livelihoods, a study focusing on ecosystems, human beings, their capabilities, needs and participation is preferable. It is usually a broader approach but one closer to reality and poverty reduction than strictly neo-liberal analyses. It comfortably accommodates qualitative analysis and methods. Analyses and the conclusion of the study make use this approach significantly.

b) Comprehensive Cost Benefit Analysis

In economics Cost Benefit Analysis is convenient on goods that have a market value. If these values are not tenable, shadow prices based on tradable goods may be used. However a more comprehensive approach is better and used, in that non market goods are incorporated and opportunity costs used where direct costs are not available, especially in reporting findings from the case studies.

c) Case Studies

As indicated above two case studies are reported in Chapter 6 and 7. Case studies are effective in pointing to areas of specific policy concerns by providing concrete evidence. Where policy makers have apathy or limited knowledge of the costs and benefits of environment these can be good advocacy tools. Rugezi Wetland shows a case of costs of mismanagement of wetlands while Gishwati Forest shows the costs of deforestation.

3.6. Data Collection

Both primary and secondary data have been collected. Primary data and information were collected in the Case Studies. Literature review and analyses of data from reports and sources in Rwanda were used for the rest of this report. Evidence from the field has been used in corroborating or qualifying some arguments developed from secondary sources.

Case Studies

Gishwati Forest is surrounded by a total of former five districts which are Mutura, Gasiza, Gaseke, Kayove and Kanama in Gisenyi province. The study was carried out in one district (present structure) of Rusatira and in one sector of Ruhango. The sample was picked from two cellules; Gihira close to the former forest and Nyakarera far away (a 2 hours walk from the former forest).

Rugezi Wetland is surrounded by seven secteurs in Bulera district; Butare, Cyeru and Nyamugali in former Ruhengeri Province and Kinihira, Bungwe, Kisaro and Byumba town in Byumba Province. The study was conducted in two secteurs of Bulera and Gicumbi, the latter being away from the Wetland. In Bulera three secteurs were selected. One of the secteurs, Butaro is more affected by degradation. The second Ruhunde is less affected by degradation while Kivuye is regarded as not being degraded at all. Another sample was selected far from the wetlands in Nyankenke in Gicumbi District.

In both cases 30 households in each of the pre-selected areas were surveyed. A total of 60 households were surveyed in each of the case studies.

Secondary data

Literature on environment, poverty reduction and natural resource management was made available by UNDP and UNEP experts. Most secondary data was collected from but not restricted to the list in section 3.7. A substantial set of data has been collected from the internet and from other studies that are not related to our analysis. The sources are indicated appropriately in the text and listed in the bibliography.

3.7. Data Sources

Major sources of data and information have been the following;

1. United Nations Development Programme (UNDP)
2. United Nations Environment Programme (UNEP)
3. Geographical Information System centre at NUR (GIS)
4. National University of Rwanda (NUR)
5. National Institute of Statistics (NIS)
6. Rwanda Environment Management Authority (REMA)
7. Poverty Reduction Strategy Paper I (PRSP I) 2002 - 2005
8. Poverty Reduction Strategy Annual Progress Report(PRS APR 2003, 2004, 2005)
9. Household Living Conditions Survey (HCLS 2002)
10. Ministry of Lands, Environment, Forests, Water and Minerals (MINITERE)
11. Ministry of Health (MINISANTE)
12. Ministry of Agriculture (MINAGRI)
13. Ministry of Finance and Economic Planning (MINECOFIN)

3.8. Instruments

Data collection in the field involved research assistants who would assist in filling in questionnaires for selected respondents. The questionnaires were designed to collect the following data and information:

Did the population that was living around those areas benefit or lose from natural resource exploitation?
Was it necessary to degrade those natural resources or would/could the population have benefited more if they were exploited in a sustainable manner?
Given that most of the population in the area rely on land and other natural resources for their livelihoods, what was the role of those natural resources (Rugezi and Gishwati) that have been degraded in their income generating activities?

In relation to the above questions various data and information have been collected from the two areas on:

Household information
Land issues
Products harvested
Agricultural productivities in the past and present
Soil and water conservation
The nature and the magnitude of the impact, which is affected and in what way

Data collection was focused on providing data of different types that can augment the economic analyses. They are in two categories;

Total cash income:

Crop income
Livestock income
Unskilled labour income
Skilled labour income
Crafts and small-scale enterprises

Environmental income:

Natural habitat utilisation cash income
Consumption of own collected wild foods
Consumption of own collected wild goods
Use of environmental goods for housing
Use of environmental goods for fertiliser

Most of the data collected show quantities before and after degradation and subsequently percentage decline or increase in the past two to three decades.

4. ENVIRONMENT AND POVERTY IN RWANDA

There is empirical evidence to show that environmental scarcity causes poverty and a feedback. The feedback is that poverty leads to environmental scarcity which completes an environment – poverty circle. However the relationship is usually circumstantial for a number of reasons. Environmental statistics are scarce and the concept of environment too broad to establish causal linkage between the two. Poverty statistics tend to focus on a narrow spectrum whose interpretation is around or based on income and consumption. These do not capture the role of environment in people's livelihoods. National Income Accounting and poverty calculations in Rwanda have not taken into consideration services that are contributed by the ecosystems on people's income and welfare.

To overcome this, a definition of environment that takes into consideration the poor and their capabilities is used. Environment is taken as the natural resource base that provides sources (e.g. material, energy) and sinks (e.g. absorbing pollution). An extension of the definition is that environment is a stock of natural resources that provide a variety of resource flows. It is consistent with considering environment as the ecosystem and poverty as the deprivation of indicators of human well-being analysed below (UNEP 2004). In the next paragraphs we present existing evidence of linkage and poverty in Rwanda from the ecosystems perspective.

An analysis of the ecosystem services show that major components are closely related to poverty. In Table 1 Ecosystem services are subdivided, as they are usually defined between provisioning, regulating and enriching. In Table 2 the ecosystem services are related generally to well-being. It is clear that a fall in the capabilities to attain those measures of well being mentioned is deprivation and poverty. Preliminary survey of the state of ecosystem services shows problems in Table 3 and Figure 2. These are consistent with evidence from environmental schools mentioned earlier and the cases studies in this report.

Table 1. Ecosystem services

ECOSYSTEM SERVICES	COMPONENT
Provisioning	• Food • Micro-organisms, plant and animal products • Genetic material, biochemical and pharmaceuticals • Fuel/energy • Fiber • Non-living material • Fresh water
Regulating	• Purification of air and water • Mitigation of floods and drought • Detoxification and decomposition of water • Generation of renewal of soil and soil fertility • Pollination of crops and natural vegetation • Control of vast majority of potential agricultural pests • Dispersal of seeds and translocation of nutrients • Maintenance of biodiversity • Protection from ultra violet rays • Partial stabilisation of climate • Moderation of temperature extremes and force of winds
Enriching	• Spiritual uses and relation of people to land and water • Aesthetic values • Social relation and values • Education and scientific value

Table 2. Ecosystem and wellbeing

ECOSYSTEM SERVICES	INDICATORS OF WELL BEING
Provisioning	• Being able to be adequately nourished • Being able to have adequate and clean drinking water • Being able to have clean air • Being able to have energy to keep warm and to cook • Being able to make sustainable management decisions that respect natural resources and enable the achievement of a sustainable income streams
Regulating	• Being able to be free from avoidable diseases • Being able to have adequate and clean drinking water • Being able to live in an environmentally clean and safe shelter • Being able to have clean air • Being able to use traditional medicine • Being able to cope with extreme natural events including floods, tropical storms and landslides
Enriching	• Being able to continue using natural elements found in ecosystem for traditional cultural and spiritual practices

Source: UNEP/IISD 2004:21

Table 3. Area in Rwanda with ecosystem stresses and threats

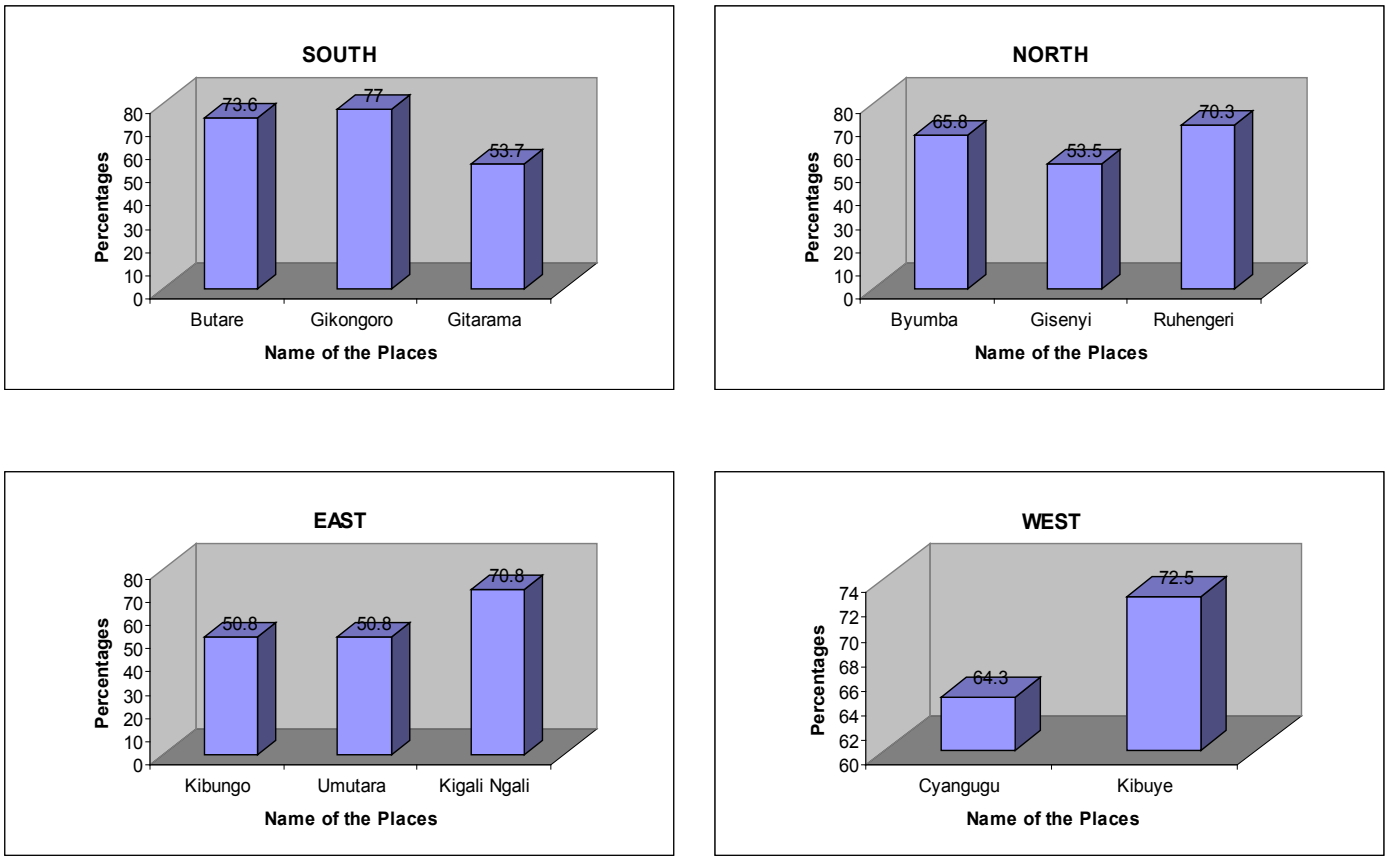
Province	Places	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
South	Butare	X	X	O	X	X	X	O	X	73.6
	Gikongoro	X	X	X	O	X	O	O	X	77.0
	Gitarama	X	X	O	O	O	O	O	X	53.7
North	Byumba	X	X	O	O	X	O	O	X	65.8
	Gisenyi	X	X	O	X	O	O	X	X	53.5
	Ruhengeri	X	X	O	O	X	O	X	X	70.3
East	Kibungo	X	X	X	X	X	X	X	X	50.8
	Umutara	O	X	X	O	X	X	X	X	50.8
	Kigali Ngali	O	X	X	O	X	X	X	X	70.8
West	Cyangugu	X	X	O	X	O	O	X	X	64.3
	Kibuye	X	X	O	O	X	O	X	X	72.5

Source: UNEP 2005

Key: X - ecosystem service components under stress, **O** - not under stress

(1) Biodiversity **(2)** food production **(3)** water supply **(4)** energy resources **(5)** adequate nourishment **(6)** clean water **(7)** energy for warming and cooking **(8)** earn livelihood **(9)** poverty incidence.

Figure1: Graphical representation of poverty incidence in the four regions



The UNEP (2005) study on Rwanda is the only one so far that shows the spatial distribution of ecosystems services stress and threatened well being indicators (see examples in Table 3). Kibungo and Butare in Eastern and Southern Provinces respectively are identified as areas where ecosystem services and well being indicators are threatened (UNEP 2005). However evidently these are summary findings. Moreover there seems to be more areas that are also threatened particularly Umutara and Kigali Ngali in the Eastern Province. Another interesting observation is the diversity between poverty incidence and the degree of stress. Umutara and Kibungo are on average not the poorest of the regions. In the Poverty and Environment Mapping mentioned below, Ruhengeri with steep slopes, land scarcity and soil erosion would be expected to be threatened. Gikongoro and Kibuye with very high incidence of poverty do not seem to be all that seriously threatened. One possible lesson is that our poverty lines and computations do not adequately include ecosystem services. Another is that more focused and localised studies will draw a better picture of the linkage between environment and poverty.

A method that is related to this approach used in the Poverty Mapping in Rwanda is selection of specific indicators that summarise most of the services or give an overall picture of the linkage between the ecosystem and poverty. These are four fold;

1. Poverty and natural resources indicators
2. Poverty and health indicators
3. Poverty and vulnerability to natural disasters
4. Poverty and housing indicators

Tables 4 and 5 show clearly the link between poverty and environment. There are plenty of indicators of well being that are threatened in every part of Rwanda (UNEP 2005).

Table 4. Ecosytem problems and areas affected in Rwanda

SOURCES	RELATION TO THE POOR	AREAS MOST AFFECTED	MAJOR THREAT OR STRESS
Natural resource management and livelihoods	• 90 % of the poor depend on NR	All country especially Ruhengeri, Gisenyi, Byumba, Butare and Kibuye	
Land and soil degradation	• Declining yield and percent of the poor living on marginal lands	• Gitarama, Gikongoro, Butare • Byumba, Ruhengeri, Gisenyi • Umutara, Kibungo, Bugesera	• Over cultivation • Gully erosion • Over cultivation and semi arid area
Access to land	• Population landless or with less than 2 ha	• Nationwide especially in Butare, Gisenyi, Cyangugu, Gikongoro	• Land fragmentation
Access to water	• % of poor with access to safe water or distance to sources	• Kibungo, Mayaga, Bugesera, Ruhengeri	• Dry spells and water deficits
Access to water for irrigation	• % poor farmers with access to sustainable irrigation facilities	• Umutara, Kigali Ngali, Bugesera, Kibungo	• Low water withdrawals and utilisation
Forest/wood resources	• % poor using forest especially fuel wood	• Gisenyi, Ruhengeri, Cyangugu	• Deforestation and over exploitation of forests
Ecosystems	• % of the poor living in ecological fragile land availability of medicinal herbs, wild fruit etc	• Umutara • Byumba, Kigali Ngali, Butare, Gikongoro, Giatarama • Gisenyi, Ruhengeri, Cyangugu and Gitarama	• Land fragmentation
Fishing	• Declining fish stock • Access by poor to fish stock and protein	• Umutara, Cyangugu, Gisenyi and parts of Ruhengeri	• Unsustainable utilisation of the fish resource potential
Environmental health related diseases	• Water borne diseases • Indoor pollution	• Nationwide especially Kigali City	• Water pollution
Sanitation	• Access to sustainable sanitation	• Kigali City, Byumba, Butare, Ruhengeri	• Diseases
Air pollution	• % poor affected by respiratory diseases	• Nationwide especially Kigali City	• Diseases
Natural disasters	• Poor under threat of natural disaster	• Gisenyi, Ruhengeri, Kibuye, Cyangugu • Umutara, Kigali Ngali /Bugesera • Byumba, Kigali City, Kigali Ngali	• Landslides and volcanic eruptions • Drought • Floods
Housing	• Poor living in substandard housing	• Nationwide most especially urban area	• In urban areas included solid waste management

Source: UNEP/GoR 2004, PEM 2 and own additions

5. ENVIRONMENT, ECONOMIC GROWTH AND POVERTY REDUCTION IN RWANDA

That environment in the context of natural resources should contribute immensely to economic growth and poverty reduction is at theoretical level almost self explanatory. The relationship between natural resources and growth is strong in a country whose backbone is agriculture and the means of livelihood depend on land. However as mentioned above, it may not be possible to quantify natural resources and their contribution to economic growth. In one sense that may not matter. Sheer abundance of natural resources has not always meant a guaranteed rate of economic growth (Sachs and Warner 1997). Likewise scarcity of natural resources does not theoretically correlate with poverty. There are countries that are ranked as middle income from developing the service industry or by promoting manufacturing. However in view of the structure of the Rwandan economy, its poor population and their livelihoods a major focus is sustainable use. Past experience show unsustainable uses that are a future threat to the poor. In this section natural resources and economic growth in Rwanda are analysed in relation to answering the following questions:

- How can more sustainable use of land and the environment contribute tangibly to economic growth and poverty reduction?
- Can we estimate the contribution of sustainable use of the environment and management of wetlands?
- What is the potential contribution of other environmental opportunities especially tourism to economic growth?

We shall attempt to answer these with quantities and estimates where possible, pointing out where there are gaps of data and statistics.

5.1. The urgency of sustainable use of natural resources in Rwanda

In this section we show the urgency for sustainable use of natural resources. We analyse how degradation caused by unsustainable land uses in the past negatively reflects on productivity and implicitly on growth and poverty reduction. It is this line of thinking which posits that more sustainable use of natural resources is important for future growth and poverty reduction. For posterity we use land and water only and later show the need for studies in numerous other sectors that fall under natural resources and environment.

Land degradation is closely related to loss in productivity which is a liability to possibilities of economic growth. Water if well managed would also save millions of dollars and augment agricultural productivity especially where rains are scanty. More sustainable use of these two and related resources would reverse possibilities of damage to the ecosystem and minimise current losses due to degradation.

a) Soil loss and land productivity

It was indicated in the background that Rwanda is topographically hilly. A primary cause of soil erosion in Rwanda is the steep slopes on which farm land is located as is the case in the Northern Volcanic regions and especially in the Central and Southern Highlands. However more efforts to control it in the past would have been a sustainable way of minimising current levels of loss.

On average 27 % of cultivated land is undertaken on slopes of more than 20 degrees, 23 % on slopes between 10 – 20 degrees, 16 % on slopes between 5 – 10 degrees and between 0 –5 degrees cover 34 % (Clay and Lewis 1996).Table 5 shows that soil erosion (lower C value) increases with the gradient of the plot. A C value is an index that shows the degree of crop cover (Clay and Lewis 1996)1. The lower the C value the higher is the rate of soil erosion. In spite of information provided in the next paragraphs, topography alone should not be considered as the villain of soil loss due to erosion. Instead more control of soil erosion and introduction of improved soil conservation techniques will help minimise the losses.

1 Clay et al (1996) define C value as the ratio of soil loss from an area with a specific cover and tillage practice to that from an identical area in tilled continuous fallow. For any given field the crop cover, canopy and tillage practices can vary throughout the year. The value represents the average soil loss ratio resulting from these factors

Table 5. Slopes and C values in Rwanda

Slope	C value
0-5	0.17
6-9	0.18
10-14	0.17
15-20	0.16
21+	0.16

Baechler (1999) assembled data on loss of good fertile soil in Rwanda. Loss of humus is to the tune of 10.1 metric tones per hectare and can go up to 36 metric tones per hectare on 5 percent of the soils and more than 68 metric tones on 1 percent of the soil. Clay (1998) states that soil erosion is moderate to severe on 50 % of the land surface of Rwanda. Rwanda is losing an estimated 14 million tones of soil per year due to soil erosion (GoR 2004). Soil erosion is in turn related to fall in levels of land productivity in Rwanda. Table 6 shows that the levels of large decline in land productivity are related to increase in slope of the plots.

Table 6 Slope and productivity decline on farms in Rwanda

Slope in degrees	0-5	6-9	10-14	15-20	21+
Large decline % of farms	9.8	6.9	10.8	15.8	16

Source: Clay and Lewis (1996)

Clay (1998) citing different sources noted that in Ruhengeri for instance 4/5 of all sampled population observed decline in soil productivity due to erosion. In Rwanda 1 in every 8 fields experience sharp decline in productivity due to soil erosion Clay et al (1999) have shown that yield may be reduced significantly by soil erosion.

Land productivity on very eroded farms is 21 percent lower than on farms with little erosion. The most extreme case is for farms with a low share of high value crops such as coffee and bananas and low share of cultivated area on which fertiliser or organic matter has been applied. The loss was estimated at about 36 percent (pg 83).

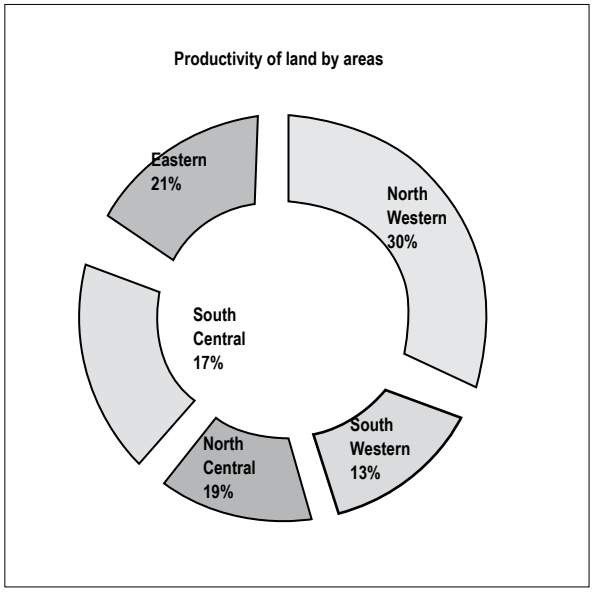
Land productivity in Rwanda has always varied by region. This is depicted in Table 7. The South West corresponding to the present South Province and former provinces of Gikongoro are obviously areas with the lowest levels of erosion.

Table 7.Productivity of land by region

Region	RWF/ ha in 000
North Western	32.6
South Western	14.3
North Central	20.1
South Central	17.9
Eastern	22.1
Average	**20.3**

Source: Clay et all(1996)

Figure 2. Graphical representation of productivity of land by areas



The foregoing analysis would suggest that soil erosion and thus fall in land productivity is attributed to the topography of Rwanda. This should not be an excuse. As hinted above, where there are farms on steep slopes is where more anti erosion activities would have taken place. A substantial amount of this soil erosion is therefore due to unsustainable stripping of forest cover and lack of firm and continuous policies of protecting soil. Thus estimates of the loss in the following paragraphs should be clearly interpreted in light of past land use practices that were not sustainable.

Using data and statements above and using the estimate of value of loss per hectare (Delpieere 1997) it is possible to state that the economic cost due to soil erosion is immense. In Table 8 we offer an estimate that loss due to soil erosion may be equivalent to almost 2 percent of GDP.

Table 8. Estimated loss from soil erosion

	Area in ha	Estimate area under erosion	Estimate loss per ha	Estimate total loss
Land under cultivation	1,144,300	572,000	33,000 RWF	18,876,000,000
			US$	34, 320,000
			As % of GDP	1.9

Source: own estimates

This is certainly a conservative figure. Our expectation is that further studies by soil scientists will reveal that it is possibly more. Firstly, the cost of loss per hectare is based on studies carried out in early and mid 1990s. More current data collection, estimates on soil loss need to be carried out presently. Secondly, the current figure of more than 14 million tones mentioned earlier has been said to be equivalent to loss of capacity to feed 40,000 people annually (GoR 2004). Failure to control erosion substantially has a high cost. More sustainable use would reduce the number who falls under absolute poverty annually and potentially increase production.

Finally we should note that soil erosion is not the primary cause of fall in land productivity in Rwanda. Table 9 indicates that over cultivation is the principal cause among a majority of farmers. There are ample data that indicate pressure on land over the last four decades (Musahara 2002). Current fall in land productivity due to over cultivation means there were no efforts to control the damage to the soil due to excessive use or if there were such policies they were not enforced effectively. This observation thus reinforces the need for sustainable use of land as the primary objective of enhancing productivity required to boost growth and reduce poverty.

Table 9. Reason for fall in productivity

Causes of fall in productivity	Percent of surveyed farmers
Soil erosion	15.2
Over cultivation	48.7
Disease	4.1
Other	25.4

Source: Clay and Lewis (2000)

b) Underutilisation and unsustainable management of water resources

Another critical issue is water. Baechler (1999) using the Falkenmark indicator estimates that Rwanda is among the water scarce countries of the world. Ehrilch et al (2000) state that countries with less than 1700 cubic metres of water available per capita cannot reliably maintain food self sufficiency. Rwanda with 870 cubic meters by mid 1990s ranks the 18th from the bottom. In this regard there are two senses that arise that are related to issues of utilisation and sustainable uses of water resources. Large amounts of water flowing into rivers with a lot of soil either pollute water or lead to siltation that affect valleys and amount of water available in them. We shall bring out this argument with regard to the degradation of Rugezi Wetlands again. Moreover they also carry away large amounts of humus (GoR 2004). In this sense water use is closely related to other conservation measures like control of soil erosion on slopes and hills adjacent to valleys and wetlands.

An apparent contradiction that arises is why Rwanda is regarded as a water scarce country. On one hand there has been fall in volumes of water flowing in lakes and valleys as demonstrated by fall of water levels in Bulera and Ruhondo. Rugezi Wetland and energy crisis analysed later reflects unsustainable management of water resources in the past.

On the other hand there is a clear restricted capacity to retain most of the water and the nutrients it carries from Rwanda's water basins. The Nile Basin covers almost 70 percent of Rwanda and drains 90 percent of its water. Rwanda is contributing up to 10 percent of White Nile water (UNEP 2005, GoR 2004). Unlike Egypt which is clearly withdrawing water from the Basin a country like Rwanda could not be considered as water scarce when it retains only 0.77 of a cubic kilometre. We show shortly that water utilisation need not suggest that irrigation is the most ideal use that is lacking in Rwanda. Coupled with the analyses on soil loss, the figure in Table 10 would suggest that more water would be retained in the country, if there are more conservation measures and if some forms of water harvesting schemes are devised.

Table 10. Comparative water loss in the region in Nile basin countries

Country	Annual water availability in cubic km per year	Retention or withdrawal	Net
Burundi	3.6	0.1	3.5
DRC	935	0.36	934
Egypt	2.3	55.1	-52.8
Ethiopia	110	2.07	107.9
Kenya	20.2	2.05	18.2
Rwanda	6.3	0.77	5.5
Sudan	35	17.8	17.2
Tanzania	80	1.17	78.8
Uganda	39	0.2	38.8

Source: Sullivan, C .2006:2

Water resource management in Rwanda needs to be informed by research and data compilation. It is sensible that a case of sustainable use of water is irrigation. Rwanda has about 9000 hectares that can be irrigated. These would require 13,000 cubic metres of water per hectare per year from the Congo Basin drainage system and 12,500 cubic metres per hectare per year from the Nile Basin. Currently only 2000 ha are under some form of irrigation and water inflows for these is 0.1117 cubic kilometres from the Congo Basin and 0.46 cubic kilometres from the Nile Basin. However given the terrain of Rwanda the overall significance of irrigation as a way of improving use of water to support better livelihoods is limited. The costs and benefits of irrigation in a country like Rwanda is undoubtedly an area that has not been adequately researched and which expectedly may raise more questions than answers. Irrigations systems that would suit Rwanda are most probably expensive to put in practice. There is however, a need to establish how poor households can water their gardens up-hill and irrigate small plots in the valleys without facing challenges of water scarcity as there is a lot of water flowing out of the basins. In managing watersheds of Rwanda the techniques of water harvesting should be within the same logic of retaining the valuable resource for supporting needy households.

Nonetheless within the ecosystem services framework, sustainable water utilisation invokes several other related issues. Two that need to be analysed in relation to Rwanda are the links between environmental management and health. A clear case in this regard is that of waterborne diseases, which is representing the most common diseases in Rwanda (CIA Fact book considers Rwanda as very high risk country with regard to water borne diseases). The other is sanitation especially in urban areas and particularly Kigali. A few general indicators show that there is still a need to improve access to sustainable water and sanitation, which would help improve the health status tremendously.

Between 1994 and 2003, 27 percent of the population had no access to an improved water source. In the same period the share of the population with sustainable access to improved sanitation went up slightly from 37 percent to 41 percent. Meanwhile 16 percent of all children under 5 were receiving oral re- hydration and continued feeding due to diarrhoea (UNDP 2005). One of these mentioned is bacterial diarrhoea which can arise from lack of access to potable water. About 3,790 households especially in towns dispose refuse in rivers, drains or water causes. About 1.26 million Rwandans depend as a source of water on unprotected wells and about 669,000 depend on rivers and streams (GoR 2003). These are contaminated with disease causing material especially during the rainy season. Malaria is a vector borne disease but is also known to be worsened by un-drained ponds caused by rain or by lack of proper drainage systems in towns. Rwanda, despite popular campaigns, still has a high incidence of malaria of about 6,510 per 100,000 people (WHO 2005). There is still data gaps on the cost of diseases

related to water and the environment. While it is common to explain the problem by rates of morbidity and mortality, there are more indicators that need to be estimated for Rwanda. One such common measure is the Disability Adjusted Life Years, which is commonly used in environmental studies2.

5.2. Contribution of conservation and management of land.

Investment in on farm soil conservation alone increases marginal productivity on land by 25 percent. The rate goes up to 33 percent on farms with low value crops and high erosion. There is a lack of detailed analysis on alternative forms of soil conservation and types of soil. Even the limited knowledge available is subject to debate. Given the topography of Rwanda, engineering strategies of conserving soil, especially soil erosion have been deemed as useful (Clay and Lewis 1996). However, it is noted also hill slopes are frequently unstable and require continuous maintenance. That type of engineering has also been known to be expensive. Clay and Lewis (1996) noted also that slopes may lead to gully erosion and on hill slopes top soils are thin and when washed away expose the acidic layers underneath.

Complementary methods controlling erosion are planting grass strips and hedgerows. However in conditions of land scarcity there is concern that they take the much needed strips of land. This may be the reason there has been concerns that Rwandans do not seem to be keen conserving their soils (Clay and Lewis 1996). Given the importance of soil conservation for sustainable use, there has to be a comprehensive strategy of making Rwandan farmers integrate soil erosion control in the cropping and land use systems. Given the usefulness of sustainable land use to agriculture it is important that investment in soil protection planned for the next ten years (GoR 2006a) follow a detailed and comprehensive study on which are the best and affordable methods of conserving soil in Rwanda.

Recent studies in Rwanda show that the most potential contribution to economic growth is in management of wetlands (Mellor 2003). We analyse the role of managing wetlands and how it is relevant to Rwanda in the rest of this section and as an implicit way of underlining the importance of Rugezi Wetlands.

Wetlands are considered as 'areas of marsh, fen, and peat land or water whether natural or artificial, permanent or temporary, with static or flowing water, fresh, brackish or salty' (Barbier et al 1999). Recent research shows that marshlands whichever approach is used give immense ecological and other services (Hoehn et al. 2003, Zalidis et al., 1999, Guterstam, 1997, Bennett and Morrison 1999 and Woodward et al., 2000).

In one approach they are regarded as wastelands. Where they are regarded as wastelands they are quickly drained for intensive agriculture, fishponds, industrial and residential areas. This is perhaps the reason they are regarded as sources of quick gains in yield such as agricultural production. In an alternative approach, wetlands are not wastelands but the most productive ecosystems that need to be protected or used in a sustainable way. They are called the 'kidneys of the landscape'. The nick name is due to the functions they perform in hydrological and chemical cycles. The functions include flood alleviation, ground water storage and recharge and retention of pollutants. They maintain surface and ground water flows, biochemical cycling, allow accumulation of peat and maintain biological energy flows characteristic habitats (Hoehn et al. 2003).

A wetland can also perform, to some degree several other functions, such as nutrient removal and transformation, sediment and toxicant retention, flood water storage, microclimate modification, shoreline stabilisation and food web support They are sources of products including fish, fuel, rich and fertile sediments and can attract tourists. The uses of wetlands in general are summarised in Table 11. It is however noteworthy that changes in one or several of these functions leads to partial or total loss of many of the nearly twenty possible values that depend on these functions (Zalidis et al., 1999).

2 *Disability Adjusted Life Year is a health gap measure that extends the concept of potential years of life lost due to premature death (PYLL) to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability (1). The DALY combines in one measure the time lived with disability and the time lost due to premature mortality. One DALY can be thought of as one lost year of 'healthy' life and the burden of disease as a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability.* ***Death and DALY estimates for 2002 by cause for WHO Member States, World Health Organisation. Available at: http://www.who.int/healthinfo/statistics/bodgbddeathdalyestimates.xls***

Table 11. Uses of wetlands

USE VALUES			NON USE VALUES
Direct uses	Indirect values	Option and quasi values	
• Fish • Agriculture • Fuel wood • Recreation • Transport • Wildlife • Peat/energy	• Nutrient retention • Flood control • Ground water recharge • External ecosystem support • Micro climate stabilisation	• Potential future uses • Future value of information	• Biodiversity • Culture, heritage • Bequest value

Source: Barbier et al(1999)

Wetlands are also called 'biological supermarkets'. In this regard, their usefulness to growth should be seen in a more comprehensive manner to include direct, indirect and other values.

In recent years, there has been an increasing interest in evaluating the economic values of wetlands. This has happened because of a growing interest in the multi-functions and services provided by wetlands ecosystems which have direct or indirect influence to human welfare mentioned in previous paragraphs. In relation to the nature's role to humans, Ulanowicz (1989) claimed that despite all the advances in modern technology, society remains irrevocably dependent upon natural systems for life support, a condition that is unlikely to change in the foreseeable future. This statement is more applicable to poor countries like Rwanda whose inhabitants depend largely on natural resources for their livelihoods. Wetlands provide many important services to human society, but are at the same time ecologically sensitive and adaptive systems. The issue here is to what extent is policy making in Rwanda cognisant of these far reaching services than mere forms of quick wins in the agricultural sector.

The Rugezi case that is illustrated in this report gives a clear example of how degradation of such ecosystems can have multiple consequences. The effects include also those that are economic in relation to the population in general and to local communities in particular. It also sheds light on the implications of destroying wetlands. Most of the time, wetlands are destroyed by human development because, as Bennett and Morrison (1999) assert, there are strong financial incentives for the natural resources that comprise wetlands to be developed as mentioned above.

The benefits derived from developmental uses of wetlands are generally private and are enjoyed by individuals in markets while many benefits from wetland protection are not enjoyed privately; they are public goods, and therefore non-excludable, which leads to free-riding. Noteworthy is also the fact that private goods benefits are also important. In our case study increased hydro electric generation has substantive private good benefits and this contributes to the overall economic and social benefits to Rwanda

Wetlands in Rwanda are important natural resources to future economic growth. There are about 580,000 ha of wetlands out of which only 165,000 are cultivated (GoR 2004b). However the question is whether the current utilisation is in relation to exploiting a 'wasteland' for quick gains or they can be managed in a manner that maximises the direct and indirect values we have noted. Presently about 15 percent of expected growth in GDP to be derived from agriculture is expected to be from utilisation of wetlands (Mellor 2003). However if it will be large scale and commercial farming that will gain from the exploitation, there is a likelihood that the management approach will not favour livelihoods of a majority of the poor. That would not lead to sustainable growth as the gains will at the same time destroy a multitude of ecosystem services the poor derive from the wetlands. The community as a whole will lose the non economic services that are nonetheless life supporting.

There is no reason why standard valuation of wetlands cannot be carried out in Rwanda. Coherent methods particularly the Willingness To Pay and Contingent Valuation Methods have been used effectively in various cases in the world (see Barbier et 1996). If for example estimates by Barbier et al (1996) for a wetland in Nigeria is a rough estimate to work with then a hectare of wetland would have Net Present Value (NPV) of US$ 51, which is about a fifth of per capita income of a Rwandan in 2005 estimates. This would mean, discounted over 50 years, that the marshlands of Rwanda have a value of about 2 million dollars a year as direct value only. However a more safe approach in the context of preserving the ecosystem would be the precautionary policy approach where exploitation is weighed against future damage to the rich ecosystem in the short and long term perspectives.

5.3. The potentiality of tourism

Tourism used to be the third earner of foreign exchange in Rwanda (Waller 1996). Estimates from studies in the area shows potential contribution to GDP e.g. a recent study in Uganda (Moyini and Uwimbabazi 2000) showed how gorilla tourism can earn a country millions of US dollars

For Uganda it was found that cash inflows discounted at an appropriate social rate ranged between US $7-33 mil, US $4.4 mil could be earned in foreign currency, US $ 8.8 mil as sales effects, 3.9 million as earned income by the people, US $ 2.7 million as government revenue and employment effect of 946 people.

Table 12. The Revenue collection from tourism to Virunga National Park

Year	Visitors	Revenue	Year	Visitors	revenue
	Pax	US$		pax	US$
1974	449	10,400	**1990**	2,726	251,977
1975	923	3,062	**1991**	1,781	107,933
1976	661	2,351	**1992**	1,011	236,983
1977	970	4,509	**1993**	1,111	235,024
1978	1,444	7,353	**1994**	61	10,475
1979	1,653	10,237	**1995**	1,663	430,542
1980	2,593	31,377	**1996**	2,653	346,164
1981	3,693	80,002	**1997**	1,192	149,145
1982	4,217	100,955	**1998**	0	0
1983	4,905	119,476	**1999**	417	87,333
1984	6,010	235,462	**2000**	1,313	281,693
1985	6,571	266,973	**2001**	2,155	233,176
1986	5,524	315,896	**2002**	5,575	1,024,137
1987	5,356	-	**2003**	7,239	1,377,665
1988	5,282	278,755	**2004**	8,593	2,213,383
1989	6,952	448,545	**2005**	10,641	3,005,783

Source: ORTPN Statistics 2006

There is a great potential of contribution to revenue from tourism. Table 12 shows a rapidly growing stream of revenues from the Volcano National Park alone. For the year 2005 the revenue is a contribution of about 0.2 percent of GDP. A study including other sources of tourist revenue, particularly the Akagera National Park and potential tourist attractions is required to indicate how this sector is important to future economic growth paths.

6. NATURAL RESOURCE TYPES, STOCKS AND PROJECTIONS IN RWANDA

As indicated in the introductory sections of this report natural resources and environment are broad concepts. However for quantitative estimates in this section we identify four types and two forms of land uses. These are firstly lakes and streams, natural forests, national parks and finally hunting reserves. The forms of land uses are roads and urban industrial zones. Our projections in relation to natural resources and land uses up to year 2020 are given in Table 13.

The table is based on estimates before 2000 (Delpierre 1987) and own projections. The projections are based on average historical rates of change without any conservation. Some of the assumptions are just estimates. We project that without conservation streams and marshes may dry at a rate of 1 percent per annum. Forests are degraded at historical rates of 2000 ha a year. The rest are projections based on the gross change divided by nearly 20 years between 1982 and 2002.

With this 'business as usual' approach Nyungwe would be depleted of 30,000 ha while Akagera by 40, 000 ha in the next 15 years. There will be no natural forest in Gishwati, Mukura, Mutara and Virunga. There would be no marshes that are not drained. While cost estimates would be important what should emerge now would be a loss of major ecosystem services from forests by more than 50 percent. Indirect results of degradation, erosion, and energy and land productivity discussed earlier would be more disastrous than current crises. All in all however, conservation is not the sole answer. As will be argued in the rest of this report, what is at stake is sustainable management of natural resources.

		1982	1987	1992	2000	2005	2010	2020
	Total land area in ha(000)	2559.5	2559.5	2559.5	2559.5	2559.5	2559.5	2559.5
1 Land unavailable for exploitation								
	Lakes	127.77	127.77	127.77	127.77	127.77	127.77	127.77
	streams and undrained marshes	39.268	39.268	39.268	39.268	39	38.7	38.2
	natural forests							
	Nyungwe	108.8	97	97	97	95	85	65
	Mukura	2	2	2	2	2	0	0
	Gishwati	28.2	23	23	23	3.36	0	0
	National Parks							
	Akagera	270.9	270.9	270.9	90	80	70	50
	Virunga	12	12	12	12	2	0	0
	Hunting reserves							
	Mutara	53.663	53.663	53.663	0	0	0	0
	Roads	7.44	8.5	9.25	10	10.75	11.5	13
	Urban Industrial zones	8.5	11.4	14.5	20.25	23.25	26.5	32.5
		658.501	**645.501**	**649.951**	**640.195**	**383.13**	**359.47**	**326.47**
2 Land unavailable for small scale agriculture								
	military zones	12.7	12.7	12.7	5	5	5	5
	experimental stations	18.121	5	5	5	5	5	5
	land concessions	16.32	16.32	16.32	16.32	16.32	16.32	16.32
		47.141	**34.02**	**34.02**	**26.32**	**26.32**	**26.32**	**26.32**
3 Land unsuitable for agriculture								
	unsuitable for any use	100	100	100	100	100	100	100
	pasture	542.8	500	470	400	350	300	200
	undrained marsh	49	45	20	20	10	0	0
	woods	57.2	99.5	130	200	240	280	320
		749	**745**	**720**	**700**	**700**	**680**	**620**
4 Maximum agricultural land								
	for small crops	1,104.86	1134.979	1655.529	1199.285	1179.3	1164.3	1144.3
	dwelling area	46.017	57.385	68.453	86.27	96.3	106.3	126.3
	cash crops	45.5	62.2	76	75	79.5	84	99
	fodder crop	n	n	5	15	25	35	55
		97.517	**119.585**	**140.455**	**176.27**	**1380.1**	**1389.6**	**1424.6**

Table 13. Scenarios of natural resources and land use

7. CASE STUDY 1- RUGEZI WETLANDS

7.1. Background to Rugezi Wetlands

Rugezi wetland is located in the Rwandan Northern province. It is estimated that 66 percent of its watershed is in the former Ruhengeri province and 33 percent in the former Byumba province. Rugezi is made up of two big valleys. The main valley measures 26 km by 3 km and the second one known as Kamiranzovu measures 9 km by 2.5 km. The waters from the two valleys meet at an altitude of 2050 m and run into Lake Bulera, about 200 m downstream. The Northern Province is the most densely populated in Rwanda. It has rural areas with an average of 524 inhabitants per km^2 in Ruhengeri and 415 inhabitants per km^2 in Byumba.

Basing on the National Population Census carried out in 2002 (GoR 2003) and an annual growth rate of 2.8 %, the population around Rugezi is estimated to be about 120,000 people. Of these 90% are involved in agriculture and depend heavily on natural resources for livelihoods. Population pressure combined with land degradation is considered as the major reasons that prompted people to invade Rugezi wetland for agricultural purposes. However the environmental policy and laws have not yet been operationalized as to control and enforce more sustainable use of the natural capital.

According to Helpage Rwanda (2004) Rugezi Wetland and the Volcano National Park are of international importance because they are water sources for both Lake Victoria and the White Nile. Ntaruka, located between Lake Bulera and Lake Ruhondo, and Mukungwa situated downstream Lake Ruhondo have been the main sources of hydro power generated electricity in Rwanda. Recent energy shortages have been attributed to considerable fall of the water level in the lakes. A principal cause, among a number of others has been the unsustainable use of Rugezi Wetland. Currently only one third of the full capacity is produced from these hydro electric power centres (see next section). The resulting energy crisis has had far reaching impact on Rwanda and the prospects for high rates of economic growth.

In addition to the above Rugezi Wetland is home to 60% of the total world population of Grauer's Swap-Warbler (*Bradypterus Graueri*)[3], an endemic bird species that is threatened by the intensive degradation of the area. The total population of this species is estimated at 10 000 birds. Apart from Rugezi area, the specie can be found in South-Western Uganda and in the Democratic Republic of Congo. The rest of wetland sites where Grauer's Swap-Warbler lives are relatively small and researchers have fears that the survival of this endangered species will mainly depend on the conservation of Rugezi Wetland. Besides that special species, fifty other bird species have been identified and could be an important attraction for tourists with particular interest in birds to come to the area.

7.2. Economic Losses Associated with Rugezi Degradation.

A major effect of the degradation, which is linked to economic loss, is the decrease in water levels and consequently the energy crisis mentioned above. Since the beginning of year 2000, the water levels of the two lakes that supply Ntaruka and Mukura hydropower stations have been declining. It was mentioned above that the water levels of the tectonic lakes have declined because of reduced water flows from the main source; Rugezi Wetland. In 2005 (Figure 3 below), the lakes reached the lowest level.

The relationship between water levels and power generation can be seen clearly from Figure 4, where it is obvious that the water levels have continued to fall progressively. This is a phenomenon that is thought to have been going on unabated for many years. A study by Helpage Rwanda (2004) found that the average water flows have been reduced to 50% of the average level from 1957-1970.

3 *Ministère de l*administration Locale, du Développement Communautaire et des Affaires Sociales (2004)*

On a typical day Electrogaz needs to supply the amount of electricity given by top demand graph line in Figure 5. From its own power stations and those of the neighbouring countries, Electrogaz is able to supply the amount of electricity that is indicated by supply line below. The gap between the two lines shows the electricity shortage.

Electricity shortage has necessitated load shedding, which is when Electrogaz switches off power to some customers. Evidentially there is a gap through the entire day that gets larger in the evenings. Frequent power shortage has resulted in individuals, production companies and firms purchasing their own generators. This has largely led to an increase in production cost and contributed to consumer goods price increase. A detailed study on economic losses due to electricity shortage and its impact on economic growth in Rwanda would be useful in the debate on policy priorities for the decision-makers to make fully informed decisions in natural resource management issues.

Figure 3. Lake Bulera and Ruhondo water levels (2001-2005)

Source: Electrogaz 2005

Figure 4 Lake levels/Power Station Outputs

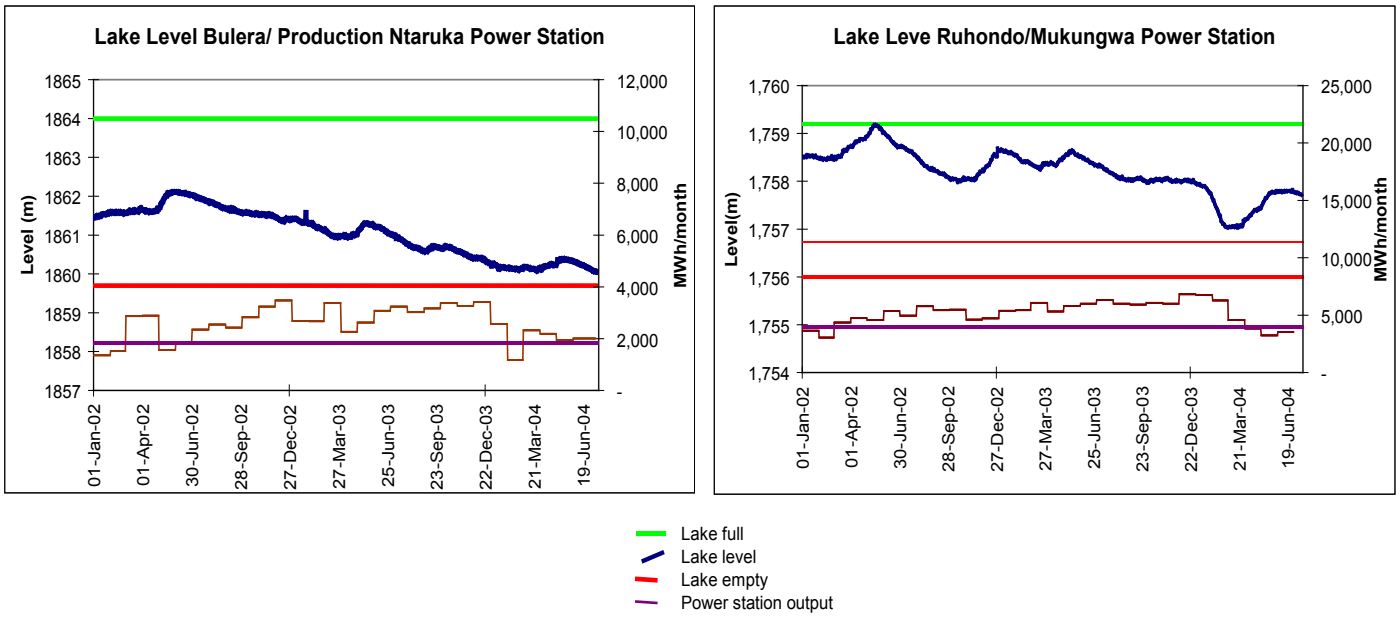


Figure 5. Electrogaz Power Demand/Supply

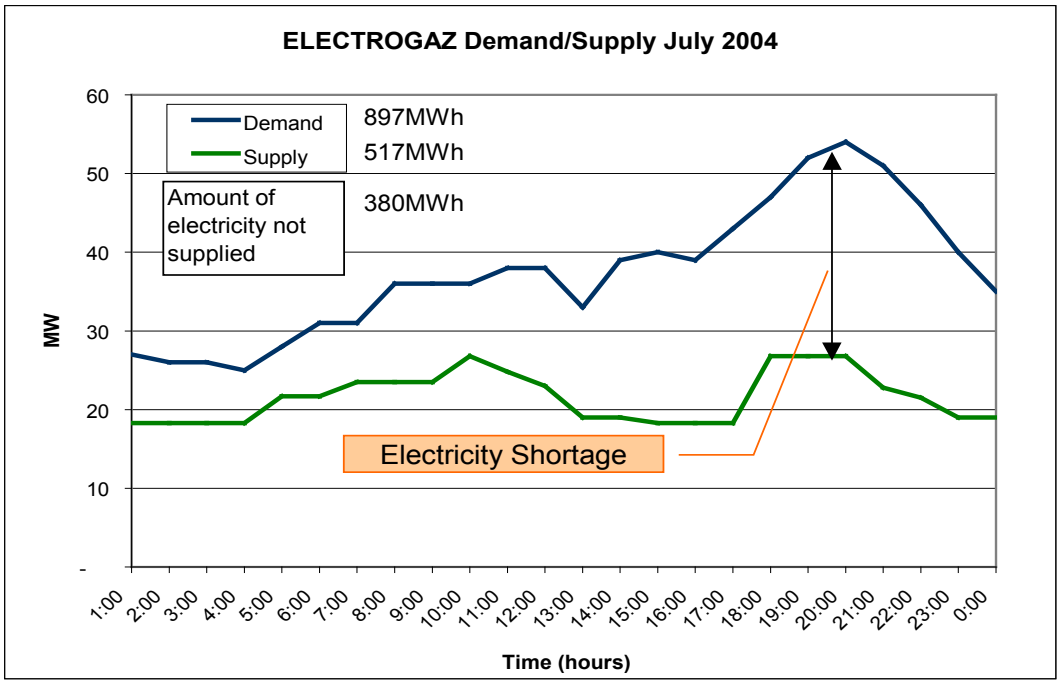


Figure 1

Electricity Demand/Supply

As a consequence of the power shortage, the electricity bill has hiked from 48 Rwandan francs to 120 per unit of power consumption; an increase of 250%. In order to meet demands Electrogaz has purchased a number of diesel powered generators. By the second quarter of 2006 the cost of paying for the diesel was estimated to approximately US$ 65,000 per day (EIU 2006). Although electricity is consumed mainly in urban areas, as noted above the cost implications of these expenditures to the rest of the economy needs to be established. Kigali alone consumes about 60 percent of the entire generated electricity. Nonetheless it is reasonable to assume that the impact of the energy crisis is having a negative effect on several productive sectors and in the economy as a whole.

It should be noted that the energy crisis was happening at the same time as when there was a charcoal shortage. Most of the shortage is caused by deforestation due to exploitation of forests for industrial purposes but more significantly, provision of fuel wood to about 95 percent of the population. In 2002 industrial demand for wood was 336,000 cubic metres while fuel wood consumption alone was 7,500,000 cubic metres. Logging in 2005 was 223,000 cubic metres for industrial round wood requirements and 10,203,000 cubic metres as wood fuel. A total of 10,429,000 cubic metres is equivalent to 12 percent of the forest base.

Secondly, it is worth mentioning that there are environmental measures in place to prevent the forest degradation. Combined result of deforestation and the measures have resulted in doubling of the price of one sack of charcoal within the last two years. The situation for poor household's consumers who have no alternatives has become precarious. Little evidence is available on the interlinked problems of services from the environment and more research needs to be undertaken.

Apart from economic problems related to power shortage degradation to Rugezi Wetland is a liability to the potentiality for tourism, incl. bird watching as suggested above. Another tourist attraction in the area is the Rusumo Falls. Rugezi Wetland is located upstream from the beautiful tectonic lakes of Bulera and Ruhondo that are easily accessible by road. It is easy for tourists to visit Rugezi on their way to the Volcano National Park to see the mountain gorillas.

Tourists interested in the historical and cultural values of Rwandan people could be served as well. For hundreds of years the local Batwa communities have lived in a symbiotic way with the Rugezi Wetland and have also played a very important role in Rwandan history. Rugezi derives from a traditional name of ' Urugezi rwa Basebya ba Nyirantwali'4. Rwandans used to come from all over the country to worship God at Rusumo falls and at the famous Kayange Hill where traditional houses were built for that purpose.

7.3. Economic Consequences for Local Communities5

Rugezi Wetland used to have a lot of economic advantages for the local people living near it. However, the degradation has affected their transport system; food sources from the wetland; fishing and materials for weaving. De Vos (1986) reported that Rugezi had fish species called Clarias liocephalus and cichlid fish (Haplochromis), which were useful for local fishermen. The fishing activities were very important especially to the poor and landless. In 1999, before the more severe degradation of Rugezi, the local fishermen were exporting fish to Tanzania. Hategikimana (2005) found that 2 percent of surveyed sample were able to buy livestock from fishing. He further found that fishing was no longer dominating the poorest communities' time occupation as in the past, but now only a few fishermen who are relatively well off. Some current effects of this development are discussed the below.

Rugezi is composed of homogeneous peat soil with patches of water areas and many canals and water flows that have

4 ***http://users.skynet.be/wirira/sema-95.htm***

5 ***This section utilises material from a recent study on Rugezi by Hategekimana (2005)***

always been helpful for local boats owners. Before the more severe degradation, the Wetland played a capital role in the economic life of the communities living around it, including transport. There were about twenty small ports where travellers could for a modest sum travel with the boats. This service also provided transport of food and building materials especially from Uganda. The southern side of the wetland benefited more from this transport system because it has always been poor in agricultural production. The main food and cash crops transported were wheat and tobacco, which were shipped to Rusumo, Kirambo, Miyove and Base markets. The boats owners were grouped in associations and they could earn up to Rwf 1,000 each per day. Today the boat transportation in Rugezi is limited and it is only practiced in the southern part of the Wetland, which is less degraded. Economic losses have been sustained by the local communities in terms of lost transport opportunities.

There are a lot of vegetal species that are valuable to local people especially the poorest communities living near Rugezi. Studies carried out in the watershed area in the past showed that vegetal collection activities were mainly carried out by widows and people, who had no land for cultivation. Many women from villages far away from the Wetland used to come to harvest weaving materials. With degradation, weaving activities have been reduced considerably and this has also affected the poorest in the villages surrounding the area (Hategikimana, 2005). The Batwa community has not been spared by the degradation of Rugezi. They used to collect perennial grass (Miscanthus) and sold it in bundles to relatively rich families. This grass as well as other grass species were used as building materials, but are now no longer available in the valley. This has naturally had a negative economic impact on the Batwa community.

There also used to be hunting in the Rugezi area. The most recent hunting targeted mainly Sitatunga (Tragelaphus Specie) and different types of birds. There are virtually no more hunting activities taking place in the area.

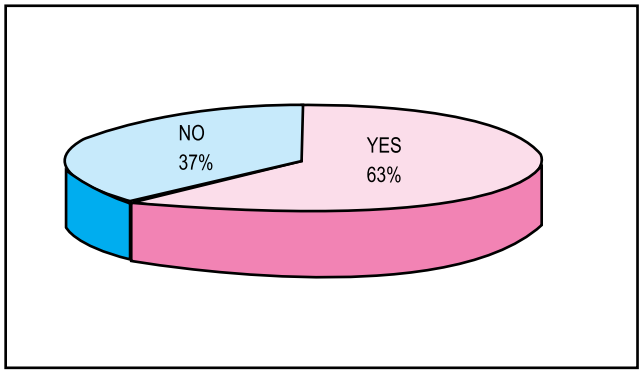
7.4. Current evidence of effectS of degradation of Rugezi Wetlands on Livelihoods

As mentioned earlier, it is not easy to evaluate all the economic losses due to the degradation of Rugezi Wetland. A lot of ecological services were lost and their far reaching consequences cannot be quantified. During the preparation for this study a small survey was carried out around the area. The aim was to confirm, classify and quantify most of what has been noted on the effect of degradation of the Wetland. Data from the field clearly show what the local community has lost due to degradation. In the field, data was collected in categories of ‘before’ and ‘after’. There is no specific date to provide a dividing line. However, in interviews respondents refer to ‘before’ as before the 1990s and ‘after’ as a loose period referring to early 1990s and the period after the genocide.

As mentioned in the methodology, information was collected from 62 households. The survey was conducted in the affected district areas and it covered 62 heads of households, 30 percent of which were women. The majority of the respondents were between 31 and 60 years old and more than 50 percent have primary school education. Respondents reported that generally families depended and continue to depend on the Valley. Figure 6 shows that about 63 percent continued depending on Rugezi

Figure 6. Location of farmers in Rugezi

Table 14 records households depending on the valley for many decades since 1930s. It shows that there are several more



households depending on Rugezi even though their farms are not located in the Valley. That translates to almost 50 percent of the sampled households.

A majority of the respondents indicate agriculture alone or other activities being the main stay of the families in and around the valley. As shown in Table 15 a majority of them depend on agriculture for a livelihood. Respondents depending on agriculture alone constituted 45 percent.

Table 14.Status of Using Rugezi (62)

From	Numbers
Before 1930	0
1931-1935	1
1936-1940	0
1941-1945	1
1946-1950	2
1951-1955	2
1956-1960	0
1961-1970	3
1971-1975	2
1976-1980	5
1981-1985	2
1986-1990	6
1991-1995	2
1996-2000	0
2001 and after	0
Others(Not living but using Rugezi)	36

Table 15.Sources of income of respondents (62)

Sources	Respondents	Percent
Agriculture	28	45.2
Livestock keeping	0	0
salaried employment	0	0
Business	0	0
Others	0	0
agriculture +livestock's keeping	28	45.2
Agriculture + business	1	1.6
Agriculture + Others	2	3.2
Agriculture + livestock's keeping + business	2	3.2
Agriculture + livestock's keeping + others	1	1.6

The valley provided incomes from different types of agricultural products. Table 16 indicates that produce providing the highest source of income was from Irish potatoes, maize and sorghum. With average annual incomes of RWF 32,669 from potatoes, 14,460 from maize, and sorghum 12,008 and beans 5,265 combined income for a household cultivating all of these would exceed the current Rwandan poverty level of RWF 64,000 (in 2000 prices).

Table 16. Annual Income from Different Crops

Crops	Average Income Per Year
Beans	5,265
Sweet Potatoes	4,484
Irish Potatoes	32,669
Maize	14,460
Rice	0
Vegetables	2,718
Soya	0
Sorghum	12,008
Others	0

Nonetheless respondents showed that dependency on agriculture is pitted against land scarcity. From Table 17 more than 60 percent of the respondents worked on farms that are less than 0.25 ha.

Table 17.Sise distribution of farms (62)

Size in ha	Frequency	Percentage
0 to 0.25	38	61.3
0.26 to 0. 50	20	32.3
0.51 to 0.75	1	1.6
0.76 to 1	2	3.2
Above 1	1	1.6
	62	**100**

From Table 18 it is clear that other non-agricultural goods from the valley are multiple and could be sources of substantial incomes. Fishing alone could earn a household up to RWF 16,392 a year while weaving could earn a family up to RWF 12,000.

Table 18. Before being evicted -Source and Qty of Income

Sources	Average Income Per Year
Grassing	3,859
Weaving Materials	12,077
Fetching Water	174
Fishing	16,392
Construction Materials	9,818
Socio Cultural Activities	0
Others	681

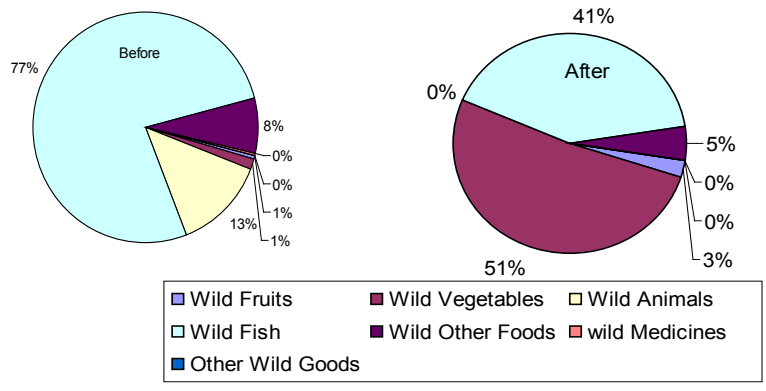
As indicated in the methodology wild goods are also sources of incomes and livelihoods to people living in and around the Valley. The field study data show that as a result of degradation these have also become less important sources, given the diminishing values of incomes that are derived from them. Table 19 and figure 7 present the findings.

Table 19. Quantity of Wild Goods before and After Degradation

Wild Goods	Average Quantity in kg Per Year	
	Before	After
Wild Fruits	113	16
Wild Vegetables	194	323
Wild Animals	2,258	0
Wild Fish	12,926	258
Wild Other Foods	1,315	32
wild Medicines	40	0
Other Wild Goods	0	0

Figure 7. Availability of wild goods before and after degradation

While there used to be on average 2 tons of wild game to the sample respondents, after degradation the quantity has fallen to zero. Wild medicine has experienced the same fate.



In the past almost 13 tones of fish were traded in the local community. After the degradation the quantity is on 0.3 of a tone. All quantities of wild goods also declined heavily. The only increase seems in collection of wild vegetables. After many households were evicted from cultivating in Rugezi, naturally the agricultural produce declined and having no alternative the population resorted to collection of wild vegetables.

Similar results were recorded for other ecosystem goods from the valley. From Table 20 it is evident that thatching grass is now scarce having declined by more than 1000 percent. Woven goods are almost insignificant as 0.097 of a tone compared to more than 1.6 tones before. Leaf litter is used as input in agricultural production as organic fertiliser. The degradation has decreased the leaf litter by 94 percent, which has necessarily affected the agricultural production. The reduction in many goods from Rugezi also may have cross-price effects on their substitutes, which further affect negatively the welfare of the communities living around the wetland.

Table 20. Availability of Other Items before and After Degradation

Other Items	Estimate av. Quantity in kg Per Year	
	Before	After
Thatching Grass	4,168	373
Woven Goods	6,229	77
Leaf Litter	1,645	97

Findings are consistently similar for other types of resources. The same decline or total decimation of resources is evident from Table 21. Pottery once a very important activity has disappeared. Termite mounds, like leaf litter, were important for enhancing soil fertility but there is a real fear that they will also soon disappear.

Table 21.Other Resource Utilisation Before and After Degradation

Other Resources	Average Quantity Per Year	
	Before	After
Pottery clays for water storage, pots and cooking pots	7,581	0
Termite mounds as fertiliser	1,355	323
Livestock fodder and browse	3,065	774
water for transport	3,468	81
water for general use	0	0

Information similar to what is reported in the previous paragraphs was collected from discussions. About 90 percent of those who participated in the group discussions depended on boat transportation to and from different market places in the region before Rugezi degradation. This has also created a loss of income for the 95 people who constituted the boat owners' association. Prices for weaved mats, which are used by the local people in the houses, have increased by 300 %. This has an important welfare implications to the population in the area as weaved mats are used in stead of chairs as well as bed room materials. Participants in the group discussions also mentioned loss of income from fishing and basket making.

River transportation has also been reduced to the minimum. From an average of 3,468 passengers a year to 81 this has caused many problems and may have increased prices of goods that were easily transported by boats to markets in the region.

Pottery activities, which traditionally are the main income source for the Batwa, have been totally prohibited due to degradation. This has also affected other social groups in the region because the majority of the population cannot afford iron pans use pots. The reduction in livestock fodder has also affected livestock keeping in the region and contributed to increase in poverty.

There have been other kinds of damages which can be attributed to the degradation of Rugezi. With degradation the Wetland lost its water regulatory property. Among the interviewees, 69 percent have experienced damages from floods which can be linked to loss of water regulation in Rugezi. Table 22 shows the most frequent damages as reported in the table include destroyed houses and roads. In some incidents people as well as animals were killed by floods. These floods had never happened before the degradation of Rugezi.

Figure 8. Respondents who were affected by floods

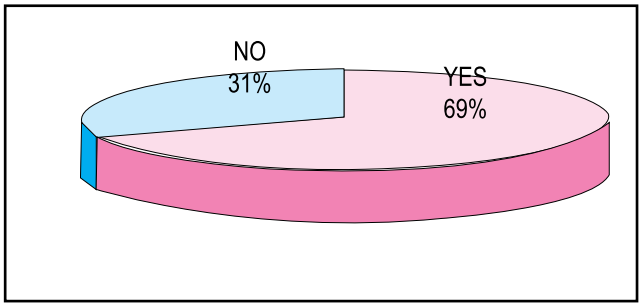


Table 22.Damages (43)

Type	Frequency
houses destroyed	2
crops destroyed	5
animals dead	4
People dead	0
roads destroyed	7
Other	0
houses destroyed + crops destroyed	4
crops destroyed +roads destroyed	2
houses destroyed +crops destroyed +roads destroyed	6
houses destroyed +animals dead +roads destroyed	1
crops destroyed +animals dead +roads destroyed	1
houses destroyed +crops destroyed +animals dead +people dead	1
houses destroyed +crop destroyed +animals dead +roads destroyed	6
houses destroyed +crops destroyed +people dead	1
houses destroyed +animals dead +people dead +roads destroyed	1
crops destroyed +animals dead +people dead +roads destroyed	2
	43

Another effect of the degradation is that some rivers have dried up in some places and hence the distance from home to where households fetch water has increased. Table 23 shows that a majority of the households depend on wells. Among those that could estimate change in distance to the water sources a majority 24 percent reported that it increased while only 14.5 percent reported that it decreased.

Table 23. Reported water sources

Place	Frequency	Percent
From Rugezi	7	11.2
From a river	8	12.9
Well	40	64.5
Bore hole	1	1.6
Other	0	0
From Rugezi+well	4	6.5
From Rugezi+well	1	1.6
From Rugezi+from a river+well	1	1.6

Table 24. Average Distance to the source of water

Respondents Answers	Frequency	Percent
No. of Respondents who say the distance is increased	15	24.2
No. of Respondents who say the distance is decreased	9	14.5
Don't Know	38	61.6
Average distance Increased	6.3	10.2
Average distance Decreased	2.4	3.9

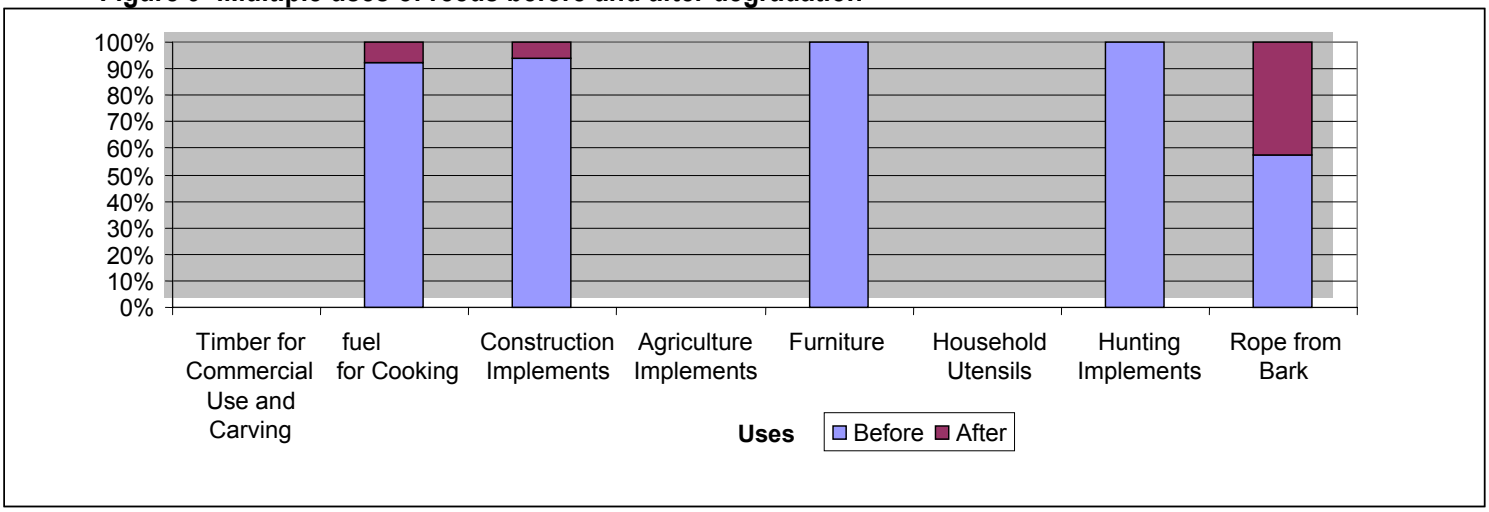
Other important economic goods in the areas that have been adversely affected by degradation are reeds (urufunzo) for building material and furniture. Figure 9 presents quantities given by respondents in kilograms. These are given in relation to the multiple uses of reeds and reed products by the households.

Supply of fuel wood has gone down tremendously. Current estimates are that only 6.3 percent of the supply before degradation is available. Current quantities of material for construction have gone down by more than 1,500 percent. Use of reeds for furniture which was estimated to involve more than 1.7 tones of reeds is no longer practiced. Reeds are also no longer used for producing hunting implements and ropes from tree barks are drastically diminishing from about 1.3 tones before degradation to 984 kilograms today. These activities being supportive to rural livelihoods imply a change that by any estimates is threatening well being of the communities.

Table 25. Multiple Uses of Reeds before and After Degradation

Uses of Wood	Average Quantity in kg Per Year	
	Before	After
Firewood's for Cooking	16,194	1,403
Construction Implements	2,516	161
Agriculture Implements	0	0
Furniture	1,750	0
Household Utensils	0	0
Hunting Implements	16	0
Rope from Bark	1,342	984

Figure 9 .Multiple uses of reeds before and after degradation

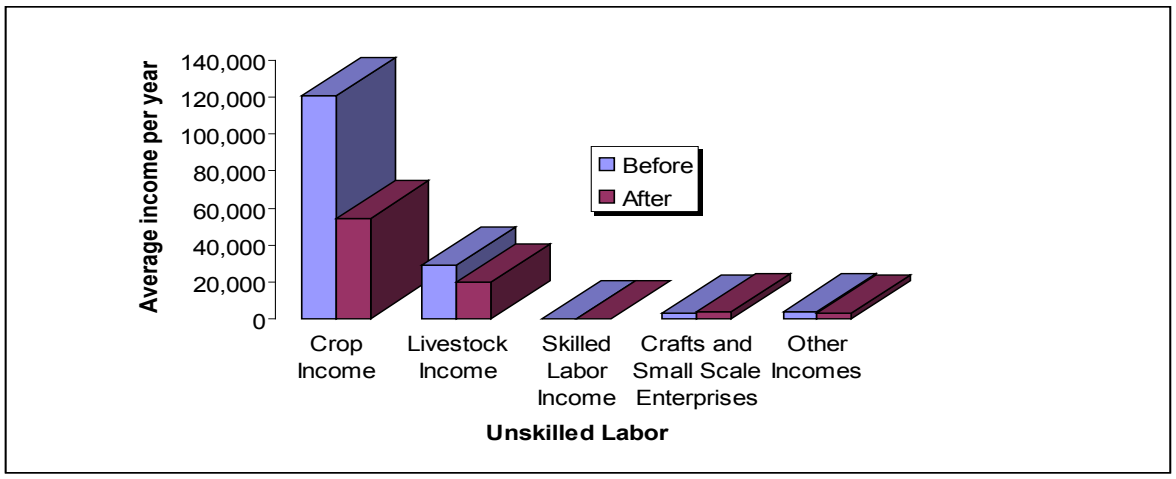


The latter conclusion is supported by the data presented in Table 26 and Figure 10 on incomes for unskilled labour in the study area. On average the income from crops income to a single household of an unskilled labourer per year went down from more than RWF 120,000 to less than 55,000. Income from livestock has gone down by about 30 percent and other incomes by almost 50 percent. It is however, noteworthy that income from crafts and small enterprises has gone up in the period after degradation, which suggest shift in sources of livelihoods to communities living in and around Rugezi area.

Table 26. Unskilled Labour Income Before and After Degradation

Unskilled Labour Income	Average Income in Rwf. per household Per Year	
	Before	After
Crop Income	121,216	54,412
Livestock Income	29,113	20,016
Skilled Labour Income	0	0
Crafts and Small Scale Enterprises	3,226	3,839
Other Incomes	4,161	2,871

Figure 10. Unskilled Labour Income Before and After Degradation



The general findings on Rugezi presented above suggest devastating effects the livelihoods ways of life for the communities in the area. The impact of degradation on individual households and communities is alarmingly negative.

The study of Rugezi Wetland has provided findings that are very useful to the policy making process in Rwanda. Degradation in a matter of decades can affect individuals, households, communities, the economy and beyond. Children and women have to travel longer distances to collect water. Firewood as an important source of energy to rural livelihoods has become scarce while there is no evidence of growing alternative sources. Economic and social activities such as weaving of mats have been disrupted affecting incomes of households. Pottery an important socio-economic activity of a social group, particularly the Batwa, has disappeared. The current insufficient supply of electricity in Rwanda, which was shown to adversely affect the economy now and in future, is closely attached to the impacts of degradation. As mentioned earlier in this report there have in the past been only limited efforts in way of regulation and management. This report bears evidence for the urgent need for more concerted efforts in managing fragile but important ecosystems such as wetlands.

Finally the case study has further reinforced the argument that there is a circle of inter-dependency between degradation, energy crisis and therefore, economic performance of Rwanda. More sustainable use of natural resources would unleash multiplier effects to several other sectors of the economy and GDP as a whole.

8. CASE STUDY 2- GISHWATI FOREST

8.1. Background to Gishwati Deforestation

Gishwati is an Albertine Rift Afro-mountain forest and for decades constituted an important area of biodiversity. It used to cover large areas of the highland range of the Congo-Nile Divide in the North-west of Rwanda before the deforestation started in the middle of the 1990s. It had a population of chimpanzees (Pan troglodytes) and golden (Cercopithecus mitis kandti) as well as blue monkeys (cercopithecus doggeti).

Gishwati Forest reserves had been heavily affected by human activities even prior to the Rwandan Civil war. In the 1970s, Gishwati had an area of 280 square kilometres. The forest was already degraded by many years of cattle herding in the forest.

The World Bank supported an integrated forestry and livestock project that converted 100 square kilometres to pasture and other 100 square kilometres to pine plantations in the early 1980s. A 30 square kilometres was designated as a military zone in the North of the forest, leaving only 50 square kilometres of natural forest. In fact Gishwati Forest has never been a priority for forest conservation.

During and following the war, the northern part of Gishwati was used to host camps for displaced people. By late 1997 the total number of families settled in Gishwati was estimated at 10,184. During 1997 and 1998, the forest was also used as a hide out by many of the Interahamwe militia. Consequently, a considerable number of military operations took place in the forest, which caused further degradation. The forest was converted to settlement, agricultural land as well as pasture. After the degradation, there is little of the original forest remaining in Gishwati. There are only a few trees on less than one hectare on an area of 700 hectares.

8.2. Impact of Gishwati Deforestation

Gishwati Forest has been supporting the country in various ways at both national and international levels. To estimate the loses of what has been lost, the total economic value of a forest can be classified into direct economic benefits based on the direct use of the resource and indirect economic benefit derived from functional services that the environment provides such as support to biodiversity and soil protection. Table 27 classifies these benefits.

Table 27.The Total Economic Value of Gishwati Forest

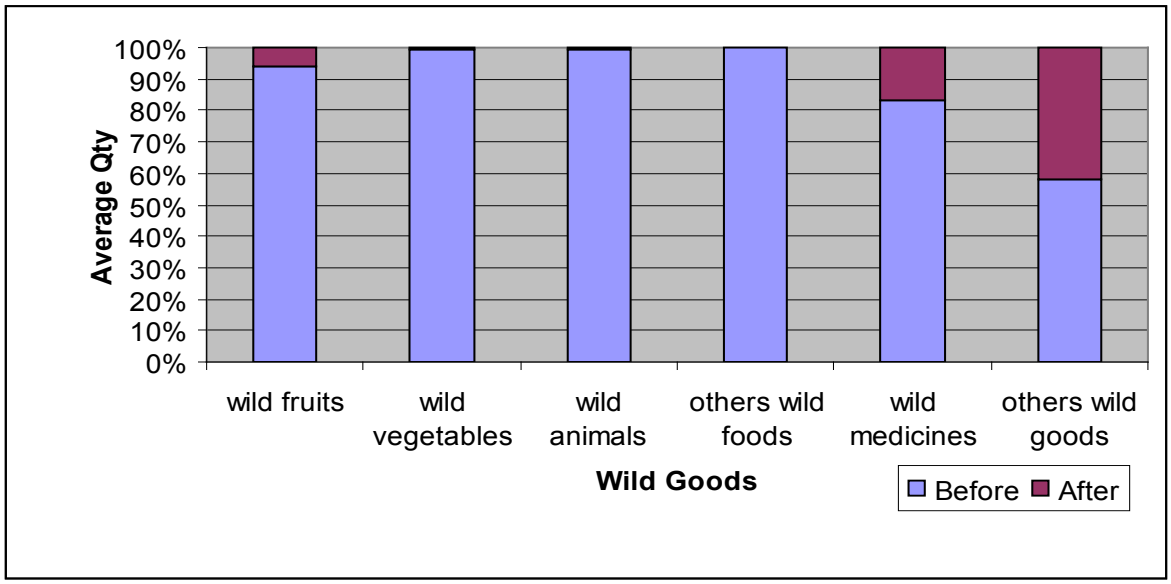
Direct economic benefit	Indirect economic benefit
Timber: - Fuel wood - Construction material - Charcoal Non Timber Forest Product: - Medicinal Plant - Wild honey - Wild food (vegetables, fruit, bush meat etc) - Hand Crafts (Thatching material, wood carving ..) Recreational use - Park entry Fees - Guiding Fees - Chimpanzees or Golden monkeys permit - Earnings by tour operators/hotels, visas fees……. Grassing	Soil Protection: - Erosion control - Fertility Water conservation: - Percolation into (under)ground water avoiding flash flooding Carbon sequestration Climate Control Option Value : Future use and bequest to future generation

8.2.1 Direct benefit

The direct benefits of the forest have been assessed through a detailed survey of the use of the forests by the local community who were living in the area prior to the deforestation. Estimates of consumption were made and current market prices were used. Many of the services did not pass through a market as products were bartered or used for subsistence.

In the study it was found that Gishwati forest has been a source of timber, wild food, firewood as well as medicinal plants. Almost all the respondents (99.9 %) have used the forest in one way or another. Evidence of its multiple goods and services supplied by the forests are summarised in Figure 11.

Figure 11. Multiple types of wild goods from Gishwati forest



8.2.2 Indirect benefits

Soil erosion and siltation

Like in any other tropical forests, Gishwati helped maintain soil quality, limit erosion, stabilised hillsides and modulated seasonal flooding. It has also protected down stream water resources from accelerated siltation.

The loss of the forest in many areas has resulted in tremendous environmental consequences such as accelerated soil erosion, landslides and flooding towards the valleys. This is mainly due to cultivation on steep slopes and the volcanic soil of the region, which is fragile. The consequent problems are also closely related to direct loss of agricultural productivity of the farmers. This ecological function is particularly important to the poorest people who rely on natural resources for their everyday survival. Photo 1 and 2 show a farm and a house near Gishwati Forest that has been damaged by floods. From personal communication with a farmer (2005) from the area agricultural loss due to degradation was estimated to be up to RWF 120.000 for the next harvesting season.

Another impact of the deforestation is flooding in the area. This has forced many families to close their house and move in with relatives. The displacement must have its own socio-economic impact to affected families that has not been quantified. Stagnant water is a common cause of water borne diseases and malaria.

Photo 1 and 2. Flooding near Gishwati Forest

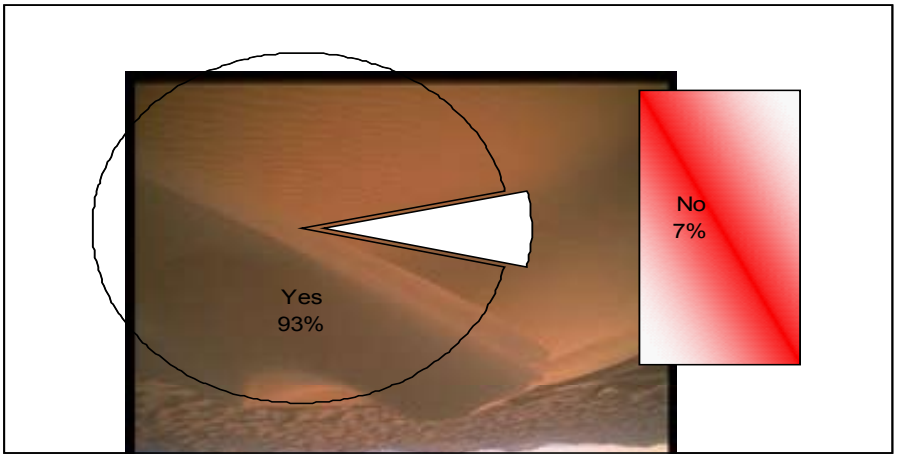
Loss of soil fertility

The economic valuation of the impact of deforestation on agriculture through soil erosion and loss of fertility are difficult to quantify since as it requires data over a long period of time. In addition it varies according to soil type and the extent of crop cover. The study has revealed that the depletion of soil resources have had a negative impact on agricultural production, which has further had economic implication to the livelihood of low income people who depend mainly on the primary sector. When these household produce less food, they consume less and are immediately affected by the income drop and have a negative effect on overall food demand. Through group discussions with farmers they estimated that the food production dropped by 25 % between 1998 and 2005.

The most dominant crops in the area are Irish potatoes and maize. Currently they require application of fertiliser and extensive soil conservation. Field results presented in Figure 12, shows that 93 percent of respondents practice kind of soil conservation

and 65 percent use livestock manure. However, the effect of manure on soil quality is short term since the soil improved in crop nutrients, soil texture and moisture retention cannot last for more than one cropping season.

Figure 12. Conservation measures in the area



It was found that the use of industrial fertilisers was not common. Traditional methods for soil fertility restoration such as shifting cultivation or bush fallow were also uncommon due to land scarcity and population pressure in the area. Rotating cereals (maize) and leguminous crops was also not common. The farmers explained this shift from beans to maize due to lack of bean stakes, which used to be secured from the forest.

Loss of income from potential tourism.

Gishwati Forest has never been a tourist attraction. However, as noted in the introduction Gishwati used to be a home of chimpanzees and golden monkeys. Had this potential been noted earlier the area could now be a tourist attraction and generate income for the area.

As indicated earlier tourism was and could become a major source of foreign exchange. Gishwati tourism could have been important in generating employment and income to the local population. Nyungwe Forest having the same physiognomy and almost the same biodiversity generate a significant amount of income from tourism. In 2004, the income from tourism was estimated to be US $ 9,947 a year. This was just revenue to Rwanda Tourist Board (ORTPN) from gate collections and permit receipts. The amount does not include other tourist expenditures like accommodation, souvenirs, visa and other indirect expenditures.

8.3. Off site impact of Gishwati deforestation

The deforestation of Gishwati has caused large scale siltation of Sebeya River, whose major catchment area is in Gishwati. The river originates from the mountain area of Gishwati and flow into Lake Kivu close to Gisenyi Town.

Photo 3. Sebeya River

Another important impact of the continuous deforestation of Gishwati, was a Wold Bank initiative that started in the 1980s. The project let to total deforestation between 1996 and 1998 and left only 10 percent of the forest remaining, which contributed to soil erosion and flooding with direct consequences of siltation of the river.

Two major local industries located in Gisenyi rely on the water from the Sebeya river. Electrogaz depend on the same river for the production of hydro-electricity and potable water. BRALIRWA, the single brewing industry in Rwanda also located in Gisenyi depend on the river for utilisation in their production.

The production capacity of electricity in Gisenyi town has been heavily affected due to the increased sedimentation of the river (Pers. comm. Nov 2005). The following major issues were raised in relation to the production of electricity:

- Production costs have increased due to additional cleaning and maintenance of equipment and hence the capacity has been reduced as additional time is spent on cleaning and repairing the equipment.
- The flooding in 1997 not only affected local community but also forced Electrogaz to close down one of the two power plants on the river. The second plant only worked at less than 50 percent of capacity over a period of one year.

According to the same sources, on average both of the two plants are closed for 5 hours per week for maintenance after the severe deforestation. The annual additional time for maintenance is 260 hours per plant. The Gihira plant produce 3240 kw/h while the one in Gisenyi produces 1800 kw/h. If we take the current cost per kw for a client which is 112 Rfw/kw the estimate of the annual cost of production lost is Rwf 146,754,800 (see Table 28).

Table 28. Energy costs Gihira and Gisenyi

Plant	Production capacity (Kw.h)	Annual Marginal production loss (Kw.h per annum	Annual Cost of production lost Rwf.
Gihira	3, 240	842,400	94,348,800
Gisenyi	1,800	468,000	52,416,000
		Total	146,754,800

8.4.Carbon sequestration

The tropical moist forest is an important carbon sink, which reduces the greenhouse gases and therefore contributes to mitigation of global warming that lead to climate changes. Estimates of carbon sequestration range between 10 tones per ha of grassland to 210 tones of carbon per ha of primary tropical forest of Gishwati type(Emerton 1995).

Table 29.Carbon sequestered

	Area (ha)	Tones of carbon sequestered
Gishwati after deforestation	700	87,500

These are of course rough estimates. However, Gishwati being a tropical forest plays an important role in determining the current atmospheric concentration of CO2 both as sources of CO2 following deforestation and sinks of CO2 resulting from CO2 simulation of forest photosynthesis.

Cost of remediation

This following includes the overall cost of activities to partly rehabilitate Gishwati. According to a project charged with its rehabilitation for 5 years the cost was estimated at Rwf 2,001,600,000.

8.5. More recent evidence of impact of degradation on livelihoods.

A survey to identify and evaluate the secondary data used mostly in most of this report was conducted as indicated in the methodology. Some of the data and information collected provide information that could be useful in the policy making process.

Of the 57 respondents only 3 - 5 percent was not involved in agriculture and livestock farming. Like in the case with Rugezi land plots have diminished in size (see Table 30). About 93 percent have plots sizes of less than half a hectare. This differs from where a higher percentage, 49, has plots between 0.26 and 0.5 ha.

Table 30.Size distribution of farms

Size in ha	Frequency	Percent
0 to 0.25	25	43.9
0.26 to 0.50	28	49.1
0.51 to 0.75	3	5.3
0.76 to 1	0	0.0
Above 1	1	1.7

The first indicator of degradation noted by the respondents was the availability of crop stakes before and after degradation of the forest (the timeline is roughly, as indicated earlier, before and after late 1990s). Table 31 shows that 40 of the 57 respondents used to get the stakes from Gishwati compared to only 4 after. Presently more farmers (32) get stakes from them from their own homestead after degradation.

Table 31. Supply of crop stakes before and after deforestation

Places	Before	After
Giswati forest	40	4
Homestead	11	32
Market	0	7
Others	6	9
Giswati forest +homestead	0	1
Homestead +market	0	4

The same trend is vivid with the availability of grass feeds for animals. Before degradation the forest provided a source of grass for animals to 40.3 percent of the respondents but this has declined to only 3.5 percent after deforestation. Consequently, more households depend on homesteads for grass after degradation compared to the period before deforestation. Deforestation has diminished a natural source of goods for households.

Table 32. Availability of grass to feed animals before and after deforestation

Places	Before	After
Homestead	29	43
From the forest	23	2
Others	4	12
Homestead, from the forest	1	0

For societies living in and around the forest an important source of livelihood is the supply of wild goods. Deforestation obviously reduces the supply of such goods. Nonetheless from Table 33 it is clear from estimates by respondents that the loss has been tremendously high with the deforestation of Gishwati. Most wild foods are completely lost or are on the verge of being lost. Wild fruits quantities collected from the forest have gone down by more than 93 percent. Wild vegetables and animals are also almost eliminated with 99.6 and 99.7 percent respectively.

Table 33. Average supply in kilograms of Wild Goods

Wild Goods	Before	After	Decline in percentage
Wild fruits	6,070	404	-93.3
Wild vegetables	7,956	35	-99.6
Wild animals	5,582	18	-99.7
Others wild foods	3,501	0	-100
Wild medicines	219	44	-79.9
Others wild goods	61	44	-27.9

The same findings are consistent with regard to availability of grass for thatching, woven goods and leaf litter. Table 34 display results showing that grass as major source of material for providing shelter has been diminished by 97.5 percent. Woven goods from the forest material have gone down by 88.4 percent and according to respondents there is no longer any litter from leaves. As indicated in the Rugezi case this litter is usually important for as an organic fertiliser enriching the soil. The contrasts are more graphically represented in Figure 13.

Table 34.Uses in kilograms of grass, reeds, canes and leaves before and after deforestation

Uses	Before	After	Percent decline
Thatching grass	1,409	35	-97.5
Woven goods	2,807	325	-88.4
Leaf litter	123	0	-100

Forests wood is an important product and usually required for several uses and users. Wood supply has obviously been one of the most affected by the deforestation of Gishwati. Similar declines in other forest products uses are presented in Table 35. Timber supply is fast moving towards non-availability with a decline in supply of more than 98 percent after the degradation. While supply of timber products were estimated to be up to 23 tones, the quantity after deforestation is hardly half a tone. Before more than 2 tones of furniture were supplied from the forest. After deforestation the respondents have indicated that there is literally no furniture products from the forest left. The same accounts for ropes made from tree bark. Other wood products approaching total elimination are agricultural supplements and household utensils with 97 percent decline in supply each as result of degradation. As with the wood products the respondents indicated that soon there will be no fodder for the livestock available in the forest. Their estimates were that about 3.7 tones before degradation and hardly 0.2 of a tone is available presently.

These findings show unimaginable consequences of deforestation. An important task is to link these findings to the changes of livelihoods of the population. For communities highly dependent on natural resources these findings point to progressive impoverishment. This observation is confirmed by results of average incomes of unskilled labour as presented in Table 35.

Figure 13. Decline in supply of other goods in Gishwati

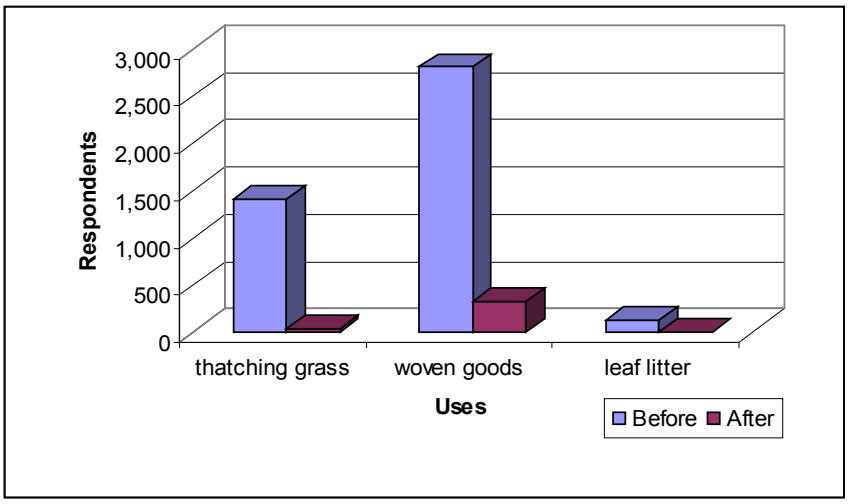


Table 35. Average annual quantity in kilograms of multiple uses of wood before and after deforestation

Multiple Uses of Wood	Before	After	In percentage
Timber	23,886	439	-98.2
Firewood	20,695	1,974	-90.5
Construction Wood	4,997	947	-81.0
Agricultural Implements	6,942	175	-97.5
Furniture Woods	2,639	0	-100
Household Utensils	1,251	26	-97.9
Hunting Implements	88	5	-83
Rope from bark	6,281	0	-100

On the contrary there seems little knowledge of water conservation measures and only 16 percent are of the opinion that measures to conserve water resources are being taken. These general opinions are depicted in Figures 14 and 15.
From the field work is became clear that there is a good understanding (93%) of the need and urgency of soil conservation and some is already being undertaken.

Figure 14. Soil conservation measures present in the study area

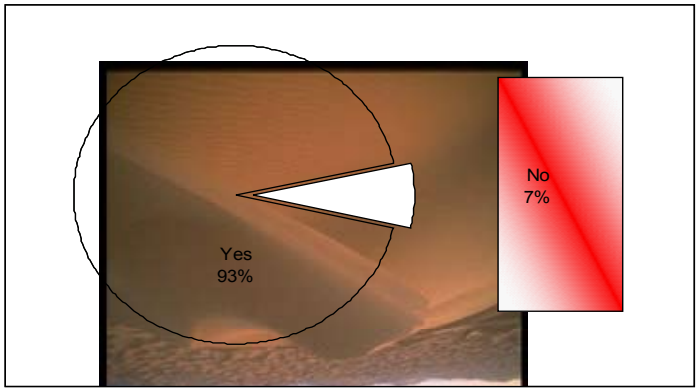
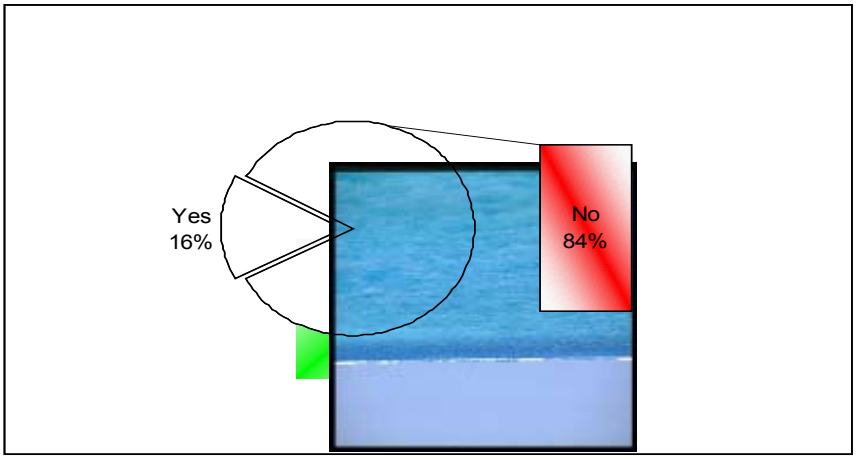


Figure 15. Water conservation measures in the area.



Though most of respondents agreed to the need of practicing soil conservation measures, in reality this was not the case on most of land. When asked why there was limited action of soil conservation, land tenure was mentioned as the biggest hindrance. According to group discussions the reason was the risk of appropriation by government. However there was some short term investment such as contour farming with grass strips, which was a common method used to prevent and control soil erosion from water runoff. However this is not fully efficient unless practiced on terracing.

Traditional agriculture in the past was better suited to the population density at the time, ecological environment and intensification of cropping. Long bush fallow periods restored soil fertility effectively. Pressure on land has resulted in drastic reduced fallow periods to complete abandon this method for the soil to recuperate. Respondents observed themselves that this is no longer possible due to scarcity of land.

Though it was not common, another farming method found in the area was the Mulch farming method that maintains surface residues on tilled land. Crops residues are useful in conserving the soil, controlling water run off, improving soil physical condition and increasing the soil's fertility. In situ mulching was fairly common practiced in the region. The practice has declined as a result of other competitive use of the crop residues such as fodder for livestock and fuel. When a conflict arises, the priority use of residues is either as fodder or fuel at the expense of soil conservation.

Research is needed to investigate the traditional approaches to land conservation so that it possibly could be adapted and integrated into the current practises, which should naturally be participatory, and not imposed. This can be done through extension workers and farmers or farmer associations as well as all decision-makers that deal with land use and management.

8.6 Overall link between forests and livelihoods

In a country with significant forests cover the contribution of forests may be as high as US $ 292 per hectare per year (Campbell 1999). However in small forests bordering villages this may go down to below US $ 100. In Rwanda these estimates are almost equal and a third of per capita income respectively.

It is clear that in Rwanda the significance and value mentioned above may be in areas where forests are still pristine like Nyungwe, Akagera and the Volcano National Park. The case of Gishwati is a showcase of how deforestation threatens livelihoods especially of the poorest. In general Arnold and Bird (1999) have shown how forests are linked to livelihoods

Table 36. Forests and livelihoods

	Importance of forests	Detail	Remark on livelihoods
1	Subsistence goods	Supplement or complement inputs of fuel, food, medicinal plants products etc in filling	Importance may decline as incomes rise
2	Farm inputs	-on farm trees provide shade, windbreaks etc -provide low cost soil nutrient recycling and mulching -provide fodder and forage, baskets for storage and ploughs and implements	-quite useful in places where decline in productivity is notable -importance diminish as capital availability increases
3.	Income	-easy access to the resources -low skills are required to exploit forests -exploitation can be part time -some forest services may offer high returns and full time employment	
4.	Reduced vulnerability	-forests services are a source of production diversification -forests act as reserves during drought	-forests act as buffer zones -government relief make some forest services as reserves less important

Source: Arnold and Bird(1999)

Forests are very important environmental resources that are closely related to poverty reduction (Arnold and Bird 1999). As rapid economic growth is sought, it is thought there will be less dependency on the forests. However, unless the poor benefit from the rapid growth, there will be less and less services from the forests that they usually depend on. Estimated figures from other parts of Africa show that forests and environment may contribute up to 10 percent of rural incomes (Cavendish 2000). Table 36 offers a view on how forests are closely linked to rural livelihoods. It is therefore clear that unless we view the issue of growth path as that of sustaining livelihoods, ecosystem services that are important tend to be ignored in favour of more quantifiable goods and services. However it is these that are closely related to sustainable use of natural resources and livelihoods of the poor. Detailed analysis of the ecosystem services importance need to be part of the search for growth. Gishwati is a tragic case showing how in a generation a whole ecosystem can be destroyed and subsequently affecting livelihoods of communities living in and around the forest.

9. PRIORITISATION AND WAY FORWARD

9.1 Strategic priority actions and policy making processes

Thinking strategic means knowing where Rwanda is and where it should be going. Presently Rwanda is caught up in a mire of environmental problems. However decisions with regard to the environment and natural resources have hitherto not taken the long term preferences and gains from proper natural resource management. However these two are not the only answer. A set of other policies need to accelerate and support the natural resource management drive. The natural resource management drive itself need to be coherent at sectoral and vertical levels. Below is a list of problem areas, which list the different priority areas.

ENRM Concerns in Rwanda

- Deforestation
- Watershed destruction
- Fuel crisis
- Soil erosion
- Siltation of water bodies
- Disrupted power generation
- Over cultivation
- Irrational use of land
- Insecure land tenure
- Rain water run off and nutrients loss
- Gully erosion and floods
- Falling levels of land productivity
- Increasing population pressure
- Lack of use of fertilisers and technology
- Inadequate conservation practices
- Low level of community participation in natural resource management decisions

From these observations there is a need to identify priority actions taking into consideration the following principles;

- a pro-poor economic path
- participation of communities in natural resource management
- conservation and protection of the ecosystem as a long term strategy
- awareness building on the role of natural resource management in Rwanda

Rwanda is at cross roads. It may continue to seek economic growth without a coherent natural resource management or it can prioritise the protection of the ecosystem not only for economic gains but for sustainable development.

Three steps can be taken currently:

Step 1. Elaborate more clearly the role of natural resource management and pro-poor economic growth more specifically:

- advocate for the use ecosystem services approach in analyses and policy application
- outlining clearly and elaborately strategies for protecting and conserving the environment
- laying out a coherent strategy to maximise the benefits from NRM at micro, meso and macro levels
- Recognising the urgency of designing methods of minimising costs of degradation and importance of sustainable natural resource management.

Figure 16 shows the need for coherence of policies at all levels. While we argue that policy making has not taken up natural resource management earnestly, it is also important that communities, decentralised organs recognise the importance of sustainable management of resources.

Figure 16. Policy coherence for Natural Resource Management e.g. land use and water resources

	Land Use	**Water Use**
International	Biodiversity Convention	Agenda 21
National	National Land Use Plan	National Water Use Plan
Provincial	Regional Land Use Plan	Regional Water Use Plan
District	District Land Use Plan	District Water Use Plan
Local	Community Land Use Plan	Community Water Use

So far environment is taken as MDG 7. However it should also be seen to be integral to each of other MDGs. If this is taken using the ecosystem approach the growth path will easily become pro-poor.

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Table 37. MDGs and environment

Millennium Development Goals	Examples of Links to the Environment
1. Eradicate extreme poverty and hunger	Livelihood strategies and food security of the poor often depend directly on healthy ecosystems and the diversity of goods and ecological services they provide.
2. Achieve universal primary education	Time spent collecting water and fuel-wood by children, especially girls, can reduce time at school.
3. Promote gender equality and empower women	Poor women are especially exposed to indoor air pollution and the burden of collecting water and fuel-wood, and have unequal access to land and other natural resources.
4. Reduce child mortality	Water-related diseases such as diarrhea and cholera kill an estimated 3 million people a year in developing countries, the majority of which are children under the age of five.
5. Improve maternal health	Indoor air pollution and carrying heavy loads of water and fuel-wood adversely affect women's health and can make women less fit for childbirth and at greater risk of complications during pregnancy.
6. Combat major diseases	Up to one-fifth of the total burden of diseases in developing may be associated with environmental risk factors – and preventive environmental health measures are as important and at times more cost-effective that health treatments
7. Ensure environmental sustainability	Current trends in environmental degradation must be reversed in order to sustain the health and productivity of the world's ecosystem

9.2. Mainstream natural resource management in the Economic Development and Poverty Reduction Strategy.

• The legislation on environment has already been passed and Rwanda Environmental Management Authority has been put in place and is operational. Nonetheless it will need to be strengthened and given capacity to inform and influence environmental discourse in Rwanda much better.

• A Sector Working Group on Environment and land has been in place and working. It is important that the sector accelerate its efforts to oversee natural resource management and environment is considered also in other sectors and consistent with 'MDGsing' the environment.

• To achieve the capacity to generate indicators for monitoring sector mainstreaming more studies as indicated in the next section will be required in the immediate period.

• In the medium and long run environmental statistics and environmental accounting will have to be collected and compiled respectively. Opinion leadership and capacity in the sector will have to be enhanced.

- As the EDPRS is on the drawing board it is important for the Environment and Land Use Management Sector Working Group (SWG) and REMA to insist being on board to ensure that environment and natural resource management is given the requisite importance in the document. Being on board should de facto mean being part of the structures that will be periodically evaluating the implementation of the EDPRS as well as drafting the document.

- The SWG should elaborate the priority areas that have been identified as of concern in Rwanda in the first section and develop clearly what strategies and policy action to incorporate in the EDPRS document.

- In relation to the above it is already known that the central theme of the EDPRS is economic development and wealth creation. The contribution of the environment and natural resources to economic growth and sustainable development should be made clear to government planners and policy makers to ensure its realised in the long term economic growth and human development

- In relation to the above there is need for EDPRS to incorporate issues of sustainable natural resource management in each of the sectoral plans and programs, in recognition of the cross cutting nature of environment

- In the next five years of EDPRS environmental data have to be collected in a more coherent manner and designs to incorporate clearly environment in Nation Accounts undertaken

- With environmental data collected EDPRS sectoral analysis should incorporate indicators for Monitoring and Evaluation of NRM

- To ensure effective mainstreaming EDPRS should be supported by a comprehensive capacity building in ERNM and public awareness component at national, meso and decentralise levels

9.3. Gaps And Needs For further Analyses

a. Accurate and quantitative measurement of amount of soil and natural resource degradation
b. More comprehensive inventory of ecosystem services in Rwanda and correct estimates of their contribution
c. Designing a communication and advocacy strategy for ENRM awareness in Rwanda at all levels
d. Study on how to introduce 'green accounting' in Rwanda
e. Sustainable land use in Rwanda and what can be done, why it has not been done by communities and how to break the impasse
f. A study on how to strengthen collection and dissemination of environmental statistics

We hope that this report, with its clear results and recommendations will assist the Government of Rwanda in the EDPRS process and in reaching the goals set in the Vision 2020 and in the EDPRS.

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