

Pilot Integrated Ecosystem Assessment of Bugesera

HUMAN WELL-BEING & POVERTY REDUCTION

Material well-being: 1. Improves for literate as well as illiterate population.
Health: 2. Enhanced access to improved community health services
Security: 3. Increased domestic security, and social order
 Freedom of choice and action: 4. Increased access to education, information, participation in decision-making; access to information for women; improved governance

INDIRECT DRIVERS

Demographic: 1. Family planning information – mobilization of programmes; women's access to information/empowerment; migration of foreign nationals to region
Economic: New market & business opportunities; high costs for funding, operation & maintenance
Socio-Political: Increased awareness of laws and policies improves consultative process and governance
Technological: Expansion of communications networks & infrastructure, expansion of biotechnology
Cultural: Traditional values eroded or challenged

ECOSYSTEMS & THEIR SERVICES

Water: Reduced water availability; decline in water quality from waste altered flow regimes of rivers; soil pollution and agricultural runoff
Food: Increased cash crop production, increased food security (more income for purchase, improved storage, access to weather forecasts) but this does not apply for the poorest.
Fuel wood: Reduced pressure on forests from stoves & woodlots; increased carbon sequestration
Biodiversity: Reduced biodiversity from species introductions, agricultural intensification; but new ecotourism initiatives & recreational parks

DIRECT DRIVERS

Land use: Better land management through a coordinated information system between different information centres like the Land Commission, GIS centre and statistics department. Intensification of agriculture through use of reliable weather forecasts data and early warning systems.
Water use: Information centres and data base with hydrological data established. This will enable increased sustainable water utilisation for irrigation, and domestic needs, more infrastructure constructed (dams), eventually irrigation becomes more efficient.
Pollution: Information shared on better waste management practices and cleaner production centre established.
 Technology Use: Improved use of information management systems.



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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)¹ 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 Pilot Integrated Ecosystem Assessment of Bugesera. The main purpose of the Bugesera IEA study was to assess the linkages between human wellbeing and ecosystem services at regional and local levels. The results of the assessment would assist policy makers and other stakeholders to appreciate environment and poverty linkages, contribute to the development of indicators for monitoring the ecosystem-human wellbeing changes, and generate advocacy tools for mainstreaming environment into the sectoral and national planning frameworks, particularly the on-going EDPRS process. 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.

¹ *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.*

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)

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List of Acronyms

Pilot Integrated Ecosystem Assessment of Bugesera

GoR	Government of Rwanda
HWB	Human Wellbeing
MA	Millennium Ecosystem Assessment
MINITERE	Ministry of Lands, Environment, Forestry, Water and Mines
ADF	African Development Fund
EDPRS	Economic Development and Poverty Reduction Strategy
ENERWA	Energy Rwanda
IEA	Integrated Ecosystem Assessment
FAO	Food Agricultural Organisation
FEWS Net	Food Early Warning Systems Network
FGDS	Focus Group Discussions
FMD	Foot and Mouth Disease
HWB	Human Wellbeing
IDP	Internally Displaced Persons
MINITERE	Ministry of Lands, Environment, Forestry, Water and Mines
REMA	Rwanda Environmental Management Authority
GPS	Global Positioning System
ISAR	Institut du Sciences Agronomiques du Rwanda.
ORTPN	National Office of Tourism and National Parks
MOH	Ministry of Health
PIE	Poverty Environment Initiative
IISD	International Institute of Sustainable Development
MINEDUC	Ministry of Education
GDP	Gross Domestic Product
FMD	Foot and Mouth Disease
MINADEP	Ministry of Defence
WATSAN	Water and Sanitation
WFP	World Food Programme
NICI PLAN	National information communication infrastructure
MINECOFIN	Ministry of Finance
PRSP	Poverty Reduction Strategy Paper
MDG	Millennium Development Goals
GIS	Geographical Information Systems
MINETRAPE	Ministry of transport and Public Works
UNEP	United Nations Environment Programme.
UNDP	United Nations Development Programme.

INTRODUCTION

EXECUTIVE SUMMARY

Stagnating or slow economic growth and escalating poverty has been associated with decline or total loss of ecosystem services. For instance, the real gross domestic product (GDP) growth rate for Rwanda declined from 9.4% in 2002 to 0.9% in 2003, as a result of the decline in agricultural production. This drop in agricultural production was precipitated, to a large measure by long and severe drought (MINECOFIN 2003a, MINECOFIN 2004a, MINECOFIN 2004b), which also resulted in food insecurity that affected about one-fifth of the country's population and consequently impacting on several other aspects of human well-being such as increase in malnutrition rates, ill health and a drop in house hold incomes (FEWs Net 2003).

The main objective of the PEI in Rwanda is to develop capacity for mainstreaming environmental issues into the national development framework, principally the Economic Development and Poverty Reduction Strategy Paper (EDPRS), by deepening understanding of the complex links between poverty, human wellbeing and environment. The Bugesera Integrated Ecosystem Assessment (IEA) was conducted as a pilot study to explore the linkages between human wellbeing and ecosystem services in Rwanda.

The approaches and methods used in Bugesera pilot assessment was based on the Millennium Ecosystem Assessment (MA), a four year global and multi-scale work programme (or "initiative") to assess the relationships between ecosystems and human well-being and life on earth (MA 2003). The Bugesera IEA therefore adopted the MA conceptual framework to assess the linkages between ecosystems, ecosystem services and human wellbeing, particularly highlighting the links between poverty and ecosystem degradation at both the local and regional scales of the Bugesera region.

A predetermined sampling strategy was used to conduct the assessment which entailed in-depth interviews and discussions with stakeholders, household surveys, literature reviews as well as GIS and spatial data analysis. The main focus of this pilot study was on the three core ecosystem services identified i.e. food, water and fuel-wood/energy during the National stakeholders workshop and the local stakeholders ranking during the reconnaissance visits to Bugesera.

The study results indicate that land fragmentation is prevalent in Bugesera and makes it difficult for modern farming techniques (e.g. mechanisation) to be used. This has led to the current less than optimal production and adoption of modern farming techniques could raise land productivity by up to three times.

Although Bugesera region was in the past one of the main food producers for the country, the region has faced chronic food insecurity since around 1999 (ADF 2006, FEWS Net 2001). Almost one-fifth (18%) of the Rwandan population is facing severe food insecurity, and Bugesera has been identified as the most affected. While the causes of food insecurity in other areas have been identified as land degradation (e.g. low soil fertility and soil erosion), in Bugesera, the main factor is unpredictable and inadequate rainfall, which is linked to prolonged drought.

In summary, the ecosystems' capacity to provide a range of food services has changed, and this has triggered responses in the form of changing consumption patterns and livelihood strategies. An important observation is that as land has become increasingly scarce and climatic conditions increasingly unfavourable for food production, food sources have changed, and availability of labour in a household is a critical factor. The decline in pastureland (rangelands) is associated not just with decline in livestock production but access to animal protein, which in the region, has become a well-known problem. The coping strategies for the locals they are vulnerable to ecosystem related shocks, and in the absence of efficient and reliable disaster mitigation measures, the poor in Bugesera are bound to plunge further into poverty.

1.0 General Background

1.0.1 *Ecosystem Services in Rwanda*

Human demands for ecosystem services are growing rapidly, and at the same time, humans are altering the capability of ecosystems to continue to provide many of these services (MA 2003, MA 2005). Ecosystem services are particularly important to livelihoods and economies of low-income countries such as Rwanda, where high dependency on natural ecosystems is still present and expanding rapidly (MA 2003, IISD 2005). In such areas, stagnating or slow economic growth and escalating poverty has been associated with decline or total loss of ecosystem services. For instance, the real gross domestic product (GDP) growth rate for Rwanda declined from 9.4% in 2002 to 0.9% in 2003, as a result of the decline in agricultural production. This drop in agricultural production was precipitated, to a large measure by long and severe drought (MINECOFIN 2003a, MINECOFIN 2004a, MINECOFIN 2004b), which also resulted in food insecurity that affected about one-fifth of the country's population and consequently impacting on several other aspects of human well-being such as increase in malnutrition rates, ill health and a drop in house hold incomes (FEWs Net 2003).

This report presents findings of an integrated ecosystem assessment carried out in the Bugesera region, Southern province of Rwanda, during the period May – August 2006. The assessment was conducted under the auspices of the United Nations Environment Programme (UNEP) funded Poverty and Environment Initiative (PEI) project. The main objective of the PEI in Rwanda is to develop capacity for mainstreaming environmental issues into the national development framework, principally the Economic Development and Poverty Reduction Strategy Paper (EDPRS), by deepening understanding of the complex links between poverty, human wellbeing and environment, and establishing a framework of indicators for monitoring them. In this regard, the Bugesera Integrated Ecosystem Assessment (IEA) was commissioned by the Government of Rwanda (GoR) as a pilot study to explore the linkages between human wellbeing and ecosystem services in Rwanda, including how the changes in ecosystems over the years have affected and could affect human wellbeing and poverty in the future.

1.0.2 *The Millennium Ecosystem Assessment*

The Bugesera pilot assessment has been inspired by, and has generally adapted, the approaches and methods used in the Millennium Ecosystem Assessment (MA). The Millennium Ecosystem Assessment (MA) was a four year global and multi-scale work programme (or "initiative") to assess the relationships between ecosystems and human well-being and life on earth (MA 2003). It was designed to provide decision makers with information to manage ecosystems in a more sustainable manner that will maintain both the ecosystem services that are essential to human wellbeing, and biological diversity, or biodiversity; that is, the variability among living organisms from all sources and the ecological complexes of which they are part (MA 2003). It is this biodiversity that ultimately underpins ecosystem service provision.

The MA demonstrated that achieving the Millennium Development Goals (MDGs), in particular the goals related to reducing hunger, reducing child mortality, combating diseases and ensuring environmental sustainability, will be very unlikely if development plans do not explicitly address ecosystem services. Achieving the MDGs will, in other words, require a genuine appreciation of the links between ecosystem

services and human well-being.

The conceptual framework for the Box 1: Definitions of key concepts used in the Millennium

Ecosystem Assessment MA describes relationships between ecosystem services, human wellbeing and

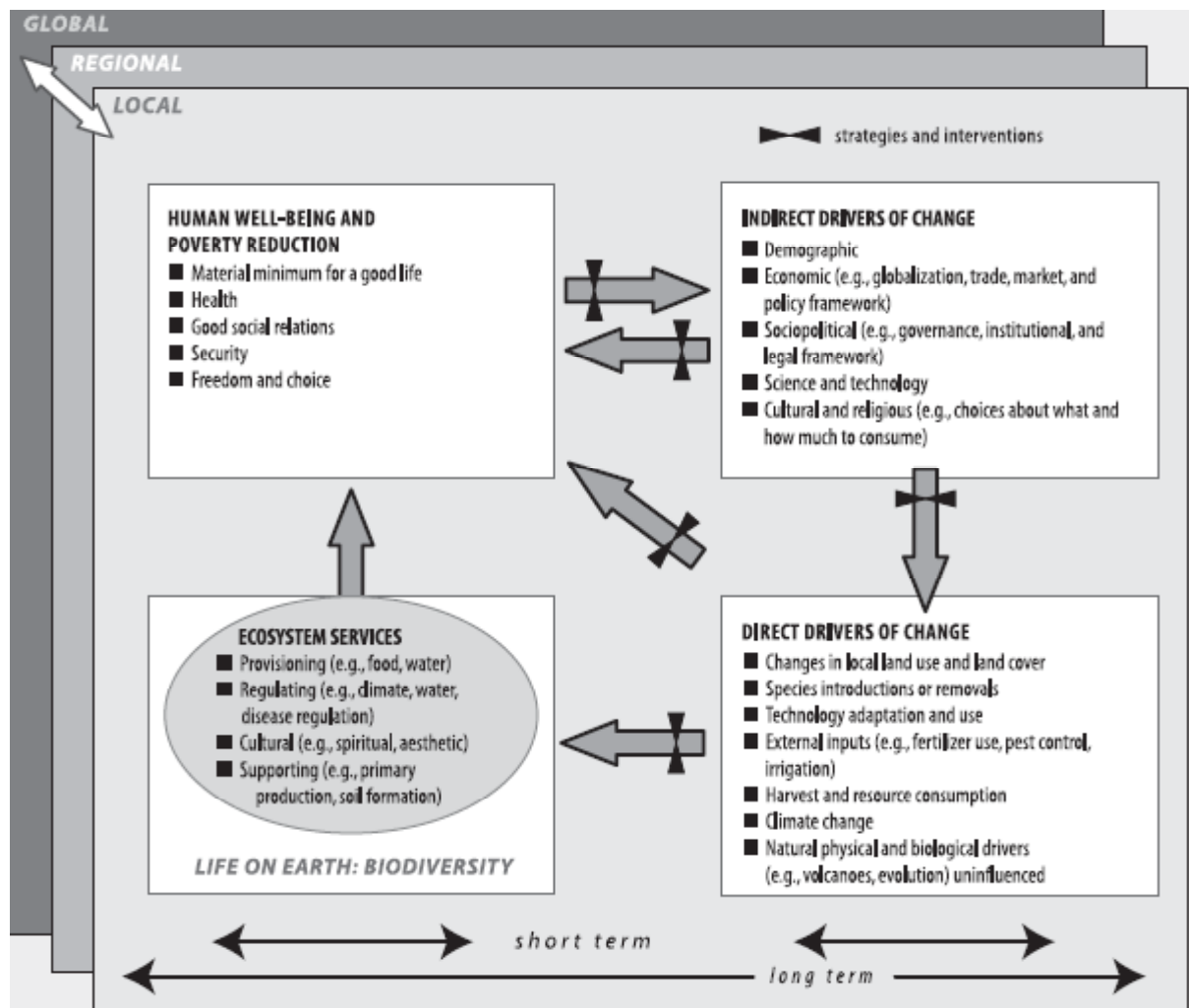
Box 1. Definitions of key concepts used in the Millennium Ecosystem Assessment

1. An ecosystem is a dynamic complex of plant, animal, and micro-organism communities, and the nonliving environment, interacting as a functional unit. Humans are an integral part of ecosystems.
2. Ecosystem Services are the benefits that people obtain from ecosystems. In the context of the integrated ecosystem assessment (MA 2003), they have been grouped into four categories:
 - (a) Provisioning services are the products obtained from ecosystems, and include food and fibre, fuel, genetic resources; bio chemicals, natural medicines and pharmaceuticals; and ornamental resources;
 - (b) Regulating services are the benefits obtained from the regulation of ecosystem processes and include air quality maintenance, climate regulation, soil erosion control, water purification and waste treatment, regulation of human diseases, biological control, storm protection and flood control, etc.
 - (c) Cultural services are the non material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences. Such services include cultural diversity, recreation and ecotourism, spiritual and religious values, traditional and formal knowledge systems, educational values and scientific values, cultural heritage and sense of place, among others.
 - (d) Supporting services are those that underpin the provision of all other ecosystem services. Examples of supporting services are primary production (photosynthesis) and soil formation.
3. Human Well-being refers to a set of conditions for physical, social, psychological and spiritual fulfilment. It includes basic materials for a good life, the experience of freedom, health, personal security and good social relations. Wellbeing exists on a continuum with poverty, which has been defined by the World Bank as pronounced deprivation in well-being.

Source: MA 2003: Ecosystems and Human Wellbeing: A Framework for Assessment.

Poverty Reduction, and drivers of change, making a distinction between indirect drivers and direct drivers. Indirect drivers are changes in factors that indirectly affect ecosystems, such as population, technology, and lifestyle. These can lead to changes in direct drivers or factors that directly affect ecosystems, such as the catch of fisheries or the application of fertilizers to increase food production. The main concepts used in this assessment i.e. ecosystems, ecosystem services and human wellbeing, are defined in Box 1. The MA conceptual framework which depicts the links between ecosystem services, human well-being, direct and indirect drivers is shown in Figure 1.

Figure 1: conceptual Framework of the MA Framework



Source: Millennium Ecosystem Assessment 2003.

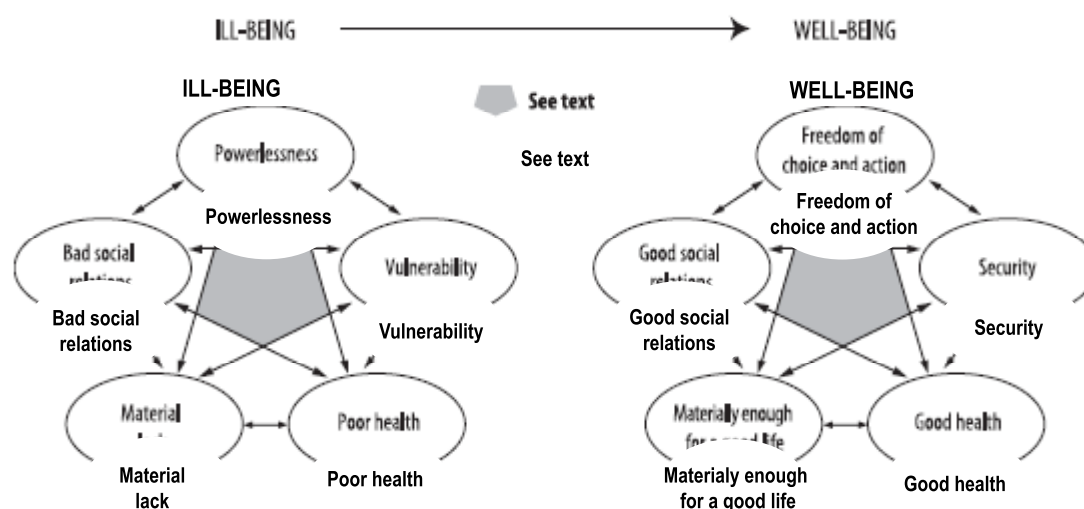
The MA (2003) argues that the constituents of well-being, as experienced and perceived by people, are situation-dependent, reflecting local geography, culture, and ecological circumstances. Hence, the 5 constituents of human wellbeing adopted in the MA in box 2, were used in this assessment.

Box 2. The Five constituents of Human Wellbeing adopted by the MA

1. Necessary material for a good life (including secure and adequate livelihoods, income and assets, enough food at all times, shelter, furniture, clothing, and access to goods);
2. Health (including being strong, feeling well, and having a healthy physical environment);
3. Good social relations (including social cohesion, mutual respect, good gender and family relations, and the ability to help others and provide for children);
4. Security (including secure access to natural and other resources, safety of persons and possessions, and living in a predictable and controllable environment, with security from natural and human-made disasters); and
5. Freedom and choice (including having control over what happens and being able to achieve what a person values doing or being)

MA (2003) observed that the five constituents of human wellbeing in Box 2 reinforce each other, and a change in one of them often brings or results in changes in the others. The interaction between the basic constituents of human wellbeing (and ill-being on the extreme side of the continuum) adopted by the MA is graphically illustrated in figure 2.

FIGURE2: Interaction between the Main Constituents of HWB and Human Ill-being



Source: MA 2003.

The Bugesera IEA therefore adopted the MA conceptual framework to assess the linkages between ecosystems, ecosystem services and human wellbeing, particularly highlighting the links between poverty and ecosystem degradation. But to localize the MA framework, basic constituents of HWB were defined as perceived by the population. Local people had to define what is basic for them – the increasing scarcity of staple foods for example was deemed important and yet this does not include animal proteins (meat, fish,..) considered a luxury.

1.0.3 Need for and Scope of the Assessment

Bugesera has experienced a steady decline in the level of ecosystem services from being the food basket of the country in the 1960s with widespread forest cover and plenty of rainfall to today's reality of drought, soil erosion and lack of grazing land. Better understanding the links between ecosystem services and human well-being in Bugesera, including the drivers of the change the region has experienced will provide useful lessons for the development of PRSP II and for decision-making regarding sustainable natural resources use both in Bugesera and in the rest of the country.

1.0.4. Key Assessment Questions

The main focus of this pilot study was on the three core ecosystem services identified i.e. food, water and fuel-wood/energy during the National stakeholders workshop and the local stakeholders ranking during the reconnaissance visits to Bugesera. To explore the links between the three main ecosystem services above and human well-being in Bugesera, four core questions were assessed:

1. How are the ecosystem services affecting human well-being in Bugesera? Which ecosystem services have the strongest impact on human well-being?
2. How have the ecosystems in Bugesera changed over the years, and how has this affected the availability and access to the three key ecosystem services above?
3. What are the main drivers (direct and indirect causal factors) of these changes?
4. What are the possible scenarios (future situations) with regard to availability, access and sustainability of ecosystem services and human well-being in Bugesera? What policy options can and should be promoted to improve or maintain ecosystem services and human well-being?

These broad questions were broken down into specific questions which were investigated through literature reviews, in-depth discussions with stakeholders, and household surveys.

1.0.5 Expected Utilization of Assessment Results

Overall, the main purpose of the Bugesera IEA study was to assess the linkages between human wellbeing and ecosystem services at regional and local levels. It is intended that the results of the assessment will assist the GoR and other stakeholders to appreciate the links between environment and poverty, contribute to the development of indicators for monitoring the ecosystem-human wellbeing changes, and generate advocacy tools for mainstreaming environment into the sectoral and national planning frameworks, particularly the on-going EDPRS process (PRSP11).

THE ASSESSMENT APPROACH AND METHODOLOGY

2.0 Selection of Temporal and Spatial Scales

2.0.1 *Significance of a multiple-scale assessment approach*

The purpose of the assessment was to understand the relationships between ecosystem services and human well-being in the region of Bugesera. However, as this is a large and diverse region, it is impossible to assess the entire Bugesera region and its population in a comprehensive way. Thus, based on recommendations during the training workshop in Butare, a multiple-scale assessment approach was adopted. A predetermined sampling strategy was used to conduct the assessment at regional and local scales. The regional scale provides an overview of the whole region. At the local scale, the team selected two villages which they believe offered an opportunity for more detailed analysis of the relationships among ecosystems, ecosystem services and human well being. It was also decided to primarily focus on the three key ecosystem services of food, water and fuel-wood.

2.1 *Methodologies for Regional Scale Assessment*

2.1.1 Interviews

In-depth individual interviews and discussions with the respondents were held with 20 people, who included local leaders, technical personnel and key informants including the elderly, who were able to provide historical information that was essential in understanding the trends. The team developed and used an interview guide to focus the questions. To obtain and validate information, the team also held Focus Group Discussions with the key informants such as elders, professional staff and opinion leaders. The focus group discussions addressed topics such as historical trends, economy and socio-political issues in Bugesera.

2.2.2 Literature reviews

Available documentation related to ecosystems in Bugesera was used to conduct background research before beginning fieldwork. This includes monographs, statistical data, District Performance Contracts, progress reports, hand-over reports between the new and the former district administration and other documents. Sources include universities, government departments, public and private institutions, and NGOs.

2.2.3 Observation

Direct observations were made deliberately on the current state of the ecosystem, ecosystem services, and human well-being throughout the period in which the team conducted their field work. Information gathered through this approach supplemented the more detailed interviews.

2.1.4 GIS and spatial data analysis.

Land cover/ land use change analysis was undertaken over a period 1977/78 and 2000, by overlaying land cover maps for 1978 and 2000. The land cover map for 1978 was made by a composite of Aerial photos for

1977 and 1978 taken at approximately 3000 meters above the ground, with a spatial resolution between 20-50 meters. These aerial photos were obtained from the Archives of former MINITRAPE (Ministry of Transport and Public works). The topographical map of Bugesera for 1983¹ was used to validate and interpret the map. For land cover 2000, a satellite image from Africover 2000 was used. Image processing was done using Erdas Imaging, while spatial analysis was performed using a Geographical Information System (GIS) software ArcGIS version 8.2. In order to compare the map for 1978 and 2000, the classification of map 2000 was re-classified from the standard Africover type to match with the (unknown) classification 1978. Mapping of main ecosystems, using a Global Positioning System (GPS) receiver, enabled to establish the current boundaries of some of the most prominent ecosystems and provide ground-truth information to update the spatial data from the satellite imagery. The prominent features mapped included Lake Cyohoha North, Gako woodland reserve and the Kanyonyomba swamp.

2.2. Methodology for Local Scale Assessment

2.2.1 Selected area of the assessment

Bugesera region is consisted of 3 general zones (upper, central and lower zone), which were identified using expert knowledge at the workshop in Butare following main ecosystems and level of human activities. The drying of Lake Cyohoha North and the prolonged drought brought to the political debate the issue of Bugesera ecosystems and people's survival. This influenced the choice of Bugesera region and the specific sites for the IEA.

Thus, the two villages selected for the Local Assessment were Biryogo located in Gashora sector in the southern zone, and Kibenga village in Mayange sector in the central zone (figure 8). The selected villages reflected the three key ecosystems and associated ecosystem services under study:- lakes which provide water services, forests which provide energy services, and agro-pastoral ecosystem which provides food services.

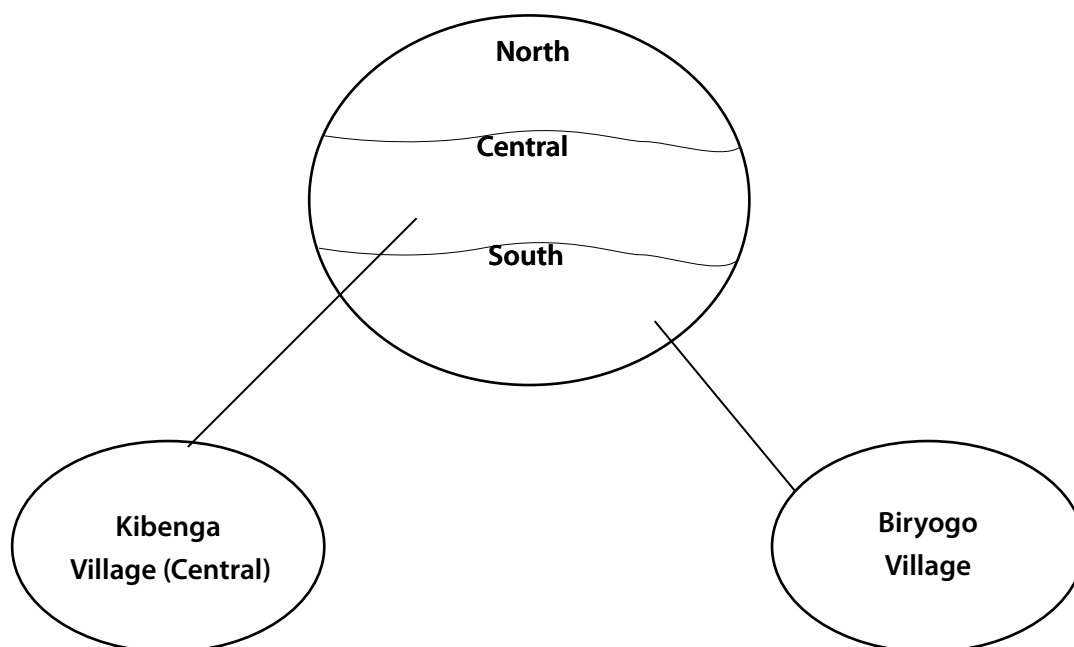
Selection criteria:

The first site (Biryogo village) was selected on account of its proximity to Kirumira and Kidogo - Lakes and the natural woodland of Gako (a reserved land presently hosting military camp). One of the prominent features in this area is grouped settlement entirely inhabited by vulnerable people (mostly widows and orphans due to HIV/AIDS). These nearly of whom were resettled in Bugesera after the 1994 genocide, have no land, and most depends on food and material handouts from charities (mostly faith based organisations, NGOs, and local associations). They have no sources of income and some have no one to help them. Yet the cost of living is very high- they even depend on the market for firewood.

The second site (Kibenga village) is located in Mayange sector in the Eastern zone in the proximity of Lake Cyohoha North. Kibenga has been selected because people depend mostly on the services from the lake and its marshland (fish and crops). With the lakes showing signs of drying up (actually a very small part of the water body is left), Government authorities imposed stringent regulations including a ban on fishing, cultivating the marshlands and watering animals on the lake shores and its wetlands.

¹ ***The topographical map 1983 is the most recent for Bugesera, as no records exist for the period since them.***

Figure 8 below shows the sketch locations of the local scale assessment sites.



This Diagram shows Multi-scale assessment design subdivision of Bugesera into three zones. Local assessments were conducted in the Central (Kibenga Village) and South (Biryogo Village) zones.

2.2.2. Data Collection Methods at local scale

2.2.2.1 Interview and Focus Group Discussion

A combination of participatory and rapid assessment techniques were used in the collection of primary data. Transect walks (in a “drive, stop, observe and record” approach) were used to make general observation and obtain a better impression of the main issues related to ecosystems and ecosystem services. Where expert knowledge among the team was not sufficient to explain local phenomena, the team asked local people for clarification. This approach was determined to be successful in providing more detailed information with improved reliability.

A total of eight focused group discussions (FGDs) were held with different categories of people in the two villages. The composition of focus groups strongly reflected the different livelihood categories and interest groups including fishermen, livestock keepers, smallholder subsistence farmers, crafts makers, agriculture – based associations with activities in the wetlands, elders, opinion leaders, and women’s groups. In addition, in-depth interviews were held with selected key informants at the local level such as current and former local leaders and experts.

2.2.2.2 Questionnaires

After a thorough research design, literature review and organization of research instruments, the team pre-tested the questionnaire. The pre-testing with 20 informants aimed at anticipating attitudes towards the questionnaire to know whether the respondents understood the questionnaire and to eliminate ambiguous questions, which could create bias in responses.

For the rapid assessment, semi-structured questionnaires were used in a household survey involving a total of 100 households in the two villages of which 97 questionnaires were actually completed. A household survey was conducted by research assistants in mid-July 2006, using semi-structured questionnaires and interviews. The households were selected through planned stratification to ensure that key wealth factors that influence the dependency on ecosystem services were captured.

2.3 PROFILE OF THE BUGESERA REGION

2.3.1 *The Biophysical environment*

Bugesera region (1303 km²) is found in the southeastern plains of Rwanda's Eastern Province. Bugesera is bordered in the south by the Republic of Burundi (Kirundo Province), Ngoma district to the east, and Kigali city and Rwamagana district to the north. The region is sandwiched between Rivers Nyabarongo and Akanyaru which converge at the southern end to form the Akagera River. Bugesera area is characterized by numerous lakes, the biggest of which are Rweru and Cyohoha. These two plus the other small lakes in the region comprise an estimated surface area of 10,635 hectares (MINITERE/CERECE 2003).

The region is predominantly vegetated by dry savannas which are characterised by short grasses, shrubs and short trees characteristic of arid and semi-arid areas (MINITERE/CERECE 2003). Plate 1 shows the typical natural vegetation of Bugesera. Part of the Gako reserve where the thick natural wood lands still exist, is in the background.

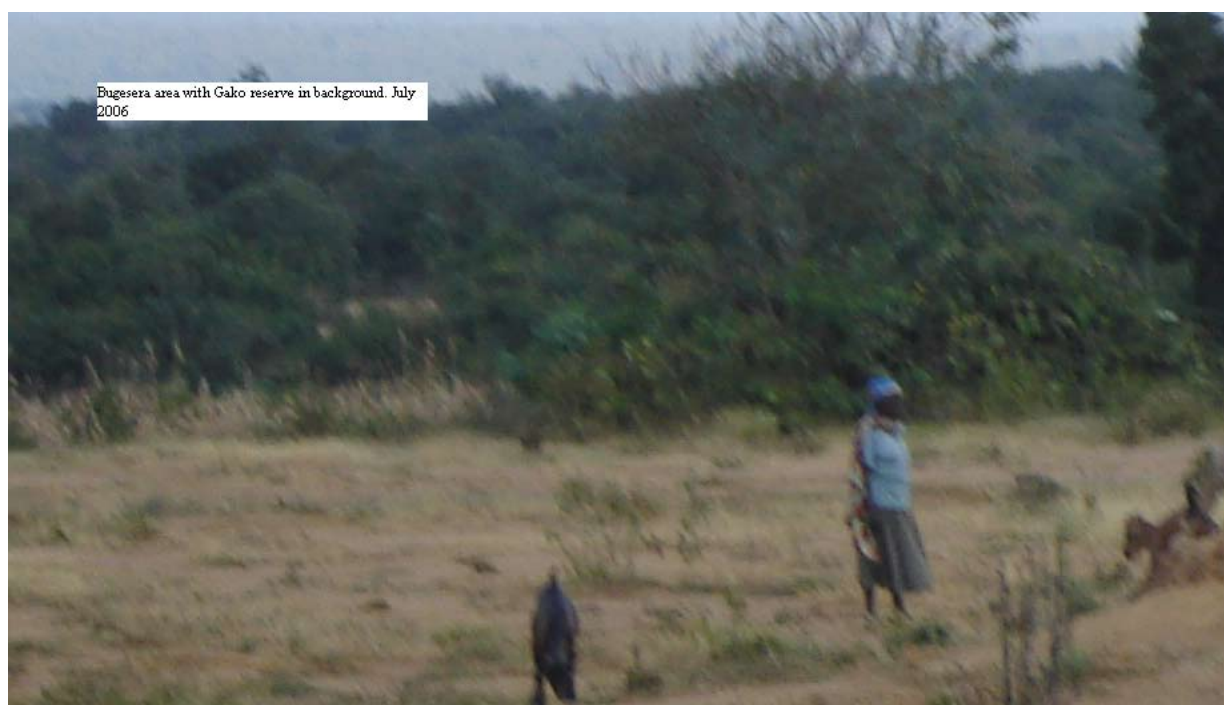


Photo 1: Wood land ecosystems in Bugesera

Shrubs and short trees tend to surround the short and undulating hills, valleys and along the rivers and wetlands. The extensive savannas and their drought resistant shrubs have historically provided grazing lands for pastoralists who are said to have been the first inhabitants of the region, but with increasing population, most of the natural vegetation disappeared due to conversion into agricultural lands. In terms of climate, the region is a low rainfall zone receiving an annual average of around 900 mm (Figure 3). The days are generally hot and dry while nights are usually cool. In terms of soil and land characteristics, Bugesera region has a forest soil classified into 3 groups according to the 3 parent rock types i.e. schist and quartz rock, granite and gneiss rock, and alluvium and colluvium rock. The agronomic characteristics of Bugesera lands have been described as favourable for growth of a variety of crops, and were it not for adverse climatic conditions, the Bugesera region would have among the most productivity potential in Rwanda. Table 1 below summarises some of the climatic parameters that influence water available for plant growth in Bugesera.

Table 1. Selected Agro-climatic parameters recorded at ISAR Karama Station (1974-1989)

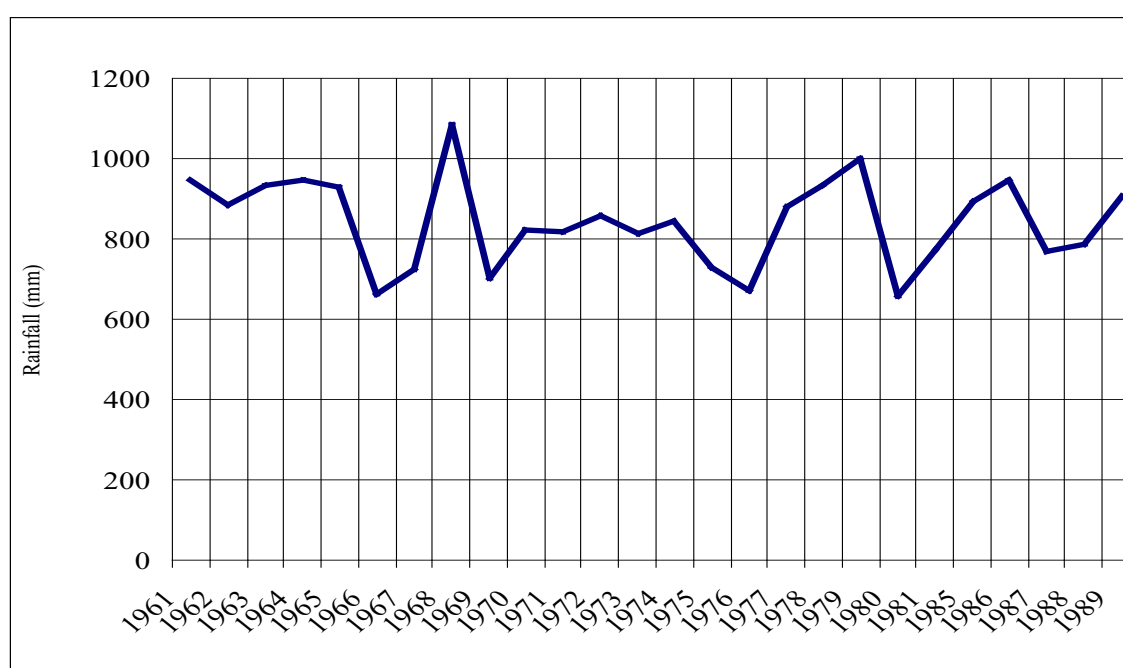
Pilot Integrated Ecosystem Assessment of Bugesera

Parameter	Average / annual total
Relative humidity	67%
Annual Rainfall	854 mm 275 mm in Humid Period 515 mm in Intermediate Period 64 mm in Dry Period
Annual Evapo transpiration (ETP)	1339 mm : 187 mm in Humid Period 734 mm in Intermediate Period 418 mm in Dry Period
Annual Length of periods	
Humid	60 days
Intermediate	213 days
Dry	92 days
Annual Underground water Rainfall	88 mm
Annual Water stress	573 mm

Source: District Development Plans, 2005; Rwanda Meteorological Services.

Figure 3 shows the total precipitation recorded at Karama station in Gashora over the period 1961 to 1989. Because of inability to maintain the meteorological equipment, no weather data has been collected since 1989, implying that an accurate assessment of past weather trends is difficult to make.

Figure 2: Total Annual Rainfall recorded at Karama station (1961-1989) at Karama station (1961-1989)



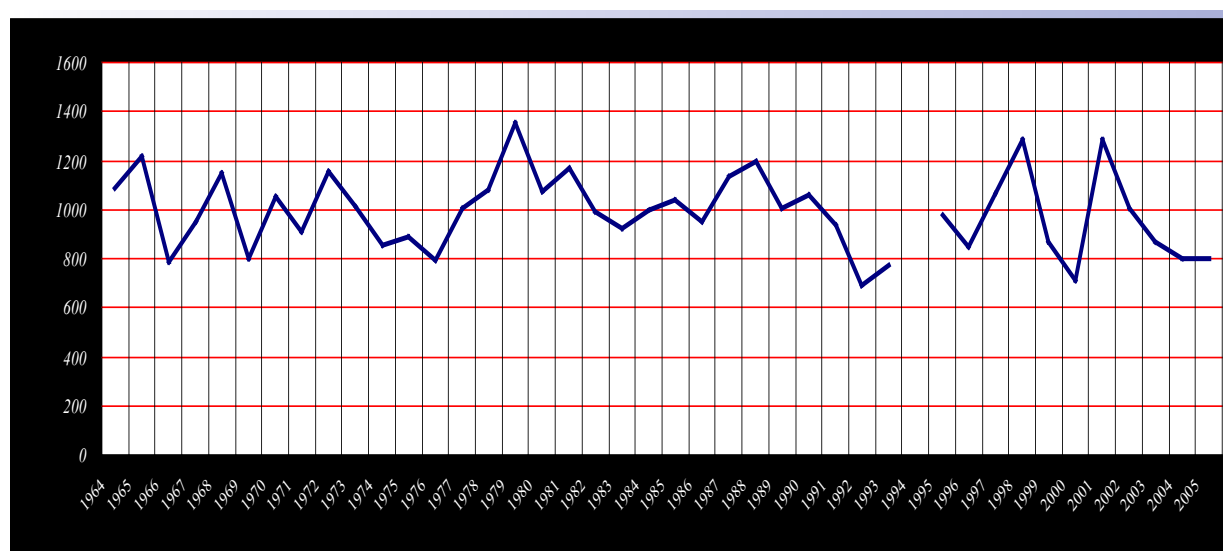
Data Source: Rwanda Meteorological Services.

The highest rainfall ever recorded was 1300 mm in 1969, and mean annual precipitation has remained in

the range of 700 - 900 mm (Figure 3). However, monthly rainfall patterns for 1961 and 1989 show significant variations, with dry spells tending to occur from June to August.

The rainfall figures for Bugesera for the period 1990 – 2005 can be deduced from the records of 40 years at Kanombe – Kigali station (Figure 5) which is the closest functioning station, and whose climatic conditions resemble those of the northern parts of Bugesera. Also, Bugesera was part of the larger administrative prefecture of Kigali in the 1970s. The missing figures for 1994 are due to the fact that no recordings were taken between April and September 1994, as a result of the war at the Kanombe International Airport. Nevertheless, as can be observed, total annual precipitation shows a declining trend, which coincides with reports of a prolonged drought during the period 2000 to date (WFP 2001, WFP 2006, USAID 2006, Save the Children 2000, IEA Household Survey July 2006).

Figure 3: Total Annual precipitation recorded at Kanombe station, Kigali (1964-2005)



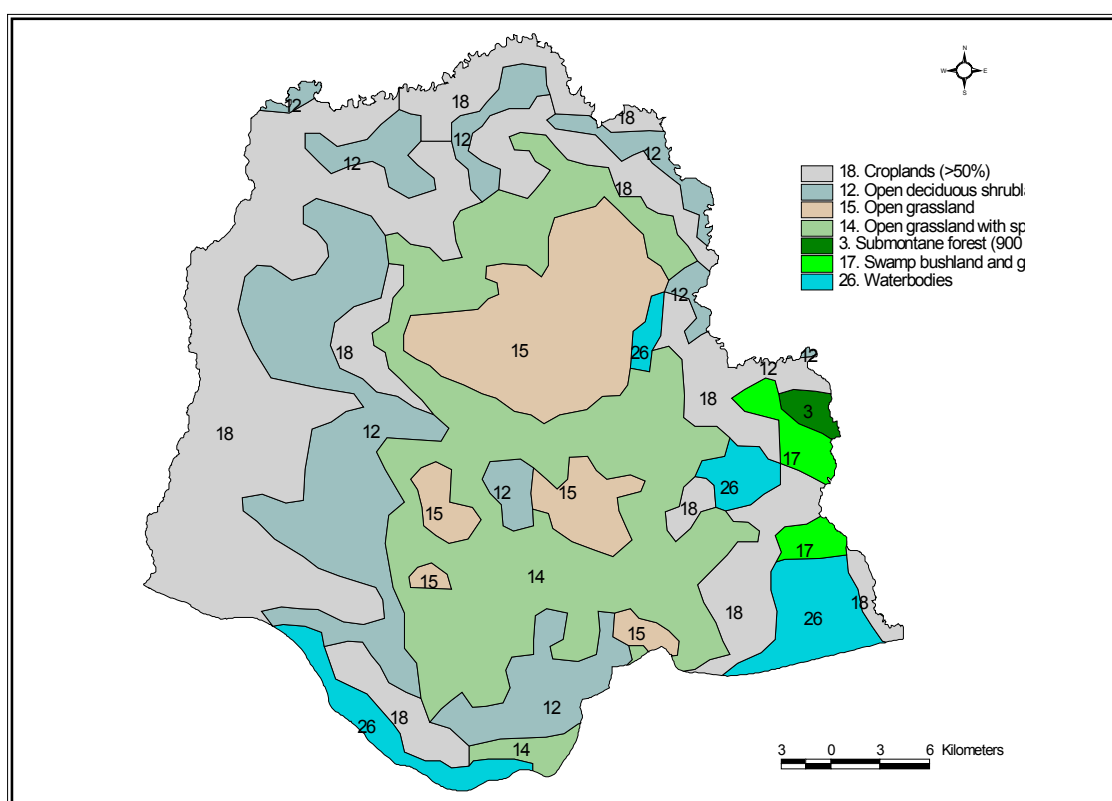
Data source: Rwanda Meteorological Services.

2.3.1.1 Bugesera Ecosystems and their Services

The main ecosystems found are wetlands, water bodies, agricultural landscapes, savanna woodlands and conserved rangelands (Map 2). These ecosystems provide a range of services for the population. The lakes and rivers are, for instance, the principal source of water for both humans and animals.

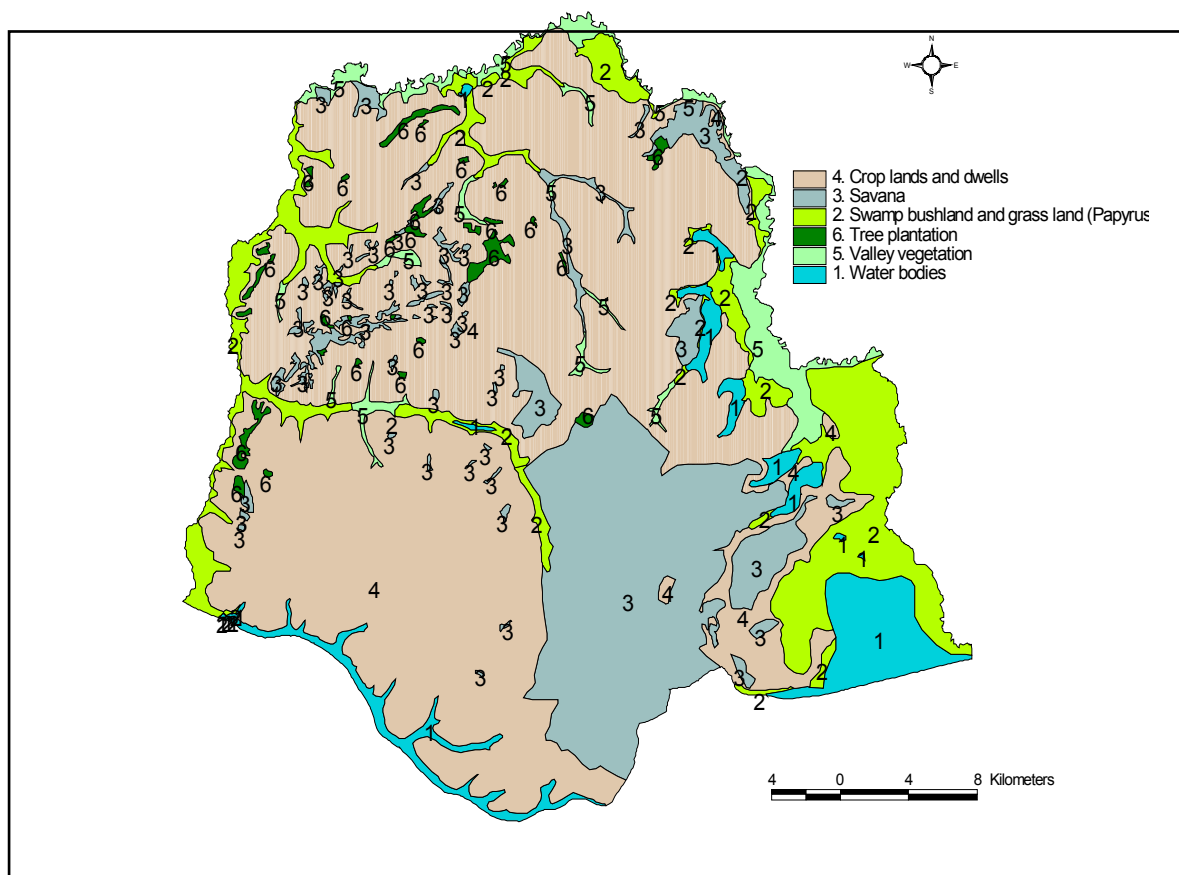
Map 2: Status of Land cover/ land use in Bugesera region in 2000

This map is based on the satellite image of 2000, the most recent available; thus, some land cover changes are likely to have occurred since then. Notice also the classification error in the Africover classification type which indicated sub-montane forest in an area covered by a wetland because of thick dark green vegetation cover whose reflectance showed that of a sub-montane forest.



Land use in Bugesera has changed tremendously over the last several decades. A spatial analysis of the land cover for 2000 (map 2) and land cover for 1978 (map 3) shows that crop lands and settled areas have expanded into areas previously occupied by wetlands, forests savanna wood lands. The near total conversion of wetlands, forests and savanna woodlands and their conversion into agricultural farms, have negatively affected the supply of direct ecosystem services such as water, fuelwood. This has also been blamed for the changing micro-climate with the most visible being the disappearance of Lake Cyohoha North, which depended on surrounding wetlands for water.

Map 3: Status of Land cover/ land use in Bugesera region in 1978



Biodiversity

As a low rainfall area, biodiversity in Bugesera is typical of dry lands, but species more often found in humid ecological areas are also present. A mixture of short grasses and shrubs are found mainly in the savanna patches, tall grasses dominate the wetlands and valleys along the river and lakes, while short savanna grasses and herbs are mainly found in cultivated lands. Shrubs and short trees skirt around the sides of short hills. The short savanna grasses and short acacia trees are found mainly in the less transformed areas in the central and southern parts stretching to the international border with Burundi. Species distribution tends to follow elevation and drainage. In the northern parts of Bugesera which have short hills and moist valleys, shrubs are the dominant vegetation on hillsides, while *Cyperus* species (including papyrus) are found along the rivers and streams. Throughout Bugesera, particularly in the north and central parts, which are relatively more transformed than the south, *Lantana camara*, an invasive plant native to South America, is common, and has proved to be resilient in the aftermath of the harsh drought that has persisted in Bugesera over the last 6 years.

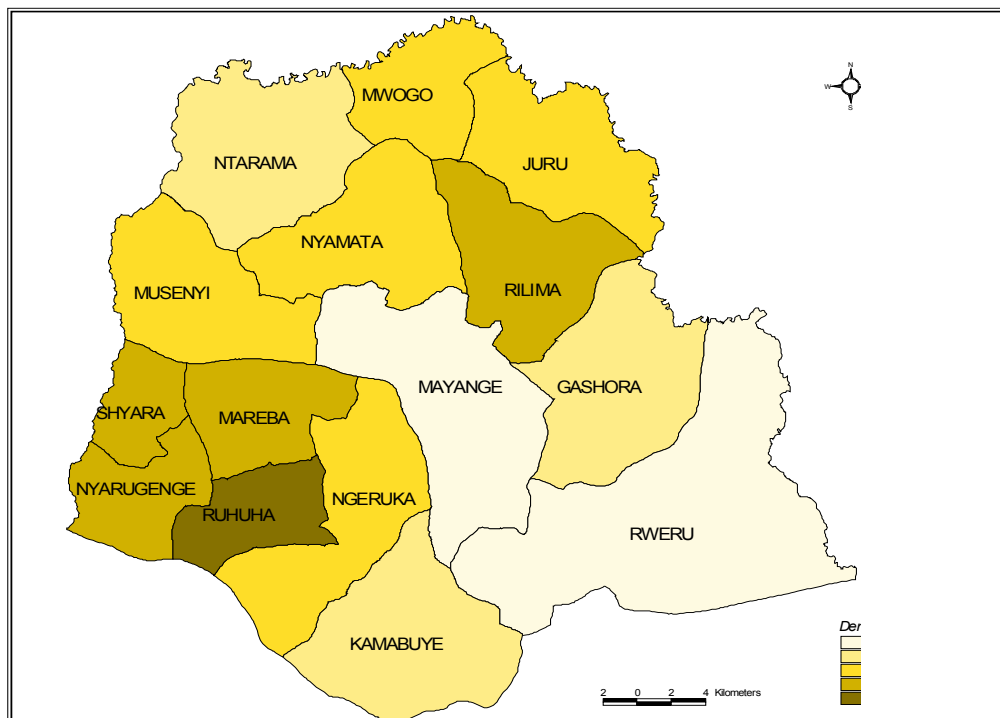
Wildlife is rare although the region used to have much wildlife before massive settlement of people (Kanyamibwa 1998). Native fish species which form important dietary and income sources for the population include *Protopterus aethiopicus* (lung fish), *Clarius spp* (mudfish) and *Labeo victorianus*. Introduced species include Nile tilapia (*Oreochromis niloticus*), *Astatoreochromis alluandi*, *Schilbe mystus* and *Cyprinus carpio*.

(Experco 2003). These fish species were originally introduced into Lakes Muhazi, Kigembe and Kiganwa and river Nyabarongo, and found their way into all Lakes in Bugesera (MINITERE/Experco 2003). These alien species, particularly the Nile tilapia, have had devastating effects on the aquatic biodiversity, as they predate on the native fish species, resulting in extinction of some (MINITERE/ Experco 2003). Water hyacinth (*Eichhornia crassipes*), a native of south and Central America, is visible in or along all water bodies in Bugesera. The massive sediment deposit that comes from the upper catchments of River Nyabarongo contributes to the proliferation of the water hyacinth and other weeds.

2.3.1.2 Demographic and Socio-cultural Issues

According to the August 2002 Population and Housing Census, Bugesera had a total population of 266,775 (RGPH 2002; Bugesera District Local Government Performance Progress Report 2006) and is estimated to be 297,168 people in 2006 (WFP 2006a). Among Bugesera's 59,665 total households in 2004, the average household size in Bugesera was 5 people. Table 2 below shows the population distribution by sector. Population density in Bugesera has progressively increased from 181 inhabitants/ km² in 1980, to 205 inhabitants/ km² in 2002. Although this is less than the national average of 321 inhabitants/ km², it raises concern for the carrying capacity of an ecologically fragile region like Bugesera. Map 4 shows population density by sector.

Map 4 Population Density by sector in Bugesera



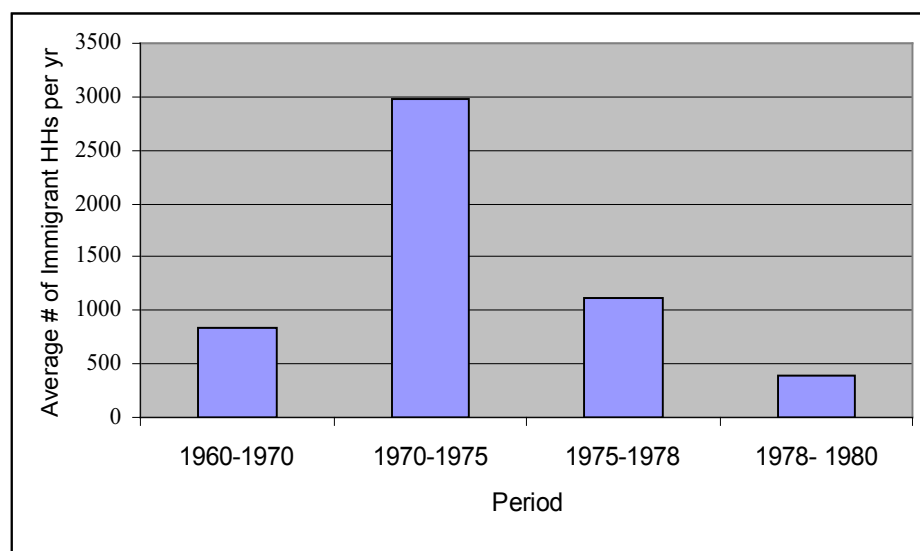
The southern administrative sectors of Rweru and Mayange have the lowest densities because a large

proportion of the land is an uninhabited rangeland and forest reserve under the management of the military authorities. The rural sectors of Ruhuha in the south and Rilima in the eastern parts of Bugesera are more densely populated than the fairly urban area of Nyamata, underscoring the low urbanisation level of Bugesera. Ruhuha is an important centre of cross-border trade with Burundi as well as with other areas such as Butare and Gitarama in the neighbouring southern province (IEA Field findings July 2006).

More than half of the population in Bugesera region are illiterate, with only 48% able to read or write. Social cohesion in the region is low compared to other parts of Rwanda because most people are immigrants, and this was exacerbated by the 1994 genocide.

Although Bugesera has been inhabited as early as the 1930s, it was very sparsely populated, and most people arrived in 1960s and after (ADF 2006). Most people immigrated into Bugesera from Butare, Gikongoro, Ruhengeri and Gisenyi provinces. Settlements were initially politically induced – a camp for internally displaced persons (IDPs) was set up at Nyamata as early as 1959 to accommodate the victims of the 1959 uprising, and a rural settlement camp had been planned in the area much earlier by the Belgian colonial administration (Kraler, A 2003). However, since 1960, the region has experienced inflow of more people from within and outside Rwanda, which has progressively changed the demographic structure of the region. Most immigrants to Bugesera mentioned search for better agricultural lands as the main reason for migrating.

Figure 4: Average Annual immigration of Households to Bugesera from within Rwanda (1960-1980)



Source: Bugesera Monographs

This influx of people into Bugesera has been associated with expansion of land for agricultural production, resulting in loss of natural vegetations like savannas, scrublands and forests.

Figure 5: Trends in Population Growth in Bugesera

Source: National Institute of Statistics

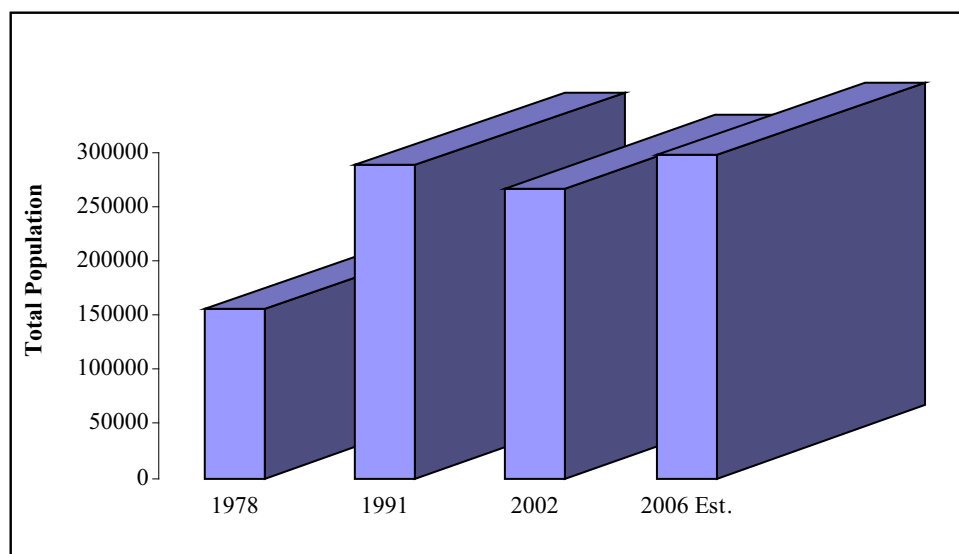


Figure 5 shows the population trends in Bugesera since the first national census was held in 1978. The decline in population growth between the 1991 and 2002 Censuses is explained by a number of factors including the massive genocide that claimed thousands of people, permanent migration of some genocide survivors and genocide suspects, and drought-induced famine which forced many households and especially livestock keepers to migrate during the period. In Nyamata, one of the former districts of Bugesera, only 5,000 (8.3%) of the 60,000 Tutsi population (verified as of January 2004) are reported to have survived the genocide (Association D'Aide Aux Orphelins du Genocide Rwandais 2006). To this day, the devastating effects of the genocide persist despite the remarkable progress in rehabilitating survivors through economic and psycho-social support.

2.3.1.3 The Economy, Livelihoods and Poverty

Bugesera is a predominantly rural area, and the main occupation of the population is subsistence agriculture. However, a sizeable number of households can be described as landless (nearly 60% of households subsist on less than 1 ha), and depend largely on their labour, usually unskilled, for a livelihood. Labour is exchanged for food either directly (through food for work) or earning money and purchasing food from the market (Save the Children 2000; USAID/FEWS Net 2002; McKay and Loveridge 2005; IEA field findings July 2006). The more vulnerable groups without household labour (mostly female and child-headed households, elderly and lonely people) depend on food hand-outs which are often inadequate and unreliable. The district has 478 Km of community roads maintained by districts, no paved roads and less than 4% of the population has a telephone. There is only one hospital situated in Nyamata town and this serves as a referral centre for small health centres in the whole of Bugesera. Each of the 15 sectors is covered by 1 health centre and only 39% of the population is covered by health insurance scheme, and less than one third (30%) of pregnant women deliver at health centres.

As of 2005, there were 9 nursery schools, 23 primary schools, 6 secondary schools and one youth training

centre for skills (Centre de Formation des Jeunes). Primary school enrolment for 2005 stood at 21,998 pupils. With only 294 teachers, the pupil to teacher ratio in Bugesera primary school averaged 75:1, which is still much higher than the target of 50:1 set by the Ministry of Education, Technology and Scientific Research (MINEDUC). Educational performance in Bugesera is low, with just about two-thirds of the primary school pupils qualifying for post-primary education in 2005. Despite the fee-free primary education implemented by the Government of Rwanda since 2003, about 6,793 (or 15.6%) of those eligible i.e. in the age bracket 6-12 years were out of school in 2004 (Bugesera District Performance Contract 2006).

Table 4. Wealth Groups in Bugesera

	"Better-off"	"Middle"	"Poor"	"Very Poor"
% of Households	10-20%	20-30%	35-45%	15-25%
Household size (No. of active people)	8-10 (2-5)	6-8 2-4	6-8 (2-3)	4-6 (1)
Defining characteristics	Salary earners, larger traders (very few with vehicles). Own farms but employ others to work for them	Smaller traders with a small shop or bicycle. May employ others to work for them.	Work for others. Do some petty trade	Often single headed (male or female) households. Rely on assistance and food handouts from humanitarian agencies (church, WFP,) and local community.
Livestock	5+ cows. (some have sent their cattle elsewhere for pasture) 1-5 goats, some chicken.	1-3 cows; 5-8 goats Some have a pig as well as some chicken and rabbits.	0-2 goats. May be some chicken and rabbits.	Possibly a few rabbits but in general, no animals.

Source: Save the Children (UK), 2000; IEA Field Findings July 2006.

Social vulnerability² is high in Bugesera even though the exact number of vulnerable people is not known (District Performance Contract Progress report for Bugesera 2006).

² Social vulnerability, according to UNDP, reflects "...the degree to which societies or socio-economic groups are affected by stresses and hazards, whether brought about by external forces or intrinsic factors – internal and external – that negatively impacts the social cohesion of a country"

2.3.2 Political, Administration and Governance issues

Bugesera district constitutes 14 sectors and 40 cells. A cell is the lowest administrative unit but with the recent territorial reforms that amalgamated administrative units, smaller units called Umudugudu³ (or Nyumba Kumi) have been created. Until the November 2005 reforms, Bugesera region had 3 districts i.e. Ngenda, Gashora and Kanzenze. Under the 2005 decentralization and territorial reforms, service delivery is expected to be enhanced by transferring responsibilities further to the sector level. There, however, remain serious challenges of qualified personnel.

Politics and land tenure in Bugesera

Bugesera is one of the regions where politics have historically influenced land use. The first pastoralist inhabitants were forcibly re-settled in the region by the then colonial administration when the area was infested with wild animals and tsetse flies. When these survived and it was discovered that the region was favourable for production of various crops in addition to livestock, many people started migrating into the area from as far as Gikongoro. With the emergence of coffee as a key export crop in the 1960s and early 1970s, the Government implemented a paysannat land system in which farmers were allocated 2 ha of land with a condition that part of it was to be dedicated to coffee production (Save the Children 2000), and that no transfer or sub-division to children was to be done (as is the common practice in Rwanda). Since then, land acquisition in Bugesera became a preserve of those with the purchasing power. Ansoms and Marysee (2004) reported that the acquisition of land on the market has become increasingly popular, and, as Andre and Platteau (1998) observed, it greatly affects traditional customs and accentuates disparities in land endowments and poverty.

3

Umudugudu as used in defining the smallest administrative unit does not coincide with the grouped settlement popularly referred to as Umudugudu.

ECOSYSTEM SERVICES AND HUMAN WELL-BEING IN BUGESERA

3.0 Food

3.0.1 General Overview, Conditions and Trends

To assess the extent to which ecosystems are important for the provision of food, and the food demand-supply situation, this study analysed food production (including types of foods produced, land under production, production systems), food marketing and consumption. Related aspects such as household incomes, food security, nutrition and health issues, have been analysed where information was readily available.

3.0.2 Food Crop Production

The main food crops grown in Bugesera are sorghum, maize, groundnuts, cassava, soy bean, sweet potatoes, beans, and rice. Rice is grown on approximately 560 ha of wetlands in former Ngenda district. Arabica coffee as a beverage is grown for cash but is mainly limited to the northern parts of Bugesera.

Table 5. Comparative analysis of main food types grown in Bugesera before 2000 and present

Main Food type grown	Biryogo Village		Kibenga village	
	Presently (2006)	Before 2000	Presently (2006)	Before 2000
Beans	X	X	X	X
Maize	X	X	X	X
Sweet Potatoes	0	X	X	X
Sorghum	X	X	X	X
Bananas	0	X	0	X
Cassava	0	X	0	X
Ground nuts	X	X	0	0

X = Grown; 0 = Not Grown (Source: IEA Field Findings, July 2006)

Sweet potatoes which used to be locally referred to as “local defence” and “kamambiri” (in reference to cheap plastic shoes affordable by even the poorest) are presently referred to as “lbiryameya,” meaning “only affordable by the Mayor”. The local people reported that these crops were no longer grown in Bugesera because of the increased soil water stress and have become locally unaffordable since they are ‘imported’ from outside Bugesera.

Important Ecosystems for Food Production

As agriculture in Bugesera is almost entirely rain-fed, crop seasons and associated farming activities usually follow the rainfall patterns, as Table 6 shows.

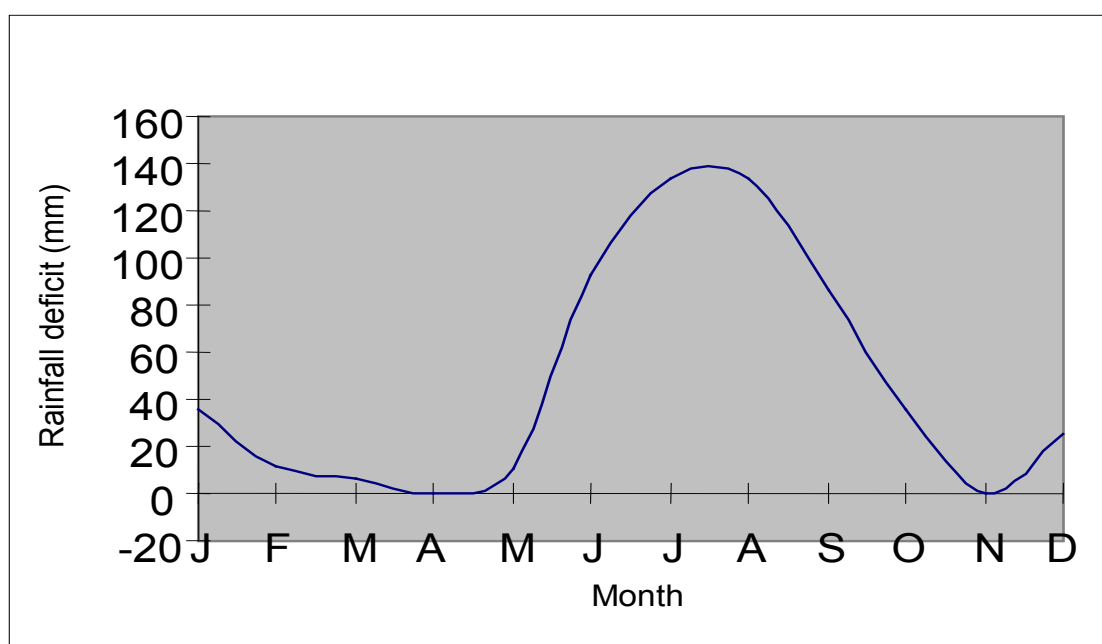
Table 6: Farming Activities in a normal seasonal calendar

Period of the Year	Status of Rainfall	Major farming activities
February – April	long rains	Planting
May – August	Dry season	Harvesting
June - August	long dry season	Harvesting Planting in marshlands (season C)
September - December	short rains	Harvesting Planting (e.g. sorghum in season B)

Source: World Food Programme, April 2006.

In general, the climatic conditions support two crop seasons (MINITERE 2003a, ADF 2006) in hilly side ecosystem, which provides the greatest proportion of food consumed in Bugesera. A third season is possible for areas where wetlands are under agriculture for the production of rice, maize, beans and vegetables. Except for rice which has been grown on floodplains, other crops are grown in wetlands on a supplementary basis (i.e. wetland crops are not the main produce). In Bugesera, however, wetland cultivation has become the main source of food in the intermediate season, and in some areas such as Biryogo, farmers reported that wetlands were their only source of food. This is because wetland cultivation enables production of crops during the dry seasons. Figure 7 and Table 7 show how wetland cultivation mitigates water stress in the absence of irrigation in Bugesera.

Figure 7: Average monthly water stress of Bugesera/Karama (1974-1989)



Data source: MINAGRI/Projet Carte Pedologique du Rwanda, 1984 &
ISAR Station Karama, 1990

Table 7. Seasonal Calendar for Crop Production in Bugesera

Season B (long rains)								Season A (short rains)				
Planting*			Harvesting					Planting		Harvesting		
Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec*	Jan	
				Planting			Harvesting					
				Season C (marshlands)								

Source: FEWS nTet 2006

From Figure 8 it can be observed that the average monthly rainfall patterns over the 15 year period indicate water stress is highest during the months of June to September. During this period the only farming activity that can be ordinarily done is harvesting. But as table 8 shows, wetland cultivation can enable an intermediary season (Season C) during which crops can be planted and harvested, thereby supplementing the crop harvests from other seasons. In terms of food security, season C provides a bridging mechanism to enable farmers to have enough food to last until season A begins, and also provides fresh seed as well as supplementary crops for income. Since 2000 when the area was hit by drought, however, wetland cultivation in Bugesera has become increasingly important for provision of food. A middle aged woman on her way to the market told the IEA team during a transect drive that she was going to buy food from the market, and on why she didn't grow her own food, she replied "for the whole of this and last year, we have depended on the people who cultivate the wetlands because of the drought".

Use of Agro-inputs in food production

Crop production systems in Bugesera remain traditional with almost no use of external inputs (Save the Children 2000, FEWS Net 2003, and ADF 2006). This situation mirrors the national one where, for instance, fertiliser consumption is estimated at 3,500 tonnes/ per year (or 2 kg/ Ha of farmed land), a very low consumption rate compared to the African average of 11 Kgs/ha, Asian average of 51 Kgs/ha, and the FAO recommended figure of 150 Kgs/ha (ADF 2006). The main limiting factors include the high cost of agro-inputs compared to the farming units, lack of extension services and low literacy levels among farmers (Kelly et al 2001). For Bugesera, an additional and equally limiting factor is the widely held perception that Bugesera land is naturally fertile and all they need to produce food is rain. In fact, rainfall in Bugesera has been termed "fertilisers from the sky". Farmers are only worried about "up" (the skies producing the rain) and not "down" (the soils' fertility and productivity) (Farmers' FGDs & Interviews with Local Leaders, July 2006).

Farming units have also become increasingly scattered as relatively well-off farmers purchase more land (especially from poor migrating farmers). The IEA household survey found out that about 25% of the households had their farmlands in separate plots, compared to about 9% reported in 1980. These scattered farming units have been blamed for incidences of premature harvests as crop thefts escalate scattered gardens are difficult to protect. Land fragmentation also makes it difficult for modern farming techniques (e.g. mechanisation) to be used. Thus, there are indications that the present production is less than optimal, and adoption of modern farming techniques could raise land productivity by up to three times. Table 9 shows a comparative analysis of present farm land productivity and ISAR plots for selected crops.

Table 8. Comparison of Productivity of typical farms and Standard (ISAR) plots in Bugesera

Crop	Current Productivity on farm (MT/Ha)	Standard productivity at ISAR Plots (MT/Ha)
Cassava	15	60
Maize	2.0	4.0
Beans	0.6	3
Plantains/ Bananas	12	35

Source: ADF 2006.

From table 9, it can be observed that with increased investments in agricultural technology, land productivity can be greatly enhanced. The need to invest in productivity enhancing technology (like external fertilisers) is even more important presently, considering that the traditional methods of maintaining soil fertility i.e. through fallowing are no longer used or even tenable in Bugesera. In 1980, crop fields and fallows occupied about 50% of the agricultural land, with the rest being used as pastures for livestock. By 2005, almost all cultivatable land (with the exception of reserved public land) had been intensively cultivated, and no land is left to fallow for more than two seasons.

3.0.2 Livestock Production

The team was unable to obtain data on livestock production to make an analysis of trends and how they are associated with ecosystem changes. Nonetheless, it was reported that livestock production in Bugesera, formerly dominated by large pastoral herds, has declined to the level where there is hardly any household with more than 5 cows. On transect walks or drives during the assessment, one rarely saw cows or large herds of smaller animals except in the southern parts of the region where there are still patches of rangelands. The most immediate reasons pointed out are the decline in pasturelands – both on private land and common property rangelands – and droughts which have become more severe and longer. The most devastating droughts of 1999 – 2002 forced many poor farmers (mostly livestock keepers) to migrate or sell livestock (Save the Children 2000; WFP 2001, WFP 2006, Personal Communication from the Field July 2006). Table 9 shows the comparison of livestock numbers for 1980 and 2002 respectively, while table 10 shows the distribution of livestock in different parts of Bugesera (by former district).

Table 9: Comparison of Livestock production in Bugesera (1980-2002)

Livestock types	1980	2002
Cattle	29,000	25,000
Proportion of cattle free range	55 %	ND
Average No of cattle per Household	2.3	0.9
Goats and sheep	75,000	56,000
Pigs	3,900	6,000
Poultry	72,000	50,000
Rabbits	ND	6,000

Source: Bugesera Monographs

Some 2,300 people (7% of the population) were beekeepers in 1980, while statistics for 2002 indicate that there were a total of 2000 beehives of which only 25% could be described as modern (i.e. constructed using modern technology). Declining tree cover and reduced fallow land were reported to have resulted in reduced productivity of bees.

Table 10: Livestock distribution in Bugesera in 2004

Livestock type	Distribution by District			Total
	Gashora	Ngenda	Nyamata	
Cattle	6,642	10,904	9,100	26,646
Goats	19,810	46,311	31,981	98,102
Sheep	1,181	752	691	2,624
Pigs	1,391	2,364	1,702	5,457
Poultry	20,373	40,017	16,418	76,808

Source: District Community Development Plans for Ngenda, Gashora & Nyamata 2004

Livestock development in Bugesera faces severe constraints, key of which include the following (ADF 2006):

Inadequate pasture land (both quantity and quality). The only part of the rangelands available for pastures is in the southern part of Bugesera, but much of it is a reserved land under Gako military camp. The local people, however, reported that grazing in the reserve is now restricted unlike previously when it used to be free. Only those livestock keepers that pay a nominal fee are still permitted to graze. In Rwebikara cell, Rilima sector, a woman complained they have problems with their goats especially when crops are in season but after harvesting, they let the goats run around and eat anything.

Limited use of agricultural bi-products. To a large degree, this is due to limited knowledge, awareness and access to technology related to animal feeds. Bugesera farming systems generate a great deal

of agricultural residues which have high nutritional values (e.g. maize and sorghum stoves, and cone husks). However, these are often used as bio-fuels and thatching materials for houses (plate 2).

Use of locally unproductive breeds. The main cattle breed in Bugesera is the local Ankole type (98% of the 26646 cattle in 2004), whose milk productivity is low and hence uneconomical. Because these breeds tend to be grazed on rangelands, the decline in rangelands has resulted in a large decrease in livestock numbers in the region.

Frequency of epidemics coupled with lack of veterinary extension services. Bugesera is part of the cattle corridor extending to Umutara region and the Kirundo region of Burundi that has been persistently affected by livestock epidemics, notably foot and mouth disease (FMD). In Bugesera, livestock epidemics were reported to originate from Burundi. This, coupled with limited access to professional veterinary services has constrained livestock production in the region.

Shortage of water. Livestock production has been affected by shortages of water, especially during droughts. Bugesera region (unlike Umutara area) has no designated water points for livestock (e.g. valley dams) and livestock keepers depended on natural sources (lakes, rivers, streams) scattered around the region. However, with the drying of streams, many have resorted to lakes and other major water bodies, which have also been restricted by the legal provisions to protect lake shores and river banks. Moreover, with the expansion of agricultural land, cattle paths have been blocked, a situation that has generated conflict. Faced with these pressures, many livestock keepers have been migrating to areas like Umutara but the poor, who lack the means to purchase land elsewhere, have been forced to sell their livestock at lower prices. Existing livestock keepers complain that the cost of rearing livestock has increased considerably, as water has to be purchased and rationed. The alternative is to walk long distances to natural water sources which are also restricted by environmental authorities (under the law to protect river banks and lake shores. In a short discussion with a tired looking herdsman met near the gate of Gako military camp with his cows, he said "I have to walk them 4 Km to Lake Ngenda or spend at least Frw 40 for each of my 8 cows to be satisfied. Where do I get such money?"



Photo 2. A house thatched with maize and sorghum husks in central Bugesera.

3.0.3 Fishing

Fishing in Bugesera, like elsewhere in Rwanda, is done by artisanal fishermen. Bugesera's numerous wetlands and water bodies (the Nyabarongo wetlands, Lakes Cyohoha, Rumira and Rweru) were historically lucrative fishing grounds. Indeed most of the early settlers of Bugesera in the 1950s were attracted by and their livelihoods depended on fishing with occasional cultivation (Bugesera Field Survey findings July 2006). In Kibenga village which is near Lake Cyohoha South, most households still fish albeit on a part time basis; men fish at night when there is no farming activity while during the day, they cultivate the fields. The peak periods for fishing are the months of April, June and August.

Fish production is modest with daily catch averaging 50 Kgs. In 2004, total annual catch in Bugesera was 45,173 Kgs (approximately 45.17MT) which is about 0.6% of the annual production nationally (Bugesera District Records, ADF 2006). Because of the high demand compared to supply, fish produced from Bugesera is considered significant for the market.

Due to the degradation of fisheries, the perceived value of fishing to human well-being appears to be limited. Fisheries of Lake Cyohoha South and other smaller lakes has been subjected to occasional closures as a regulatory measure to allow regeneration, a situation that forced many fishery dependant communities to switch to other livelihood sources. In terms of nutrition, fish is not an important source of protein. Discussions with local fishermen in Mayange sector indicated that the most men do fishing on part time basis, but fish was not mentioned anywhere as part of the diet. Fish production was also not reflected among the main sources of household income during the participatory discussions. It was not clear whether some information was deliberately withheld considering that some of the fishers did so illegally. Two main factors that need further investigation are: (a) the huge demand for fish outside Bugesera, especially in Kigali city and Butare town, where most of the fish caught is readily sold; and (b) the unexploited potential of the Bugesera fisheries which do not seem to have received sufficient attention in the national policy framework.

Fishing is one of the ecosystem services that have suffered tremendous declines in Bugesera, and the key factors mentioned by the local people and also in documents reviewed (IIED/ UNEP 2005, ADF 2006) include the following:

- Destruction of wetland ecosystems and drying up of water bodies – Lake Cyohoha North dried out (see maps 2 and 3 in chapter 1) and Lake Cyohoha South has decreased in size.

- Loss of fish biodiversity along with the destruction of wetland biodiversity and habitats. Fishermen were concerned that commercial species have disappeared;

- Infestation of weeds (particularly water hyacinth), eutrophication and sedimentation of rivers (Nyabarongo and its tributaries);

- Introduction of new species, especially the Nile perch that predares on indigenous fish species, and has thus reduced total fish catch.

- Stringent regulatory controls. Frequent closures of the fishing grounds, while a good management strategy to enable regeneration has resulted in loss of livelihoods for dependant fishing

communities.

Inappropriate fishing methods: regulatory regimes outlawing undersize nets to prevent catching of immature fish have been introduced, but are yet to be effective. In addition, fishermen complained about the stringent requirement for them to use large nets, suggesting that there was low awareness among fishermen about the dangers of underage fishing. They also complain that nets are too costly.

3.0.4 Links to and implications for Human Wellbeing

Having enough food is a fundamental aspect of security, one of the five constituents of human well-being assessed by the MA. The concept of food security has been defined by the World Bank as “access by all people at all times to enough food for an active and healthy life (FEWS Net 2001, ADF 2006). Food insecurity is one of the major indicators used in assessing vulnerability of individuals, households and communities to natural disasters such as drought.

In assessing the links between food as an ecosystem service and human wellbeing, this assessment used a number of selected core indicators categorized into:

- food availability –analysed using household production and land productivity, marketing; and
- food access – adequacy/ quantity, quality (diet variety and nutritional value)

These indicator sets have been used in Rwanda’s poverty monitoring systems, both at sectoral and national level (MINECOFIN 2001). In the context of Bugesera, several aspects of food security are important:

- Food availability denotes physical presence of food as and when required, and depends on local production and imports from outside the region. In Bugesera, local production is the main parameter to measure food availability, as the economy is generally agrarian;
- Food access at the household level depends on the household’s ability to produce own food and the purchasing power of the household. As discussed previously, household food production depends on landholding and labour, with climatic factors being a common limiting factor. Purchasing power ultimately depends on income sources, and in Bugesera, these range from trade, casual employment (mainly unskilled labour), salaried employment and remittances from family members. Households that do not have diverse sources of income are the most affected by food insecurity (Save the Children 2000, IEA Field Survey July 2006).
- Food utilisation relates to the whole process of transforming food from its accessible state, preparing and digesting it. It also embraces various conditions (such as health, sanitary, and psychological) under which food is prepared and consumed (FEWS Net 2001). This thus links food to other ecosystem services such energy and water.

Although Bugesera region was in the past one of the main food producers for the country, the region has faced chronic food insecurity since around 1999 (ADF 2006, FEWS Net 2001). Table 11 shows the populations of Rwanda most affected by food insecurity at the beginning of 2006 (FEWS Net 2006a).

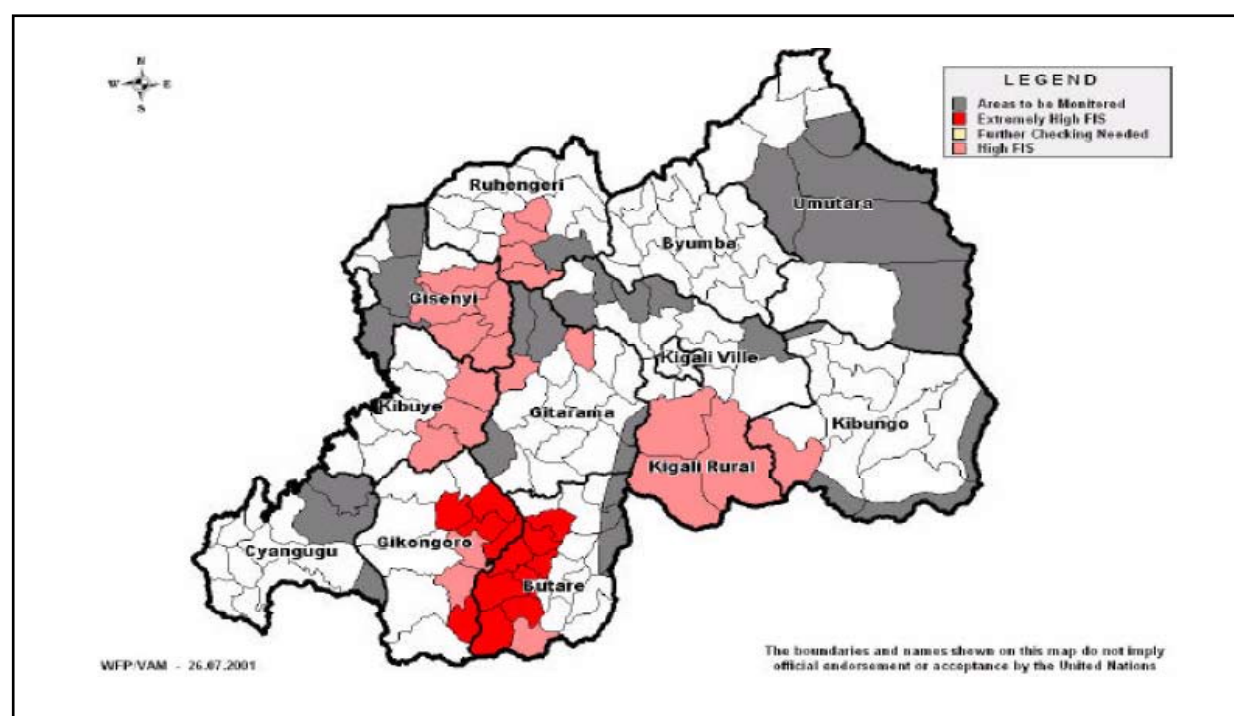
Table 11. Affected Population requiring food Humanitarian Assistance

Province	District	Estimated Total population	Severely food insecure
Eastern	Bugesera	297,168	52,955
	Kayanza	284,930	50,775
	Kirehe	578,303	103,054
Southern	Gisagara	256,970	45,792
Southern	Huye	233,945	41,689
Total		1,651,317	294,265

Source: FEWS Net 2006a.

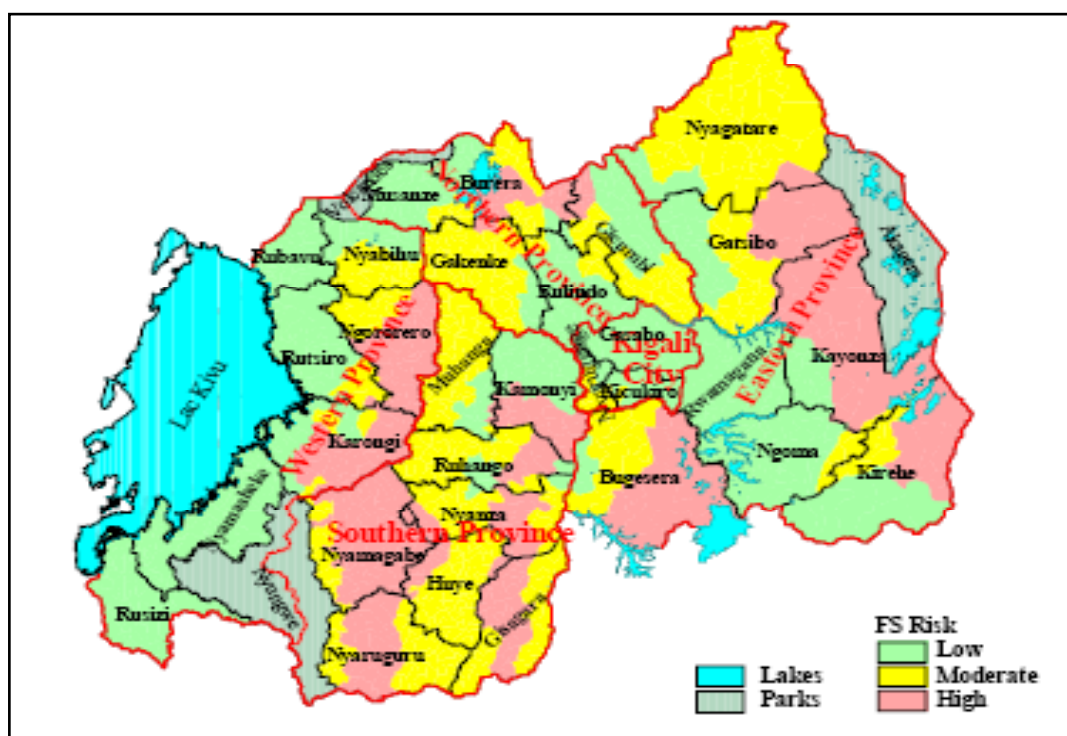
Access to food and vulnerability to food insecurity are important aspects of human well-being, relating not only to nutrition and health but also freedom of choice and action (MA 2003). As shown in table 11, almost one-fifth (18%) of the Rwandan population is facing severe food insecurity, and Bugesera has been identified as the most affected. While the causes of food insecurity in other areas have been identified as land degradation (e.g. low soil fertility and soil erosion), in Bugesera, the main factor is unpredictable and inadequate rainfall, which is linked to prolonged drought. A spatial analysis of the food insecurity risk by region in 2000, 2001 and 2006 shows that Bugesera has persistently been among the most food insecure (maps 6, 7 and 8, respectively).

Map 7. Vulnerability to Chronic Food Insecurity by Region (2001)



Source: FEWS Net August 2001

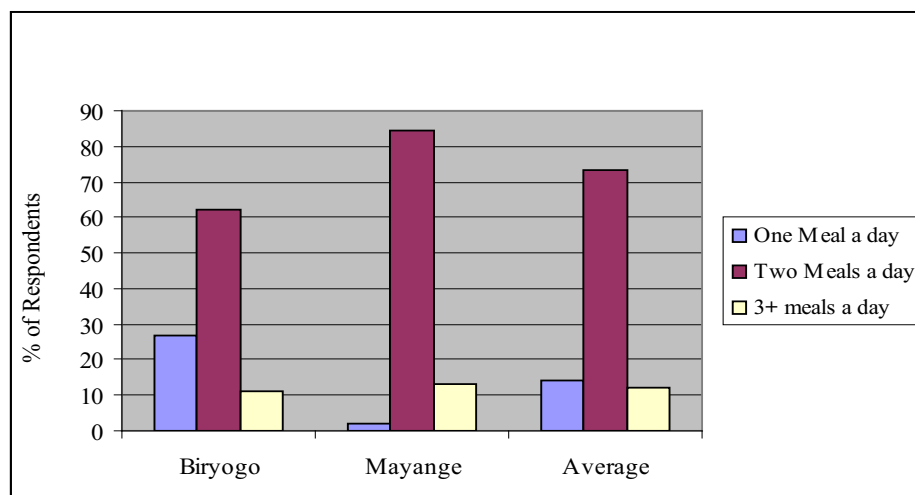
Map 8. Comparative Analysis of Food Insecurity Risk Status by Region (2006)



Source: FEWS Net. April 2006.

The populations most affected by food insecurity are those categorised as poor, which reinforces the arguments that environmental disasters such as drought have greater impact on poor people. Bugesera has one of the largest proportions of vulnerable groups (e.g. women and child headed households, people living with HIV/AIDS, and landless people), mostly a result of the 1994 genocide. Nonetheless, although food insecurity is persistent in Bugesera, the results of the household survey conducted for this assessment in two villages (in July 2006) seem to imply that most households have access to food. Figure 8 shows the frequency of meals consumed in the villages of Mayange and Biryogo.

Figure 8: Frequency of Meals at household level



Source: IEA Household Survey (July 2006).

As pointed out above, household purchasing power, a function of income, is critical to food access in Bugesera. In the case of Bugesera, being largely a non-monetary economy, use of wealth rank (which combines both purchasing power and land holding or ability to produce own food) presents a better picture of how different socioeconomic categories have been affected by food insecurity, and their different responses, or coping strategies.

Paid labour is the most important source of food for the very poor. Labour in Bugesera is characteristically unskilled with low productivity in terms of returns. Thus, households in the “very poor” wealth category who have no labour (mostly female headed households, orphans and the elderly) have to rely on food assistance in the form of handouts by humanitarian agencies or support from relatives outside the region, but the latter are few in Bugesera, given the history of migration. Cultivation of one’s own food and markets are more important sources of the “middle” wealthy category because they are the ones who own land and often have diverse sources of income which include livestock, trade and for a smaller proportion, formal employment. The market has become almost as equally important a source of household food as farming on one’s own land, because of the drought that has rendered land unproductive and the reduced variety of foods produced. Food insecurity in Bugesera has been associated with the following:

1. Prevalence of malnutrition: the decline in agricultural production (traditionally the main source of food in Bugesera) has undermined food security, resulting in inadequate calorific intake and nutrition-poor diet (FEWS Net 2001, ADF 2006). In Bugesera, malnutrition problems are reflected in the high severe malnutrition rates as shown in Table 13.

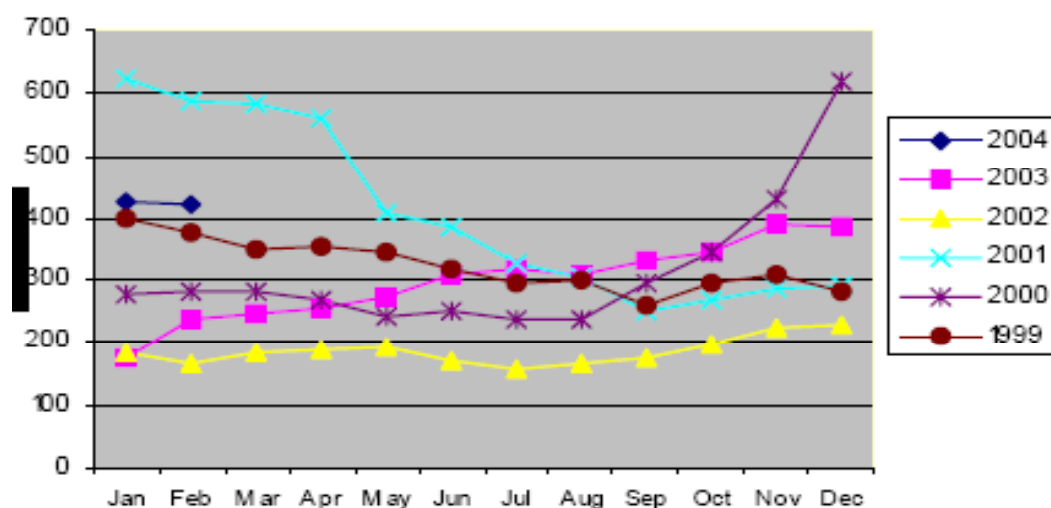
Table 13. Status of Selected nutrition related indicators for Bugesera 2003

Indicator	Status 2003	Comments/Observations
Severe acute malnutrition (weight-for-height)	11.04%	This is ranked high by the Refugees Nutrition Information Systems (RNIS)
Stunting	44.65%	Very high
Prevalence of underweight	26.55	Very high

Source: ADF 2006

High stunting levels imply chronic under-nutrition and are linked to poor childcare and poor feeding practices (FEWS Net 2003, MoH 2000, and MoH 2004). Severe acute malnutrition was also linked to the exposure to diseases, particularly the high incidences of malaria (at 19.4%) and diarrhoea (17.7%) (FEWSNet 2003). The demographic categories most affected by malnutrition are children under 5 years and poor people. Figure 14 shows the trends in monthly admissions at Rilima Health Centre over the period of the drought. In general, the trends appear to show lower admissions during harvest seasons and rise when out of season. The higher than average trend for 2000 extending up to 2001 reflects the shocks resulting from the drought, when there was virtually no rain at all throughout the year, and the decline in admissions was a result of external humanitarian interventions.

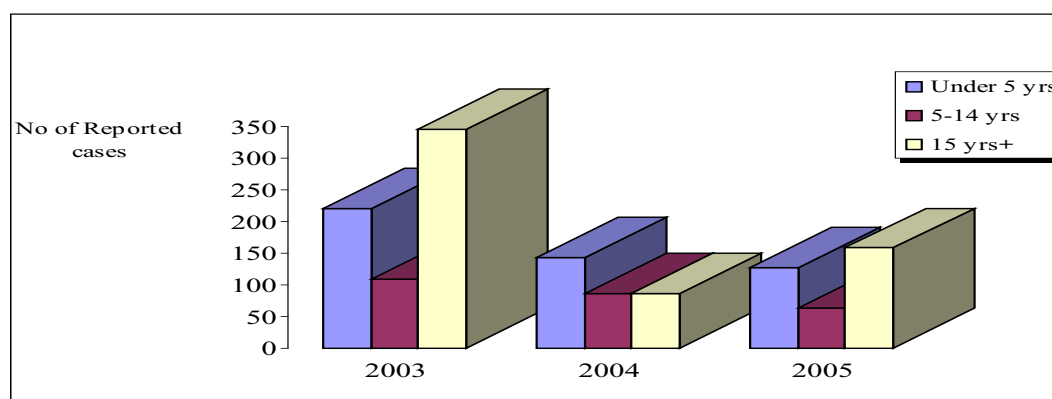
Figure 9: Admission Numbers to Nutrition Clinic at Rilima Health Centre, (1999-2004)



Source: Fews Net/WFP, March 2004

Analysis of epidemiological records (MoH 2006) also shows high prevalence of malnutrition related illnesses among all age groups in Bugesera (Figure 15). As in Figure 14 above, the progressive decline in reported cases over the three years was related to a relative increase in food production, supplemented by relief supplies.

Figure 10: Prevalence of Malnutrition MPE by age group in Bugesera



Source: MoH Epidemiological Records 2006.

From Figure 15, it can also be observed that children under 5 years are more affected than other age groups. Among the adult categories, most of the cases were women. This underscores the disproportionate impact of food insecurity on women and children.

Box 3. Drought, food insecurity and unemployment

Since the 1960s, the livelihoods of the population in Bugesera depended almost entirely on agriculture. Very often most people with relatively large landholdings tended to have diverse income sources, and would employ the poorer households to work on their farms. However, the long drought spells experienced consecutively during 1999-2002, were an unusual and surprising disaster that changed the livelihood structure in the area almost permanently. It was reported that no single crop grew during 2000 and the entire region depended on external food supplies. Poorer people became even poorer, largely as a result of distress sales in which many were compelled to sell, at less than nominal value, their possessions including land, livestock and household items such as radios and bicycles (Save the Children, 2000, WFP 2006). But, as can be observed in the discussion above, the poorest categories of the population are the most affected. During the field visits, the vulnerability of poor households was visibly observed in many malnourished children, young men desperately looking for work, limited agricultural activity and high prices for food “imported” from other areas like Kibungo.

The conceptual framework for the Box

1:Definitions of key concepts used in the Millenium Ecosystem AssessmentMA describes **relationships between ecosystem services**, human wellbeing and Poverty Reduction, and drivers of change, making a distinction between indirect drivers and direct drivers. Indirect drivers are changes in factors that indirectly affect ecosystems, such as population, technology, and lifestyle. These can lead to changes in direct drivers or factors that directly affect ecosystems, such as the catch of fisheries or the application of fertilizers to increase food production. The main concepts used in this assessment i.e. ecosystems, ecosystem services and human wellbeing, are defined in Box 1,,,,5

2. Increased vulnerability and loss of resilience, The persistent food insecurity experienced in Bugesera since 2000 in Bugesera pushed the poor people further to margins of survival. The poor in Bugesera region depleted their food reserves, sold all saleable household assets or migrated to other areas (internal displacement), a situation that has reduced further their resilience to climatic and non climatic shocks both in the short and long term. As they migrate, they lose their social safety networks – community cohesion, mutual health insurance schemes, and because of shortage and high cost of land, are forced to even more marginal areas. Some farmers were reported to sell off entire crop fields even before they are due for harvest. In this situation, farmers’ crops tend to be undervalued as private buyers take advantage of their desperation. Farmers who migrated to areas like Umutara faced further restrictions due to epidemics associated with livestock movements (foot and mouth diseases, Rinder pest).

3. Declining livestock production: The impact of declining livestock production has been felt in various aspects of human well-being:

- Animal protein is almost a forgotten aspect of the diet and people largely depend on beans for proteins. This has contributed to the prevalence of malnutrition related diseases;
- Incomes as livelihood safety nets for the poor have been compromised. Livestock production provides incomes and livelihoods security for the poor (Ashley 1999) and in Rwanda including Bugesera region, livestock (especially cattle) provide more than economic security – they are social and cultural assets, such as bride wealth during marriages. During the drought-driven famine that characterised Bugesera region during 1999-2002, livestock were among the first assets to be sold off (Save the Children 2000, FEWS Net 2001). With no livestock or other assets to fall back on, economic and social vulnerability escalated as some people even plucked iron sheets off their houses and sold them at very low prices.

What causes food insecurity?

A number of factors are frequently pointed out:

1. Frequent and Prolonged Drought: the decline in rainfall over the last 5-7 years, largely explains famine and food shortages in the region (Save the Children 2000, USAID 2001, WFP 2001, WFP 2006). Cassava, the crop that used to contribute the most to food and incomes in Bugesera, is now a rare commodity (FEWS Net 2003). Changing climatic conditions has been blamed for declining cassava production because of low moisture content. Where it's cultivated, productivity was further affected by early (or premature) harvesting and inadequate post-harvest handling facilities. Early harvesting was blamed on fear of rampant food thefts that had reportedly escalated because of the food crisis.

2. Changing seasonal patterns. Late and below normal rainfall levels for three consecutive agricultural seasons have been primarily blamed for poor crop yields (WFP 2006). Beans, for instance, require adequate moisture throughout the growing season, but because of low soil moisture, their production has been declining over the years. Yet, little effort has been made to mitigate the problems of rainfall unpredictability.

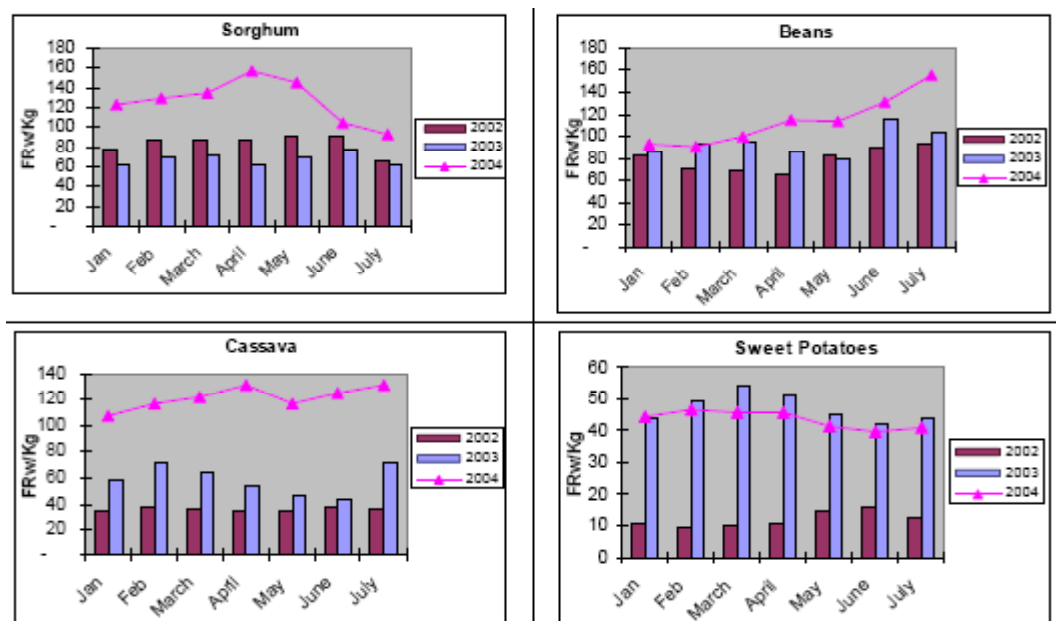
3. Emergence of pests and diseases: possibly because of changing environmental conditions, crop pests were reported to have increased, Cassava mosaic is one of the most economically important.

4. Lack of quality seeds. Because resource poor smallholder farmers often do not produce enough food to take them to the next season, have lost capacity to identify and preserve seeds, and yet have no means to purchase quality seed (Save the Children 2000; FEWS Net 2003, FEWS Net 2004). Moreover, seeds are available in small quantities on the market, and are too expensive for many farming households. In some instances, farmers have to do casual labour to raise money to purchase seeds (FEWS Net 2004).

5. Market prices and changing Government policy. Food commodity prices within and outside Bugesera were reported by the local people, to have sharply increased since 1999. The main reason mentioned for these increases is the decline in local production, the high demand for staple foods in Bugesera most of which comes from Kibungo and Gitarama (FEWS Net 2004) and increasing urban demand in areas surrounding

Bugesera (e.g. Kigali City Municipality of Butare). The high market prices imply that food is too expensive for the market-dependant poor communities in Bugesera, resulting in malnutrition and related health diseases. Figure 11 shows comparison of commodity prices for selected staples for the period 2002-2004, in major cities (Kigali and Butare Municipality).

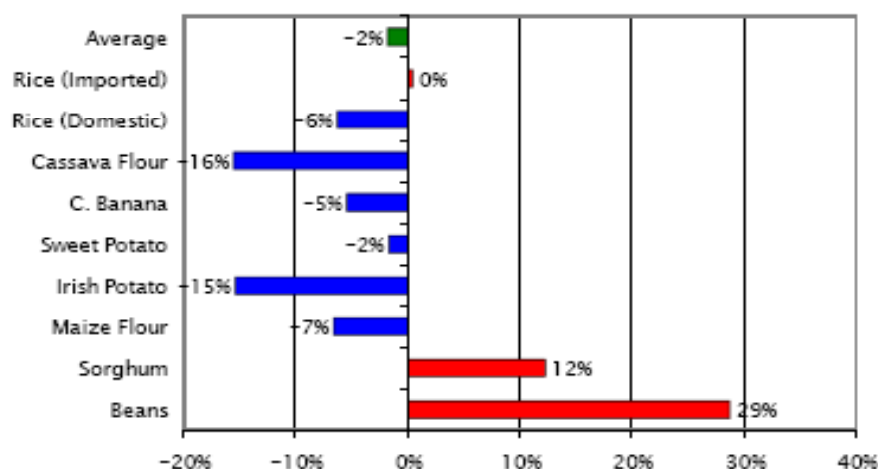
Figure 11: Seasonal Price Trends of Selected staple crops



Source: FEWS Net 2005.

Figure 12 shows that prices declined for all but two essential food crops, sorghum and beans, by 12% and 29% respectively. Butare and Kigali cities are the most important markets for food crops from Bugesera. The large increase in prices for beans has a particular negative impact on poor people's health, as beans are the main source of protein for the majority of the population (FEWS Net 2006b).

Figure 12: Change in Food prices in Butare Market (March 2005-March 2006)



Source: FEWS Net 2006b

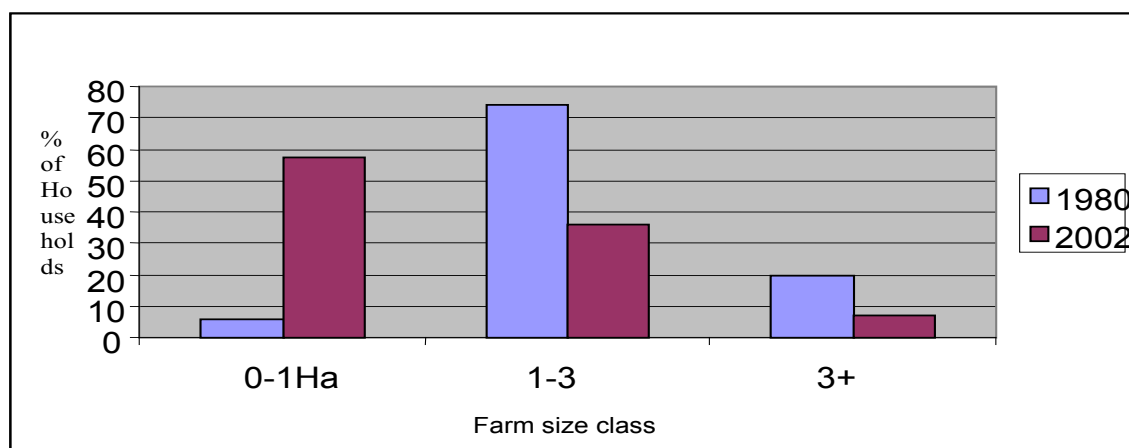
Wetlands provided grazing and watering area for livestock keepers during the droughts. In addition, as part of the wider Government strategy to increase the production of cereals in the country, the GoR is encouraging the production of only maize and rice in wetlands. The local people interviewed were not happy with the decision about which they had not been consulted, especially since inhabitants of some areas like Biryogo depend for most of their food on the wetlands. The most affected crops by this policy shift are bananas, beans and potatoes which have long been cultivated in the moist valleys and along wetlands, and which require a lot of moisture. In addition, a sizeable proportion of the wetland has been allocated to the Rilima Prisons to grow food on a large scale, and it was reported that small plot holders in the wetland were being evicted with no alternative sources of livelihood. This loss of tenure rights is expected to worsen the household food insecurity problem, particularly since most of the losers are the poor smallholder farmers.

5. Pests and diseases. Bugesera region has experienced serious infestation of the cassava mosaic virus (CVM) which destroyed the crop (FEWS Net 2004). The most affected is the Creolinha cassava variety that was being multiplied by many agencies. ISAR (Institut des Science Agronomique du Rwanda) and the Agricultural Technology Development and Transfer (ADTT) Project, however, undertook to develop and multiply four new resistant varieties on an 8 Ha land in Karama (Bugesera) and 1 Ha at the ISAR station in Rubona. With regard to livestock development, foot and mouth disease (FMD) was reported in the southern part neighbouring the Republic of Burundi (FEWS Net 2004b).

6. Declining farm size and landholding. The main factors responsible for the declining landholding (and farm sizes) are population pressure and inappropriate land tenure which promotes land fragmentation (MINITERE 2004a). In areas where food production is dominated by smallholder farming units, household food production depends of the amount of arable land to which a household has access. While the total food production in Bugesera has in absolute terms increased because of opening more **land by more**

households, in effect, household food production has declined. The principal factor for this decline, besides drought, is the increasing shortage of land, as population increases. Figure 13 shows the changes in average household farm size over the period 1980-2002.

Figure 13: Changes in Household land holding in Bugesera over the period 1980-2002



Source: District de Bugesera (2002); MINAGRI-Projet Bugesera- Gisaka – Migongo (1981)

As the graph in figure 13 shows, the average household farm size has declined tremendously, and an increasing number of households have plunged into landlessness. Considering that most households own or cultivate land less than the minimum of 0.9 Ha recommended by the FAO for an average household to meet nutritional requirements (MINITERE 2004), there are concerns that food insecurity and its associated negative impacts on human wellbeing might continue to be chronic in the region. In addition, shortage of land has severe implications on income and employment, considering that in Bugesera, the agricultural sector is the main source of livelihoods for the people. The declining land ownership/ farm size reflected in figure 13 above has important implications for the type of interventions to be designed to improve ecosystem services. For instance, investments in improved land productivity alone (e.g. irrigation, increased use of agro-inputs) are unlikely to be effective in enhancing access to food and income unless it is considered with non land based livelihood opportunities.

Box 4. Changing Role of wetlands in food security- how, why, what next?

Analysis of table 8 and the graph in figure 8 shows that season C, which lasts from June to October, coincides with the driest months when water stress is highest and hardly anything grows on normal arable land. From the interviews conducted and literature (FEWS Net 2006a), it is the harvests from season C that have traditionally mitigated the food shortages during the dry months until harvests for season A are due. Cultivation of pumpkin, sweet potatoes, cassava and vegetables in wetlands increases availability of food in the local markets there-by improving the food security situation (FEWS Net 2004c). This implies that wetland ecosystems have historically played a critical role in ensuring adequate and sustainable provision of food for the population. With the recent prolonged droughts, however, there are concerns that wetlands are increasingly over- and inappropriately cultivated, a situation that may change their hydrological and ecological structure. Many projects are planned to put thousands of land to irrigation, but at the moment, no one has thought about how much there is, raising questions for demand-supply balance and sustainability. Already, some local people in Bugesera have expressed concern that the declining water levels in lakes and rivers will escalate if the proposed irrigation activities they hear, are implemented. This has potential for increasing conflict among local, national and international stakeholders, especially given the fact that utilisation of Bugesera waters has transboundary implications. Yet, the existing institutional arrangements for water resources management seem to be too weak to manage the emerging issues, and almost non existent at local level. But the trend can be reversed. The most immediate thing to do is to review the policy on wetlands utilisation especially under agriculture; take stock of the available water resources and (both surface and ground water) and use the information to inform policy decisions; and improve water resource governance – policies, regulations and local byelaws, institutional collaboration; among others.

Finally, land tenure system in Bugesera is unfavourable for poor farmers. In 1980, only 1% of households rented land, yet the IEA Household survey found out that 18% of households in Kibenga and Biryogo villages rented the cultivated. This affects food production by way of the expenditures incurred by tenants to pay land rent. It also serves as a disincentive for farmers to undertake investments for sustainable land management whose benefits usually accrue over long term. In over-cultivated lands such as in Bugesera, failure to implement sustainable land management measures contributes to land degradation.

3.0.5 Major Coping Strategies and Policy Responses

With drought that affected all wealth categories and the shortage of land for farming, all households in Bugesera have had to devise mechanisms to cope with shortage of food.

(a) Sale of household items. At least every household has been forced to sell something. This included livestock, but for the poor, almost any type of household possessions was disposed off in a desperate move to acquire money to buy food.

(b) Reduced proportion of food in-take. Most poor households responded to food shortages by reducing the number of meals and/ or amount of food taken per person a day (Save the Children 2000, Claire and Jeune 2001, FEWS Net 2001, IEA Household Survey 2006, USAID 2006). However, the diet of children tended to be protected.

(c) Migration. Most households that could not cope had to migrate. The first to be affected when the drought started were livestock keepers who faced both shortage of food for humans and pastures and water for livestock. Most pastoralists moved into neighbouring Umutara and Kibungo provinces (now Eastern province), which, according to the local people, fuelled land conflicts. For households who depend on unskilled labour, household members (usually household heads and energetic male members) tend to temporarily migrate in search of work, and tend to return after a period usually between three weeks and three months, but the length of stay away from home depends on how quickly one gets work.

(d) Diversification of livelihoods. Fishermen have shifted to farming when the fisheries were temporarily closed. Some people lost their fishing rights when the fishery was leased to some local associations. Farmers, especially able-bodied young men took to doing petty businesses (including bicycle transport, sale of small items on the roadsides) when it was apparent that they could not depend on agriculture.

External response interventions included:

(a) Humanitarian food aid relief. The WFP and several NGOs (notably Caritas, World Vision, and Red Cross) have provided food supplies mostly targeting the most vulnerable groups i.e. widows and orphans.

(b) Food-for-work programmes implemented by WFP, World Vision, Caritas and other agencies. Under this arrangement, local people exchange their labour for food but they work on communal projects such as roads, construction of bridges and schools. A day's work earns about five Kgs of food (usually posho and beans)

(c) Restrictions on sale of food stuffs: the Government announced a ban on sale of all agro-produce to private businesses, and directed farmers to sell to local cooperatives, reportedly to avoid speculative business people. In addition, some NGOs have been buying off produce and storing it to be resold to the communities during times of crisis. It would appear, from this policy intervention that the GoR is attempting to regulate food prices. Yet, it was observed, the poor farmers would be the ultimate losers, in a

market regulation mechanism that has no safety nets for farmers in case of unfavourable price fluctuations. Secondly, it is unrealistic to expect poor people to keep money so that when food crises re-emerge, they can re-purchase the food. Thirdly, a move to force farmers to sell their produce to cooperatives which are in effect, non-existent does not sound rational. There is only one cooperative in Bugesera certified by MINICOM (District Records 2004). Moreover, farmers complained that the local associations (labelled cooperatives) do not have sufficient funds or storage capacity to purchase and stock all the foodstuffs they produce.

(d) Encouraging food storage through communal food banks. Under this strategy, each household is required to deposit some proportion of their food harvest to the public food store at sector level (no silos exist). This food is then recorded and in time of crisis, it can be withdrawn. The main criticism, however, is that this mandatory food saving flatly ignores the fact that most households do not even produce enough for their consumption that is those with some land, and that forcing households with no surplus to save what they don't have can further escalate malnutrition. Perhaps the focus ought to be put on enhancing increased food production (for those with land) and labour productivity (for labour dependant households) and expanding social security safety nets to reduce food related vulnerability, particularly for those with neither land nor labour assets to produce their own food.

(e) Creating off-farm employment opportunities. The Labour intensive public works programme (HIMO)⁴ implemented a tree planting programme to restore tree cover and conserve the environment while providing employment for local people. In this and other related off-farm employment initiatives, the local people have not benefited. "They promised us jobs when the road construction work started, but no one I know has been employed on that road. They came with their workers from Kigali including for jobs that we unskilled people here can do" a 22 year old married man complained during a participatory meeting in Bugesera. Many residents feel they got a raw deal from HIMO – those who were employed were grossly underpaid and only had very few days of work. The Bugesera people's perception of the HIMO programme is better reflected in their referral to the programme as "HIMANO," - loosely translated as something that destroys rather than build. This is because although the local people had been promised that the programme would provide thousands of jobs for unskilled workers, with a daily saving of about Fr 500 (approx. US \$ 0.90), the expectations were met. Instead, a Kigali based private company was contracted which, in a bid to maximise the profits, underpaid the workers and employed them for very few days, contrary to the programme objectives and what they had promised the local people.

In summary, the ecosystems' capacity to provide a range of food services has changed, and this has triggered responses in the form of changing consumption patterns and livelihood strategies. An important observation is that as land has become increasingly scarce and climatic conditions increasingly unfavourable for food production, food sources have changed, and availability of labour in a household is a critical factor. The decline in pastureland (rangelands) is associated not just with decline in livestock production but access to animal protein, which in the region, has become a well-known problem. The coping strategies for the locals they are vulnerable to ecosystem related shocks, and in the absence of efficient and reliable disaster mitigation measures, the poor in Bugesera are bound to plunge further into poverty.

4 *HIMO = Haute Intensite de Main d'Oeuvre*

3.1 Water Services

3.1.0 General Overview

Water is an essential service linked to nearly all constituents of human wellbeing. In Bugesera, the following functions of water are:

- » drinking and other domestic uses (cooking, washing/hygiene maintenance)
- » watering of livestock
- » water for crop production
- » transport/navigation
- » Water for industrial services (construction, brick making, etc.)
- » water for recreation (swimming)

The main aspects of water as an ecosystem service assessed in this study are access to safe water for drinking and domestic use, and impacts on human health (water borne diseases).

3.1.1 Condition and Trends

Water supply

Surface water is the main source of water in Bugesera and ground water is available with big quantities in the swamps and valleys. Ground water level is near the surface of land and always recharged from the lakes and rain water washed down from hills. The use of ground water may not be economic due to high cost making it accessible

There are 2 rivers within Bugesera area; Nyabarongo River runs from north to south east and ends at Lake Rumira which is located near Burundi border. And Akanyaru River runs from south west of Rwanda to the west of Bugesera and ends in Nyabarongo River.

Table 13 illustrates the size and distribution of lakes in the Bugesera region. There are 2 main Lakes located south of Bugesera, Cyohoha and Rumira with large surface area. Rumira Lake supplies Akagera River while Cyohoha South Lake is closed. In addition, there are 7 Lakes (closed Lakes) inside the Bugesera District and their surface area ranging from small to medium and also many Ponds. All these Lakes are generally full of water all through the year, except during the dry season when water levels tend to fall, sometimes up to 2 m.

Table 13 Size and spatial distribution of Lakes in the Bugesera region

Lake	Geographical Location	Surface area (ha)	Depth (metres)
Cyohoha South	Ngenda, Gashora & Nyamata Sectors	600	1.4
Gashanga	Rwinume and Rilima Sectors	232	2.5
Kidogo	Rilima Sector	225	2.5
Rumira	Gashora and Rilima Sectors	280	3
Mirayi	Gashora and Mwendo Sectors	232	4
Kirimbi	Mwendo Sector	230	2.5
Gaharwa	Mwendo and Nkanga Sector	230	2.5
Rweru	Rweru Sector	1.868	5.6

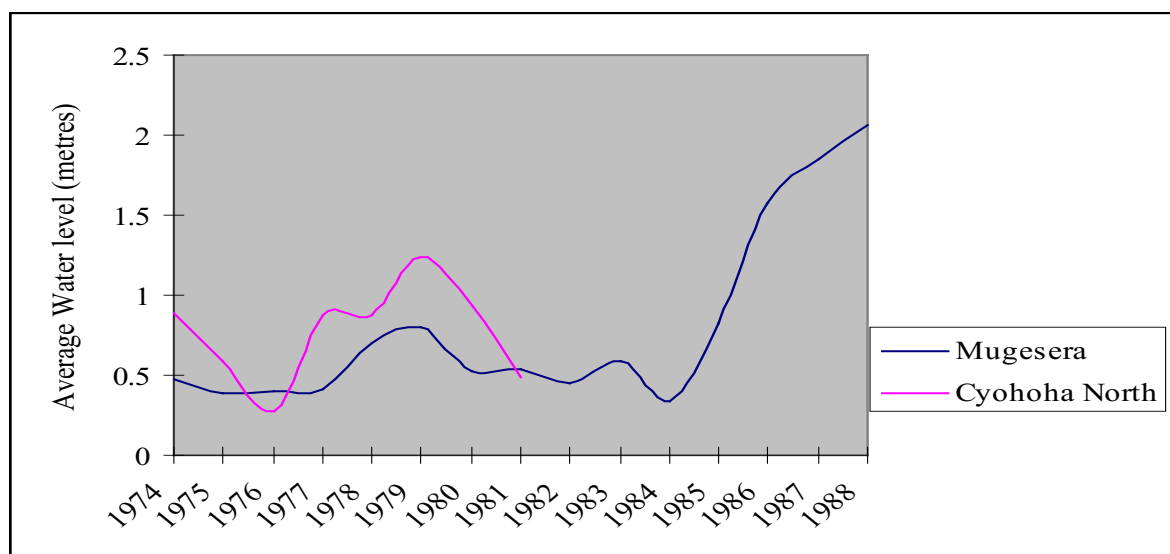
Source: Selon Petricec (1962), MINITERE/CERECE (2003)

Water bodies in Bugesera are re-charged by natural precipitation. Annual rainfall may decrease during the dry years from an average of 900 mm to about 300 mm and standard deviation about 550mm/yr (Figure 3) and dry season of up to seven months is in a low rainfall zone, which makes it very prone to frequent water shortages and severe seasonal drought.

These lakes are very rich in plankton and from time to time are affected by cynaphyceae blooms which reduce the transparency to less than 20cm (Verheust 1986, Munyagaju 1990, P.D.P.A 1993). The macro flora is mainly dominated by cyperus papyrus which forms the wetlands that separate from the rivers of which they are tributaries.

In addition to the lakes, rivers are the other main sources of water. The benefits of these rivers range from provisioning ecosystem services like water for domestic consumption and irrigation, to regulating ecosystem services such as buffering of stream flows, flood amelioration, sediment trapping, water purification, groundwater recharge, micro-climate stabilisation, and wildlife habitat. It also provides option values such as potential pharmaceutical products and intrinsic benefits offered by cultural services (Nile Basin Transboundary Environmental Analysis, 2001). A limited strip of the riparian vegetation, particularly the extension of the Kanyonyomba wetland in the eastern part of Bugesera is the only habitat left for aquatic and wetland species. This also appears to be facing immense pressure from smallholder cultivators, livestock farmers and increasingly, large institutional users such as prisons, military authorities and other developers

Figure 14: Changes in Water levels (Metres) in lakes Cyohoha North and Mugesera since 1974



Source: MINITERE Department of Water & Sanitation

There are no figures on the lake levels beyond 1988 because no measurements have been made since then. Lake Cyohoha North has since dried out as its feeder wetlands were destroyed, and the area is presently transformed into agricultural land.

Water for ecosystem maintenance, particularly wetlands, is very critical in Bugesera where wetlands provide multiple benefits to the population. They provide water for humans and livestock, act as critical grazing areas during dry seasons, and most importantly, support food production during the dry season (Season C). With the recent drought that has been recurrent and prolonged, wetland cultivation has progressively become the main source of food. In some areas like Ngenda, flood rice production depends on intensive water use, and these pressures have affected the supply of freshwater from the lakes. River Nyabarongo, which was originally surrounded by a dense network of streams and thick swampy vegetation, has been stripped bare by intensification of agricultural activities and total destruction of the wetland vegetation resulting in drying up of streams. Thus, with the reduced capacity of the catchment to retain, store and regulate runoff from rain, the river occasionally gets silted and water is almost permanently brown due to soil erosion into the river.

3.1.2 Water Demand

Safe water for Domestic Consumption

While surface water in Bugesera is readily available from the lakes and rivers throughout much of the year, it is not necessarily of a quality level that is safe for domestic consumption. Surface water through a pipe network is the main source of safe water in Bugesera. From the key informant interviews held both in the

field and with water officials in Kigali, it was established that the entire region is served by three water supply pipelines, which source water from River Nyabarongo. One of the water supply lines extends from Karengye, Mayange and Gashora and the other serves Rwakibirizi and Nyamata areas. A third one, which was installed after 1994, extends from Lake Nsoro to Ngenda.

Figure 15: Sources of drinking Water in Kibenga Village

Source: IEA Household Survey July 2006.

Natural water bodies (lakes and rivers) are the most important sources of water for household use. As figure 17 shows, most households in Kibenga reported that they obtain water from lakes. In Biryogo on the western end near Lake Cyohoha south, all the households surveyed stated that their main source of water is the lake. The total coverage of these safe water supply lines is about 30%, making Bugesera among the areas with the least access to safe water. Table 14 shows the different sources of water for the population in the three former districts forming Bugesera region as of 2003.

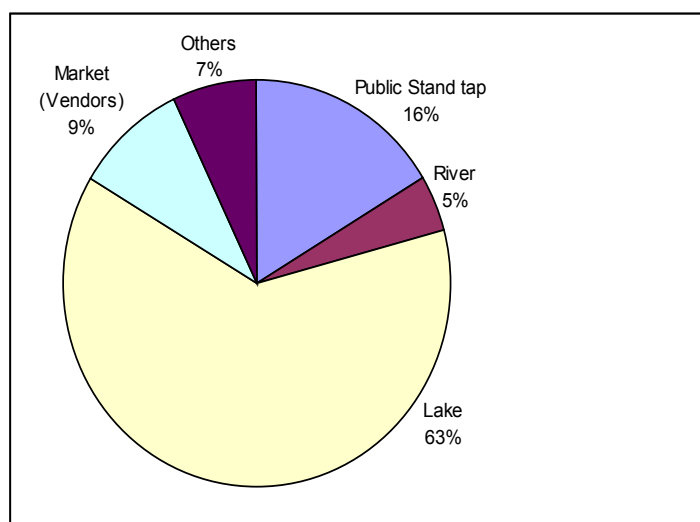


Table 14. Number of households using different water sources (2004)

Location Water source	Gashora	Ngenda	Nyamata	Total number
Rain water	867	2545	1216	4628
Water from Lakes & Rivers	8370	9185	7558	25113
Improved water source	0	6888	5100	11988
Public wells	7440	5697	4586	17723
Own stand point	11	5	123	139
Planned improved water sources	0	54	6	60
Price per 20lt Jerry can	17	14	10	41

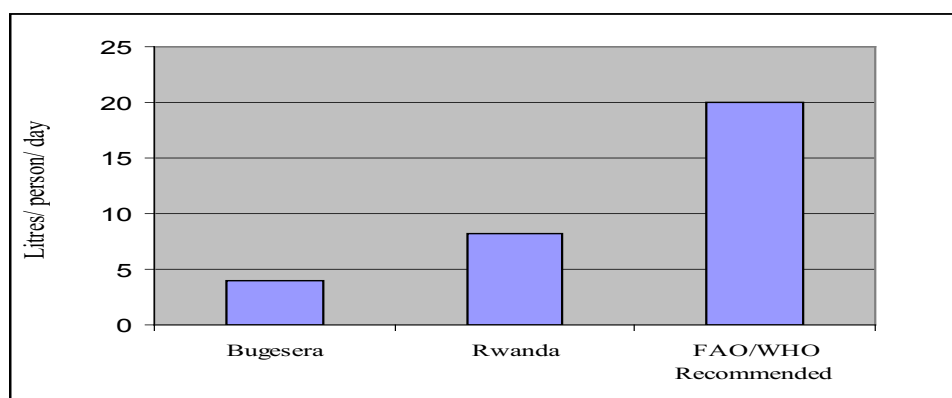
Source: Bugesera District Records (2004)

With the growing population, the demand for water resources has also been increasing yet this has not been matched by access to clean water. As a result, long queues are frequently observed at the few and unevenly distributed public water points installed. In addition, the fees levied at public stand pipes are generally unaffordable. As a result, some resort to fetching water from natural sources (rivers, streams and lakes). The price of drinking water in Ngenda, Gashora and Nyamata, ranges between 10-15 Frw per 20-litre container.

The increasing number of large scale institutional consumers such as schools, health centres, prisons and military centres, etc, is exerting further pressure. For instance, Rilima Prison, with a population of about 7,000 inmates reportedly obtains approximately 40% of its water supplies from Lake Kidogo, with 60% met from the water supply pipeline.

In general, safe water coverage in Bugesera is very low and there a huge water supply-demand imbalance. Average per capita use is estimated at four litres per person per day, which is less than half of the Rwandan national average of 8.15 litres and only one fourth of the recommended FAO/WHO figure of 20 litres (figure 18) . This, to a large measure, accounts for the high incidences of water borne diseases.

Figure 16: Comparison of Recommended water requirement and current Access



Data Source: IEA Field Survey 2006; MINITERE 2004a

Water for Livestock

There has been a decline in range pastoralism and livestock production remains traditional, with limited indoor or paddock controlled grazing. Livestock watering is communal and lakes, rivers and streams are the main watering points. There are no designated livestock watering points and there are increasing restrictions on use of natural water sources because livestock trample on and degrade river banks and lake shores. During discussions with livestock keepers, it was reported that milk production has tremendously declined because of shortage of safe water and the fact that herds expend a lot of energy and get stressed in moving long distances in search of water. Another consequence mentioned was the intensive movement of livestock both within and outside the region, a situation they acknowledged could contribute to increased livestock epidemics. During discussions with local communities, livestock producers expressed their discontent with the move to restrict them from using natural water sources (lakes, rivers and wetlands) without providing alternative options.



Photo: A herd of cattle on their way from watering on the shores of Lake Cyohoha South

Water for Irrigation

Very limited irrigation activities exist in Bugesera. There is high potential and possibility for irrigation to boost agricultural productivity in the wetland areas. The planned scheme to convert over 1000 hectares of Kanyonyomba swamp into maize and rice growing as high yield crops is one case in point. There are also plans to put more land under irrigation but it is not clear as of yet how much water will be abstracted. In this regard, sufficient focus should be put on identifying the recharge capacity of the wetlands and lake bodies, so as to establish the threshold for consumption. It should be noted that rivers and lakes in Bugesera depend largely on precipitation for most of their water, and therefore, there is need for development of appropriate water balance models, to inform policy actions for monitoring the water demand-supply balance. Plate 3 shows water loss (through runoff and exposure to rapid evaporation) in a former permanent wetland transformed into a rice paddy. Such land has lost much of its capacity for water retention and purification.



Photo 3. A permanent wetland converted into rice field in Gashora

Water for Industry

There is virtually no conventional industrial activity in Bugesera. However, since 1994, Bugesera has progressively been a centre of institutional activity with the establishment of schools, health centres, prisons, and urban development. The ongoing construction works on the highway linking Kigali to the border with Burundi, was also observed to be using a lot of water from the River Nyabarongo. Brick making and road construction are presently the most water demanding industrial activities. There are also plans to establish an international airport in Bugesera, which if realised, could facilitate greater industrial growth implying increased demand for water.

Water for Transport

Transport is one of the significant services provided by the lakes in Bugesera. Lake Cyohoha South is particularly important for providing cheap and easy means of transport for people and produce across villages. During the local scale household survey, it was realized that there are established transport associations composed mainly of the youth who live in the neighbourhood of the lakes. These youth learn early in life to navigate the waters using simple boats or canoes. The navigability of the water bodies in Bugesera has been affected by declining water levels, notably Lake Cyohoha North which has virtually dried out and Lake Cyohoha South whose size has significantly declined. These drought shocks threaten the livelihoods of youth associations involved in marine transport and the local communities who transport their crop harvests across the lake to the market. According to the residents of Kibenga village, some of their foodstuffs like tomatoes are transported from Ngenda across the lake by boats.

Water for fisheries

As discussed previously in the section on food, the perception on the importance of fishing is not very highly ranked probably because of various other demands but fisheries used to contribute significantly to the livelihoods of people in Bugesera and the declining quantity and quality of water resources has had a negative bearing on the production of fish. Although fish has become increasingly scarce due to depletion of water resources particularly in the lakes and reduced sales and incomes, it has also significantly affected the dietary composition in terms of proteins and surplus income to buy other foods.

3.1.3 Links to Human Well Being

Limited access to safe drinking water has a lot of implications for human well-being. Most obvious among these are health and related issues. Safe water and sanitation coverage in Bugesera are extremely low, which has a wide range of issues discussed below.

3.1.3.1 Water Quality

While water services are provided to a wide range of sectors, some activities that use water have negative effects on water quality. Water quality has significantly reduced in Bugesera and this has impacted on the human well-being. According to the IEA findings, 50% of the respondents regarded their water as poor while 14% felt their water was good. This is further emphasized by the epidemiological reports which indicate that 90% of the diseases in Bugesera are water borne (Ministry of health annual reports on Bugesera 2003-2005).

The major source of water pollution has been the agricultural run-off from upstream caused by unsustainable farming practices and overgrazing which also causes susceptibility to soil erosion. According to the village focus group discussions, the water of Lake Cyohoha north and Rumira has changed colour in the last one decade possibly indicating eutrophication or other physical or chemical change in water.

Alien invasive plant species, and in particular, water hyacinth in the lakes and rivers has been associated with declining water quality and shrinking of the water bodies (MINITERE 2003a). However this is not yet a major problem to the resident population. Another potential source of contamination may result from the waste discharge from Kigali, which is situated upstream of Bugesera on the River Nyabarango.

Sedimentation is a further problem. Sediment carried by the Nyabarongo River is estimated to be around 51 kgs on the Nyabarongo-Kigali stretch, 44 kgs on the Nyabarongo-Kanzenze stretch and 26 kgs on the Akagera-Rusumo stretch (MINITERE 2004a). This suggests that River Nyabarongo enters Bugesera with most of the sediment load. Besides the sedimentation which is associated with soil erosion in the upstream part of its watershed, the destruction of numerous wetlands along River Nyabarongo has worsened the water quality problems.

1. There is a high prevalence of water and environmental related diseases. Due to extremely low access to clean drinking water and sanitation and low awareness about best hygiene practices, the prevalence of water borne (or water related) diseases such as diarrhoea, bilharzias, intestinal worms, malaria and skin diseases is high throughout Bugesera (Table 15 and the graphs in figures 19 and 20). The principal causes of mortality and morbidity in Bugesera are malaria, HIV/AIDS and respiratory tract infections (IEA Household Survey July 2006, MoH Epidemiological records 2006). Apart from HIV/AIDS, most of the leading causes of mortality are preventable diseases associated with access to safe water and hygiene practices. In children and infants, high mortality and morbidity rates have been linked to high prevalence of worms, and diarrhoeal diseases. All the households involved in the July 2006 IEA survey reported at least one member had fallen sick during the year, and 95% of them reported malaria. Intestinal worms, diarrhoea

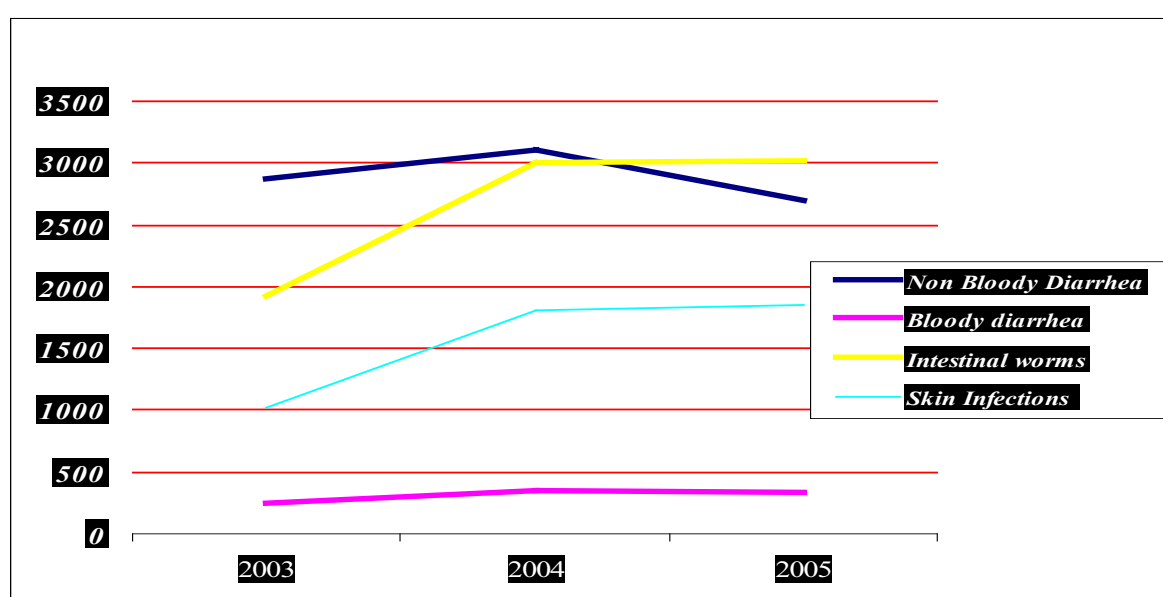
and respiratory tract infections were also mentioned. Skin infections, although unreported, were frequently observed in almost all households (particularly extremely poor ones). Because of extremely low coverage of mutual health insurance (mutuelles de sante), access to treatment for these diseases is limited.

Table.15. Percentage of Population in Selected Villages Affected by Common Diseases in the Past Year

Type of diseases	Biryogo	Kibenga	Average
Malaria	48%	50%	49%
Worms	2.2%	0%	1.1%
Throat Infection	6.7%	6.8%	6.7%
Malaria & Worms	17%	6.8%	12.4%
Malaria & Throat infection	4.4%	22%	13.5%
Malaria & HIV	2.2%	0%	1.1%
Malaria, Throat infection & worms	17.8%	13.6%	15.7%

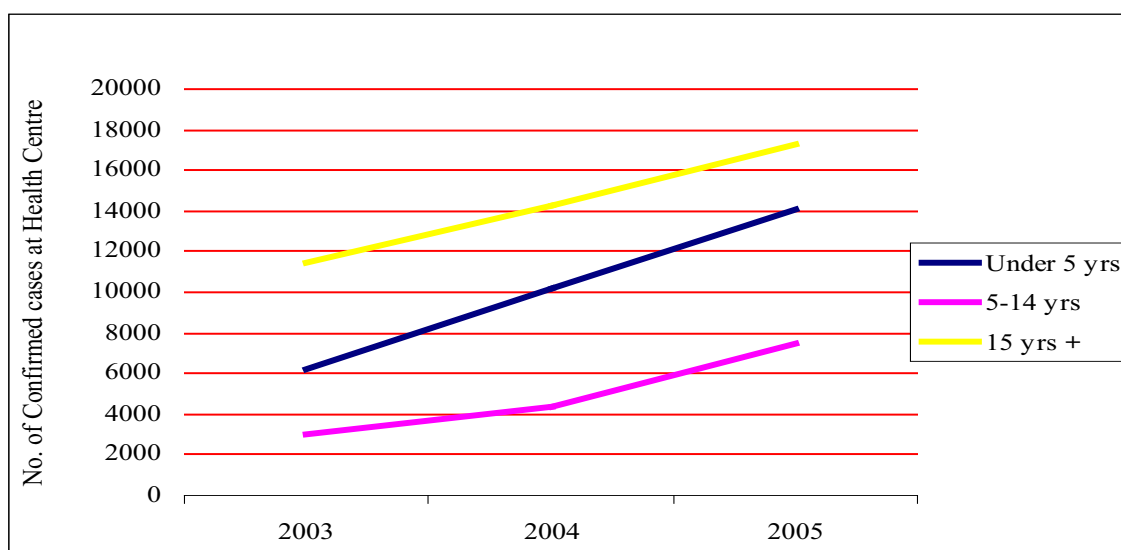
Source: Bugesera House Survey (July 2006).

Figure 17: Prevalence of Water related diseases among Infants(less than 5years)



Data source: MoH Epidemiological Records 2006

Figure 18: Cases of Malaria reported at Health Centre by age groups in Bugesera



Data source: MoH Epidemiological Records 2006

Access to water (let alone safe water) is one of the main concerns in Bugesera presently. Irrespective of its source or quality, the cost of water in Bugesera – whether expressed in monetary or other values – has skyrocketed in recent years. These costs have several implications for human well-being:

(i) Lost time for schooling and other productive work. According to the household survey conducted in the two villages, up to between one and three hours are spent on collecting water, mostly by women and children. Very often, it was reported, children are kept away from school in order to help with household chores including fetching water. For the women, the negative impact is felt in the opportunity cost of spending productive time fetching water instead of household chores, and the calories burnt in the process, which may result in health problems and reduced income due to lost productivity.

(ii) Changed priorities of households: as a means to transport water over long distances, bicycles have now become essential items in households. Yet many households, faced with constraints of labour and income, have to sacrifice important items such as health insurance, meat, clothes, and other items to purchase bicycles.

(iii) Reduced productivity resulting from low or unsafe water consumption. Livestock keepers particularly complained that because of water shortages, they have to ration the amount of water taken by each cow, a situation which has resulted in poor health and reduced milk productivity of livestock. Human water intake is also rationed in Bugesera. It was reported that occasionally, households sacrifice their little income to have access to clean drinking water specifically for sick members, or other special purposes (e.g. when there are guests). This was reported to be a very common phenomenon in villages like Kibenga where the nearest clean water point is at least 5 km away.

3.1.4 Response Options

Response options to balance supply and demand of water ecosystem services have been adopted at the community level and in the form of policy interventions. It was realized however, that different communities respond differently to water stress issues.

Community Responses in Bugesera

With the depletion of water in the lakes, people who depended entirely on fishing have now shifted to cultivation of crops because the lakes have been seasonally drying up and some fish species have disappeared, leading to lower fish catches. As their incomes from fishing could no longer sustain them, they diversified their livelihoods by taking on agriculture.

In one FGD with the local people, it was reported that some households had migrated closer to the lakes and swamps for better access to water and crop cultivation. This was very common in Gashora around the Kanyonyomba swamp.

As a way to cope with water scarcity as well as domestic needs like food, women commonly use bicycles to transport water. Traditionally, women in Bugesera have not normally used bicycles, and thus the water scarcity issue has brought about a departure from the widely-held perception of women's roles in society. Local people also adjusted by buying plastic Jerry cans and big clay pots to transport and store water. Water use is also rationalised, with a household or about 5 people using a 20-litre container daily.

Policy interventions

Strengthened water resources policy framework. There has been no clear policy on the protection of water bodies and wetlands in the recent past to reverse and prevent depletion and unsustainable use of freshwater resources. The lack of a coordinated and coherent policy framework makes it difficult to manage the multiple interests in water resources sectors, and the likelihood that any interventions will be less effective.

Introduction of measures to limit inappropriate use of water for agriculture. Extensive flooding of rice paddy fields, without regulation, not only abstracts and extravagantly uses wetland water but also exposes the surface water to rapid evaporation. This is progressively affecting the hydrological cycle including the soil's ability to retain and regulate the flow of water. It was reported that floods have become frequent whenever it rains, and this could be attributed to altered flow and declining capacity of the ecosystem to naturally regulate water flow. With the current desire to increase food production and to address the shortage of clean water, through technologies such as irrigation, piped water supply, installation of boreholes and community dams, there are concerns that the hydrological balance will be negatively affected, unless environmental impact assessment is conducted to inform interventions and that promote integrated and sustainable water resources management.

Protection of river banks and lake shores through legislation and community conservation activities is a visible intervention. Planting of grasses along the Nyabarongo river banks and prohibition of grazing and agricultural activities around lake shores are being implemented. However, livestock watering on natural waters (rivers

and lakes) have been prohibited without providing alternative options, a situation that farmers are not happy with. Some of these legal provisions have not proven effective because the farmers cannot easily comply due to lack of choice. To effectively protect the water bodies, there is, therefore, need to provide alternative options for those who depended on natural water sources.

Extension of safe water supply pipeline. A large scale water project is ongoing and it is planned to supply safe water to some 60% of the population in Bugesera. The project, being developed by SOGEA is expected to extract, clean and pump some 12,000 cubic metres of water daily from Lake Cyohoha South, once completed by 2008.

Rainwater harvesting. Irrational use of water and the perception that water is abundantly available was mentioned as one of the underlying explanations for the drought-induced famine in Bugesera, a region considered well-endowed with water resources (ADF 2006). Rainwater harvesting is not yet very popular in Bugesera, although in some areas like in Mayange rainwater harvesting tanks have been introduced under the Millennium Village project. Widespread adoption of the technique will, however, depend to a greater extent on the appropriateness and affordability of rainwater harvesting technologies to the local communities. The focus should probably be on developing a technology that uses more local materials in the construction of rainwater storage tanks and facilitating and encouraging the local population on the use of iron sheets for roofing rather than the grass thatch. The National Water and Sanitation Policy 2004 recognize the need to promote rainwater harvesting as a mechanism to control runoff and minimise water wastage.

Fisheries management. The decision to regulate the size of fishing nets was reported to have effectively controlled the harvesting of immature fish, thereby helping to control depletion of fish stocks. But the strategy to “lease the fishery” to cooperatives and private companies at an annual nominal fee of Frw 150,000 (US \$270) raised concerns for exclusion of some legitimate users and the concern that commercial interests may conflict with sustainable resource management principles.

3.2 Fuel wood

3.2.1 General Overview

Energy in Bugesera region is mainly needed for heating and cooking. Fuel wood, in the form of firewood and charcoal, is the main source of energy for both domestic and commercial consumers. More than 95% of the households of Bugesera rely on biomass as energy for cooking (Community Development Plans for Ngenda, Gashora and Nyamata, 2004), and therefore ecosystems that provide woody biomass are the most important sources of energy. Brick making is the predominant industrial activity in Bugesera requiring energy, but use of wood for burning bricks was outlawed by a Cabinet decision in 2004. The same legal restriction was extended to charcoal making that used to provide employment and income especially among the youth. Bugesera's proximity to Kigali city (only 35 Km from the city centre), where demand for charcoal and firewood is high, has worsened the pressure of fuel wood demand.

This study analysed fuel wood demand and supply mainly from the perspective of households, as this was the most direct way of linking fuel wood as an ecosystem service to human well-being. Institutional consumers (such as schools, hospitals and prisons) are assessed in the context of the influences they have on the availability, pricing and access to fuelwood.

3.2.2 Conditions and trends

Forest ecosystems are vital for livelihoods of rural and urban people in Rwanda, providing not only fuel wood but also other products. In Bugesera, the utilisation of this ecosystem service has risen progressively and rapidly over the last three or four decades. Before the 1970s, the Bugesera region was densely forested with natural forests and constituted an important area of biodiversity, supporting elephants, buffaloes, hyenas, leopards, lions, antelopes, wild pigs, reptiles, birds, insects, and other species, which have now completely disappeared. Since the early 1970s, people from all parts of the country destroyed forests in order to satisfy the needs of resettlement and access to lands for agriculture. Because of its proximity to the capital Kigali, where there is high demand for wood products, Bugesera soon became one of the main biomass production zones in Rwanda, producing firewood and charcoal to meet institutional and urban households' demands. Partly because of this and the expanding agricultural land, forest ecosystems have virtually shrunk, and woody biomass today is largely supplied by woody savannas, which are also declining. Over 50,000 ha of woody savannas were registered in 1983, dropping to less than 10,000 ha by 1988 (MINAGRI Forest Survey, 1988). The woody savannas have in some places been transformed into pastures, as has been the case for Rilima prison, Institut des Sciences Agronomiques du Rwanda - Karama (ISAR), and Gako Military base. The distribution of forest area by districts in 2003 is shown in Table 15.

Table 15: Forest area in Bugesera in 2003

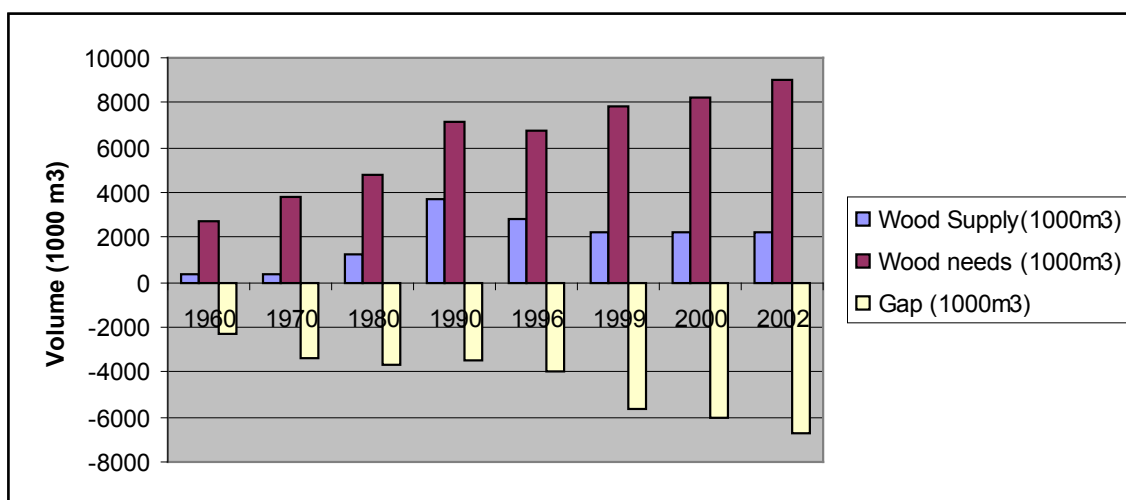
Ex-districts	Public forests (ha)	District forests (ha)	Private forests (ha)	Total (ha)
Gashora	9,800	199.7	301.9	10,301.6
Ngenda	10	57.1	97	164.1
Nyamata	No data	No data	No data	1,100
Total				11,565.7

Source: Community Development Plans for Gashora, Ngenda and Nyamata (2004-2006)

Fuel wood shortages are currently experienced in Bugesera and are in part due to the massive loss of forests due to deforestation that the country, Bugesera inclusive, has suffered over the last four decades. This deforestation is a direct result of population pressure, whose impact as a driver for fuel wood shortage has been devastating from at least two main perspectives – the demand for land for agriculture and settlements which resulted into massive conversion of woodlands into crop fields, and the unprecedented growth in the domestic and institutional demand for fuel wood and other wood products, thereby increasing the crisis.

For instance, during the period 1960-2002, more than two-thirds of the forest cover was lost, contributing at least partially to an increasing gap between national demand and supply of wood such that in 2002, estimated national needs were four times greater than supply (Figure 21). This implies that in order to address the gap, reforestation efforts must be increased by at least four-fold, which is a daunting challenge.

Figure 19: National wood demand and Supply



Source: National Forestry Policy 2004.

Although this trend of wood energy deficit is reflected at the national level, it is particularly acute in Bugesera, where there has been massive deforestation leading to complete disappearance of forests, especially between early 1970s and late 1990s. While the exact contribution of the Bugesera region to the total wood consumption in Rwanda is currently not known, Bugesera has been a major charcoal supplier for Kigali city, which consumes 75% of Rwanda's total charcoal (MINECOFIN, 2004a). It has also been a major firewood supplier for institutions which are dominant consumers. At the country level, schools appear to be in the lead (35% of the total consumption) followed by brick burning (21%) and prisons (13%). There is enormous pressure on ecosystems producing woody biomass in Bugesera. In 2004, around 221 m³ of firewood (2,652 m³ per year) and 263 bags of charcoal (3,156 bags per year) were sold from Bugesera (Table 16).

Table 16. Biomass energy sold from Bugesera in 2004

Biomass type	Districts	Species	# of m³/bags per month	Distance to destination (km)
Firewood	Nyamata	Natural forest	28	7
	Gashora	Eucalyptus	130	15
	Ngenda	Eucalyptus	63	12
	Total (m³)		221	
Charcoal	Gashora	Eucalyptus Umusave, Umuvumu	120	17
	Nyamata	Eucalyptus Umusave, Umuvumu	95	39
	Ngenda	Eucalyptus Umusave, Umuvumu	48	12
	Total (bags)		263	

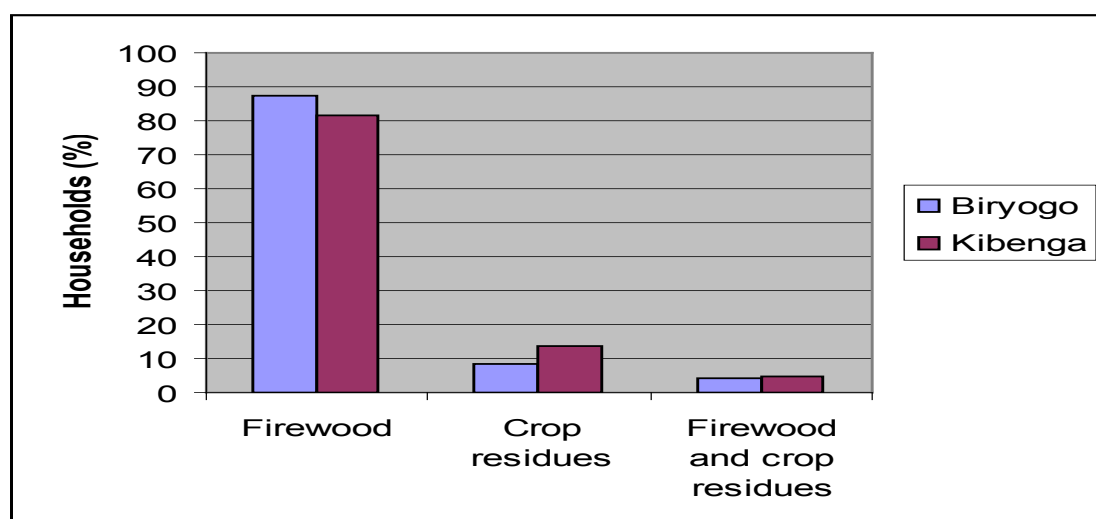
Source: Butare & Hudes (2004), MINECOFIN (2004a).

Large quantities of firewood and charcoal are still extracted from Gashora district which contains about 89% of the Bugesera's remaining woodlands. Some quantity of firewood is still harvested from the natural forest. The negative effects of charcoal production on the woody biomass are quite severe. For instance, on average, 10 kg of wood are required to make 1 kg of charcoal in a traditional charcoal kiln. Using charcoal requires four to five times more wood than when wood is used directly for cooking. But charcoal is more convenient to use, as it has high energy productivity, and, for commercial fuel wood, is easier and cheaper to transport and store.

The main wood species used for charcoal production are Eucalyptus (Eucalyptus spp.), Makhamia spp, and fig (Ficus spp.). Eucalyptus, mostly native to Australia and New Zealand, is an exotic species introduced by the colonial authorities. Eucalyptus, although an industrial forest species, has traditionally not been used for charcoal production, as natural species such as acacia and tropical hard wood species are preferred. The increasing use of Eucalyptus species – to a large extent grown in plantations - and low productivity shrub-like species such as Euphorbia, locally known as Imiyenzi, indicates the scarcity of fuel wood trees due to widespread deforestation.

Access to fuel wood has also become increasingly difficult. Evidence to this effect is partly provided by the increasing distance from the fuel wood source to destination. The average distance to fuel wood trading points in Bugesera was estimated at 11km for firewood and 23km for charcoal (Butare & Hudes 2004), which could imply that most of the firewood and charcoal produced in Bugesera is consumed within Bugesera. Indeed as shown in Figure 22, firewood is the predominant source of energy for cooking in Bugesera villages (85%).

Figure 20: Sources of cooking energy in Kibenga /Biryogo



Source: Bugesera IEA Household Survey, July 2006

Although Kerosene is the most important source of energy for lighting for the majority of the households interviewed (Figure 23), directly burnt biomass (wood and agricultural residues) provide lighting energy for a considerable number of households, especially the very poor who cannot afford kerosene.

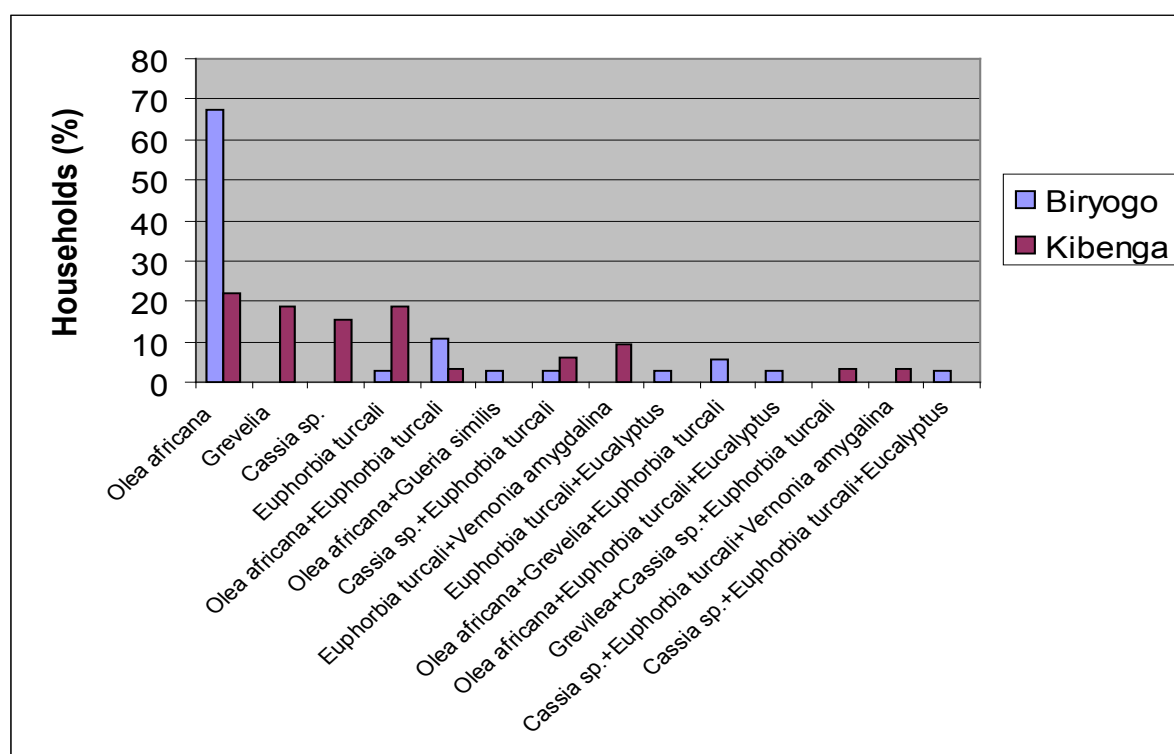
Figure 21: Source of Energy for lightning in Kibenga/Biryogo



Source: Bugesera household survey, July 2006

A combination of over-dependency on firewood, the production of charcoal for urban consumption, and deforestation (where both natural and planted forests have been cut down without replacement), has caused the total disappearance of high-calorie species like Eucalyptus, forcing the population to resort to low quality species such as Euphorbia spp. and Olea africana for cooking energy as indicated in Figure 24.

Figure 22: Species used for cooking energy in Kibenga/Biryogo



Source: Bugesera Household Survey, July 2006

A number of observations can be made from Figure 24:

- First, *Euphorbia* spp are the most commonly used, yet they are in fact shrubs with very low calorific content and therefore would be least preferred for firewood. *Euphorbia* spp., particularly *E. turcali* are highly resistant to drought, and were reported to be the only relatively cheap affordable source of fuelwood for poor households. The cost of four short pieces of wood (mostly *Olea Africana*) is 100 Frw (as of July 2006) in Biryogo local market. Since an average household needs at least one bundle per meal, the total monthly expenditure on fuel wood would be in excess of Frw 3,000. This is very expensive for most households in Bugesera. Hitherto unheard of, fuel wood in Bugesera is currently a tradable commodity even in rural areas. With extensive deforestation, most of the woody biomass has been depleted and the recent prolonged droughts have only worsened the problem. In these circumstances, *Euphorbia* spp provide the only available wood. Use of *euphorbia* and grasses is, therefore, an indicator of the escalating fuelwood crisis.
- Secondly, the tree species indicated above are mostly planted ones in the agricultural landscapes and planted forests. The declining abundance of natural forest and other woodland ecosystems has serious implications for the people's livelihoods. These include the cost of alternatives and loss of livelihoods.
- A growing number of institutional users are another area of concern. Over the last 10 or so years, particularly since 1994, there has been progressive increase in the number of schools and other institutions such as the military camp, expansion of Rilima prison, all of which have a sizeable population. These institutions are big consumers of commercial fuel wood, which has impacted negatively on availability and access to fuel wood by the local population. For instance, the prison of RILIMA had 3,364 in-mates and was using about 10,000 m³ of wood per year. Secondary schools are also big consumers of firewood as far as most of their pupils are facilitated in accommodation and meals (the average consumption per day is about 5 to 6 m³). In 2002, Bugesera had a total of 14 secondary schools and at least 3 more have been established since then. For primary schools which never used to provide food, a National policy decision in 2002 to provide meals for all children, has resulted in increasing demand for commercial fuelwood in the region. Consequently, fuelwood, essential as it is and despite its naturally occurring status, has become one of the scarcest commodities in the region.

Yet the option for households to plant their own woodlots in response to the wood deficit is severely limited by many factors, chief of which is land shortage. Average landholding has declined rapidly, and the majority of households live on less than 0.5 ha (Figure 13.). The feasible option for most people is to move long distances in search of firewood and/ or use agricultural residues.

3.2.3 Links to human wellbeing

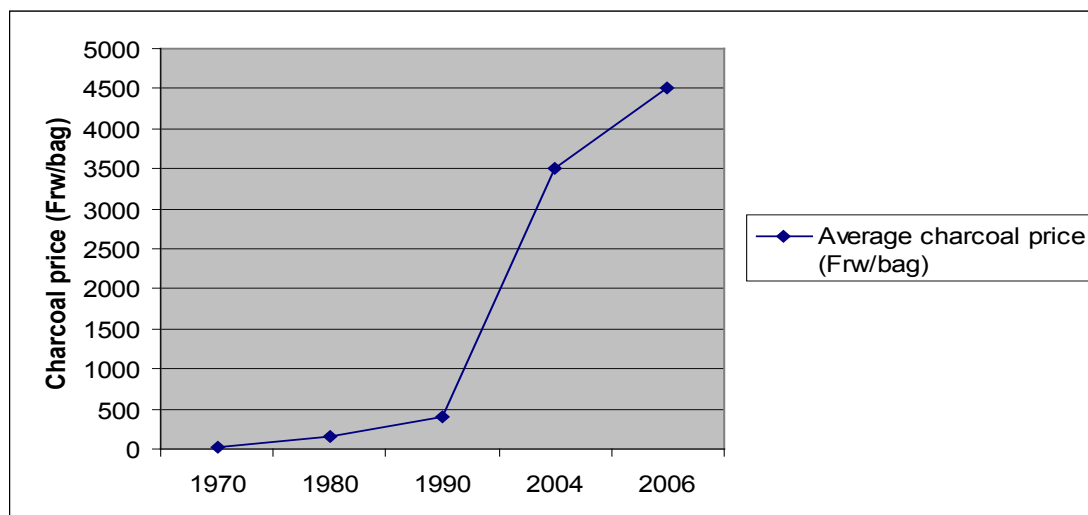
(a) Material wellbeing. As rural and urban people rely on fuelwood as the main source of energy for cooking, negative changes in the supply of this product may impact negatively on their human wellbeing in terms of cost and access. As they have no woodlots for direct supply of this essential ecosystem service, their incomes are depleted by purchases from markets. Plate 4 shows market transactions in Biryogo market in the East of Bugesera. This adversely impacts their well-being by leaving little income to purchase items such as food and healthcare or to use for emergencies.



Photo 4: Firewood is one of the dominant items in Biryogo market

(b) Lost incomes and employment. On the other hand, the people who were producing and selling charcoal and firewood in Bugesera have lost opportunities of income with the disappearance of forests. The shortage of charcoal has affected urban populations, mainly Kigali City consumers, who depend largely on this kind of energy for cooking and who previously obtained it from nearby sources. A cabinet pronouncement in the aftermath of the prolonged drought imposed stringent restrictions on harvesting of wood, including a ban on charcoal production in some areas, and outlawing burning of bricks. Although this has positive long term benefits, it has affected the availability of affordable charcoal. Sharp increases in fuelwood (charcoal and firewood) prices observed during the last two years (figure 25) have been linked to restrictions on wood cutting. Given the absence of wood substitutes, the impact of such regulatory measures will be far reaching for human well-being.

Figure 23: Charcoal Price trends (Kigali City)



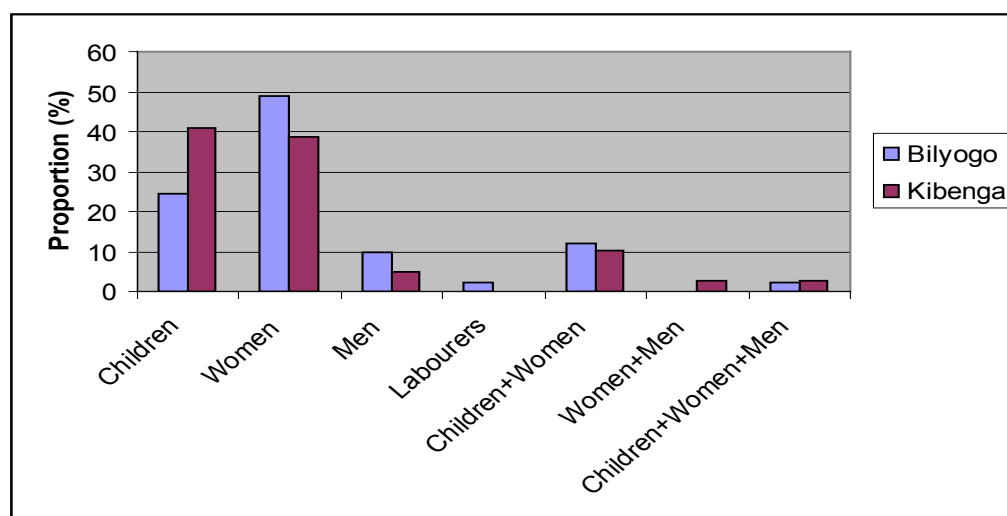
Source: Field data collected from Biryogo & Mayange Villages, July 2006

The prices reported in Figure 25 are generally in agreement with those reported by Butare & Hudes (2004) which showed that charcoal prices in Kigali city had risen from Frw 1,400 (approx US \$2.5) per m³ before 1994 to Frw 9,000 (US\$ 16.2) in 2004.

c) Health: Water related diseases (including diarrhea, malaria and intestinal infections) were reported to be the leading causes of morbidity and mortality especially among infants. Lack of access to safe drinking water was cited as the main cause. Nearly all households reported that they do not boil the water, and this, to a great extent, was attributed to shortage of firewood. "How can you waste firewood boiling water when there is hardly enough to cook food?" was one of the responses from some residents.

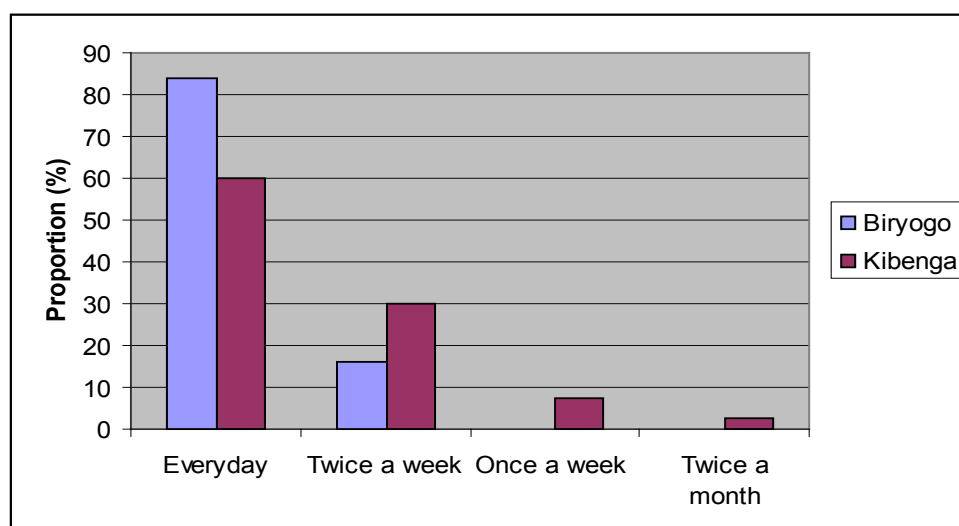
(d) Freedom of choice and action. The household survey in Kibenga and Biryogo villages has clearly shown that fuel wood collection is mainly done by women (43.8%) and children (32.5%) (Figure 26). It follows without saying therefore, that the impacts of fuel wood scarcity in Bugesera are felt more by women and children, especially in tying up their productive time and energy. Children in particular are affected as they have to walk spend a lot of productive time gathering fuel wood, at the expense of attending school. Fuel wood collection may also reduce women's ability to undertake agricultural and other household tasks by way of lost time and spent energy. In general, the poor have felt the fuel wood scarcity more as they are forced to dangerous or no option situations - use of poor quality alternatives, going without meals, etc, which affect their health and wellbeing.

Figure 24: Fuel wood collection in Kibenga and Biryogo households



Source: Bugesera Household Survey, July 2006

Women and children spend a lot of time collecting firewood on a daily basis (Figure 27). The people who rely on crop residues spend more time collecting them. Time spent collecting fuel wood has a negative impact on freedom of choice and action, because it deprives children of educational opportunities and women from engaging in other economic activities.



Source: Bugesera Household Survey, July 2006

(e) Good social relations. Time spent by women collecting fuel wood and crop residues may reduce their time for social relations with neighbours. As they have to undertake agricultural tasks, to provide food for children and to collect fuel wood, they can't have time to help neighbours in need. Particularly for children, they can't have enough time to play with others, as they have to spend more time collecting fuel wood for the family and for their meals at school. This may affect them psychologically and a recipe for potential conflict.

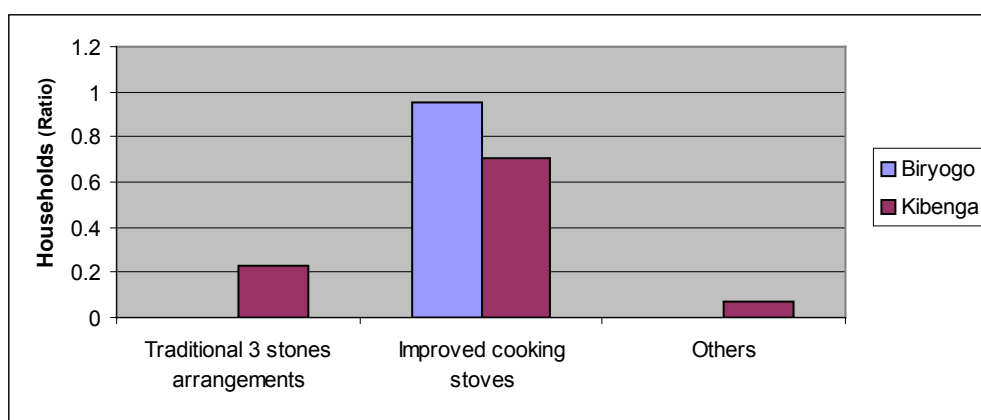
(f) Security. The high degradation of forest ecosystems in Bugesera has resulted in low and irregular rainfall which has been affecting the population. Until now, they have been suffering from regular and prolonged droughts and some of them have been forced to migrate or to stay in a permanent environment of hunger insecurity and despair. Thus, livelihood security is affected by the uncertainty surrounding future wellbeing of individuals and their families.

3.2.4 Responses

The recent shortages in fuel wood and other forest products and services (evident in the recent prolonged drought that caused famine at the scale not witnessed before), has triggered responses at policy and project interventions. In particular, for fuel wood, they include:

1. **Adoption of energy saving technologies.** Improved stoves have been disseminated in Bugesera with impressive adoption rates (Figure 28). Improved mud stoves have been widely promoted by NGOs and Government institutions, notably Energy and Environment in Rwanda (ENERWA) and the Ministry of Defence (MINADEP). These cooking stoves are very efficient: one bundle of wood (equivalent to four pieces of wood) can cook three meals instead of one with a traditional stove.

Figure 26: Use of improved and Traditional stoves in Kibenga and Biryogo



Source: Bugesera Household Survey, July 2006

Biryogo village has higher proportion of households using improved stoves compared to Kibenga, largely because of its proximity to the Gako military detach, where MINADEFF has effectively disseminated the improved stove technology as a measure to reduce pressure on the remaining woodland. It was noted that the military camp are some of the biggest institutional users. In addition, the prison authorities embarked on reforestation activities where it takes advantage of its manpower (prisoners) and has also mobilised surrounding communities by providing them with seedlings for planting trees.

2. Alternative energy sources: faced with a growing crisis of firewood and associated costs, the Prisons authorities at Rilima established a biogas plant. The results registered since the installation of the biogas plant are impressive – fuel wood consumption was reported to have been reduced by about 40%, which is a big boost to the ecosystems and to local consumers.

3. Reforestation initiatives. Public and private tree planting initiatives are responses to the problem of deforestation in Bugesera. Local authorities and some public institutions like PAFOR and HIMO are very active in the reforestation of Bugesera. However, these are fairly recent interventions that have emerged in the aftermath of long drought, and whose impact is not expected soon. In the District Performance Contract for 2006, the local government authorities identified reforestation as a key priority, with a target of planting two million trees, in addition to mass sensitization and awareness creation on environmental protection. The main external intervention, *Projet d'Appui à l'aménagement des Forêts au Rwanda* (PAFOR) had planned to plant 512.4 ha on lake shores, river banks and denuded hills during 2003-2005 (PAFOR 2001), and field observations indicated that many trees had been planted. On the banks of lakes, it has planted *Cassia spectabilis*, the *Cassia siamca*, *Leucaema leucocephala*, *Calliandra calothyrsus*, *Makhamia lutea*, and *Sesbania sesban*. On the denuded hills, the main species planted were *Eucalyptus grandis* and *Eucalyptus microcorys*. Most of these species, however, are exotic, and there are concerns that with drought and emergence of pests, their survival rates are low.

4. Planting of pest resistant tree species: following poor response of most tree species due to pest and termite attack, authorities and intervention agencies have resorted to planting more resistant species like *Cassia spectabilis*, *Cassia siamca*, *Leucaema leucocephala*, *Calliandra calothyrsus*, *Makhamia lutea*, and *Caesalpinia digitata*. *Eucalyptus* species (mainly *E. grandis* and *E. microcorys*) are planted after destroying termite mounds and spraying with pesticides.

5. Legislative reforms. The forestry policy and related laws aim at a sustainable management of forest resources at all levels (national and local). But it appears there is lack of a clear strategy and strong institutional capacity for afforestation and forest conservation. Most of the tree planting activities have been undertaken on ad hoc basis (on road sides, hill sides, with no clear ownership), and the level of involvement of local people in the decision process is low. In addition, institutional capacity for forest management at local level is still weak.

The overall picture is that fuel wood availability and access in Bugesera has and is declining both in quantity and quality, and that this has affected the population in various ways. If not checked, there is a danger that poverty will escalate.

SUMMARY OF THE MAIN DRIVERS OF CHANGE

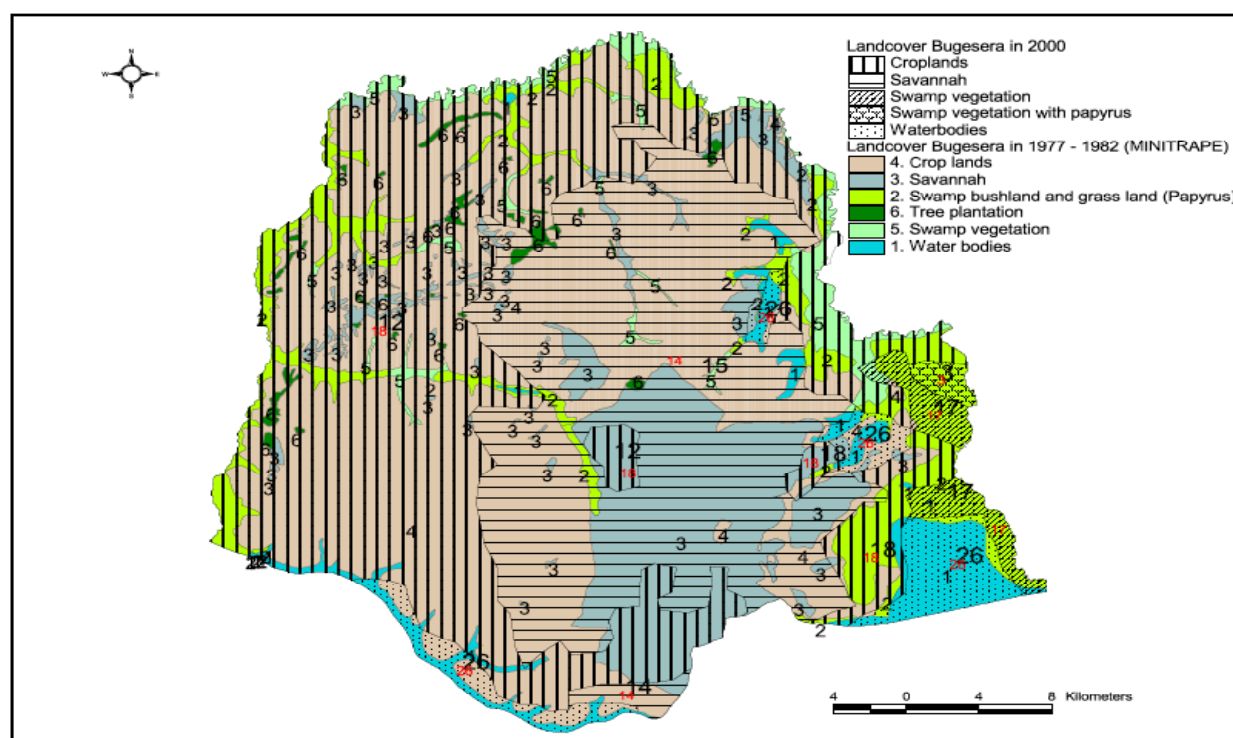
This assessment has established that the population in Bugesera depends on ecosystems (both directly and indirectly) for their livelihoods and wellbeing. It has also established that ecosystems have changed and so has the quality and quantity of services and goods obtained from the ecosystems. The main drivers for change identified have been discussed in more detail in previous sections, and are summarised, in a more integrative way, in the following texts:

4.0 Direct Drivers

4.0.1 Land Use/ Land cover change

From the literature reviewed, land cover/ land use change analysis and the interviews held with local and regional stakeholders, it was indicated that the transformation of ecosystems through land cover/ land use change has resulted in changes in the range and diversity of ecosystem services in Bugesera. Map 10 below shows changes in major ecosystems between 1977/78 and 2000.

Map 10. Overlay Map of Bugesera showing Land use/ Land cover change between 1977/78 and



Agricultural land has expanded significantly, with other ecosystems such as wetlands, forests and savannah rangelands declining or disappearing altogether. The wetland ecosystems that formed a protective thicket around rivers and lakes and the large pockets of ever green forests scattered throughout Bugesera, were all converted into crop lands and settlement areas. This resulted in reduced water quality and quantity, soil erosion, decrease in woody biomass upon which the entire population in Bugesera depended for energy, loss of biodiversity and changing microclimate, among others. The loss of wetlands, which protected the water bodies against siltation and recharged them with relatively clean water, has been blamed for the drying of some lakes, rivers and streams, and the attendant crisis shortage of water for livestock, domestic use and agriculture.

4.0.2 Climate modification

Climate induced drought has been blamed as the main driving factor for food insecurity and water scarcity in Bugesera region. Although farmers indicated that Bugesera had historically experienced droughts, they had never had so devastating effects as in recent years. In particular, the period 1999-2002 was characterised by long and continuous droughts which resulted in even death of humans and livestock, as vegetation was depleted, and the entire region depended on external food handouts. Considering that Bugesera was previously a good source of relatively affordable food especially for the neighbouring urban areas of Kigali city, Butare and Gitarama, the food scarcity effects of the droughts were felt beyond the region.

4.0.3 Over harvesting and/or inappropriate use

Low technology use of wood fuel, both in households and industrial uses have resulted in inefficient use of biomass energy, with the consequence of wood fuel crisis. Most charcoal production is done using traditional methods, whose wastage is more than 50%. Indiscriminate conversion of wetlands into agricultural fields has resulted in loss of their buffering purifying and water recharging capacity, unique and sensitive habitat for flora and fauna. Conversion of rangelands and hilly areas into intensive agricultural lands has affected their sustainable use as they are fragile and sensitive to inappropriate use. Over- and indiscriminate harvesting of young fish, resulted in loss of many fish species in the lakes, which in turn triggered stringent regulatory actions from Government, that had a direct effect on the people whose livelihoods depended on fish or fishing activities.

4.0.4 Pests and diseases:

Over the last several decades, the changing environmental conditions have resulted in the emergence of pests, especially termites which destroy planted trees, a situation that undermine efforts to reforest and establish woodlots. The negative effects of termite attacks and plant diseases are further exacerbated by persistent drought which makes the plants wilt and lose their natural resistance. In Bugesera, the most affected species by termites are Eucalyptus, Grevillea, and Cupresus lusitanica.

4.1. Indirect Drivers

4.1.1 *Demographic Change*

From the literature reviewed and the interviews held with key informants, it was clearly indicated that the increasing human population and associated demographic characteristics are the main underlying driver of changes in ecosystems and ecosystem services in Bugesera. Demographic change has influenced changes in ecosystem services and human well-being in a number of ways:

(i) High natural birth rates. Fertility rates in Bugesera are among the highest in the country. This is partly fuelled by the traditionally held belief of increasing social security but also the need for household labour.

(ii) Migration. Since 1960, Bugesera, as a relatively under-populated region, has attracted population from other areas within and outside Rwanda, and the most commonly cited reasons were because Bugesera was barely populated and people migrated in search of agricultural land and charcoal burning business since it was still forested and close to Kigali city. Indeed by 2002, cultivated land in the Bugesera region covered 87,000 Ha, which are more than two-thirds of the total land area in Bugesera. This influx of people into Bugesera largely explains the tremendous transformation of ecosystems, with the effect that forest area has declined tremendously.

4.1.2 *Political and civil conflict*

In the past, particularly before 1994, Bugesera was the country's major breadbasket, producing major food crops such as beans, sorghum, cassava and sweet potatoes (ADF 2006). The genocide had a devastating effect, one impact of which was the escalation of vulnerable groups. As a result of the genocide, about 38% of the women and several young children are now household heads in Bugesera (ADF 2006). These are some of the most vulnerable groups who dominate the poorest wealth category (Save the Children 2000, Bugesera IEA Field findings 2006).

A SYNTHESIS OF THE MAIN MESSAGES AND EMERGING ISSUES

4.2 Main Messages

4.2.1 Food

1. There is increasing inability to meet basic minimum food demands. About two-fifth of the food needs in Bugesera are currently met by humanitarian agencies due to declining production.
2. Households with diverse sources of incomes are the least affected by food crises. The households that depend on the market (mainly by trading their household labour) are the worst affected. These households have fallen into the extremely vulnerable category due to loss of employment opportunities on other people's farms and the shortcomings of food for work programmes noted above.
3. There is limited scope for resource-poor farmers in the planned technological interventions. The options for irrigation that are presently being considered, and in some cases are already being implemented, are expected to result in remarkable increases in overall food production. However, their net effect on food insecurity in Bugesera is questionable and needs to be examined, particularly in light of emerging concerns that smallholder farmers cultivating the wetlands might in fact lose cultivation rights. It is not yet clear how marginal farmers and the landless communities will benefit from the large-scale irrigation schemes that are planned. Also, the likely impacts on availability and adequacy of water for production have yet need to be analysed from the perspective of the poor communities who depend on the natural water sources.
4. Recent policy interventions to promote food security, such as restrictions on food marketing through cooperatives, are not aimed at empowering farmers to make decisions but rather at forcing them to market their food through ineffective and exploitative cooperative systems, which are grossly under-developed. Market regulations, where they exist, tend to be associated with a package of incentives that protect farmers and encourage them to produce. But the recent initiatives in Bugesera (especially the pronouncement to market food only through existing cooperatives) are neither encouraging sustainable production nor protecting farmers.
5. Contrary to public perception, the incidences of drought in Bugesera are not a recent phenomenon. Bugesera communities have for years experienced droughts which caused famines but the difference with the recent one has its persistence and devastating nature, and the lack of resilience among farmers to carry through. Previously, farmers had the capacity to anticipate famines, and often had the means and strategies to take them through the drought periods by ensuring adequate food storage and use of wetlands. These capacities have, however, declined, and as seasonal patterns changed, the farmers' knowledge and experiences were rendered ineffective. Local farmers noted that in the recent periods, especially since 1999,

dry spells are hotter and drier, recur more frequently and are often longer. In the absence of effective meteorological services, farmers have experienced crop failures, which have exacerbated their poverty and vulnerability.

6. Finally, it should be noted, that despite the changing climatic and ecological conditions, food production in Bugesera continues to depend on the regulating services provided by the ecosystems (e.g. soil nutrient recycling and soil water retention and flow) with limited, if any, augmentation through application of external inputs or better land management. Moreover, loss of fallow due to shortage of land, and the involuntary shift from cultivation of soil-stabilising perennial crops such as bananas to seasonal crops with short rotations expose soils to exhaustion and erosion. This situation raises concerns as to whether the ability of Bugesera's agro-ecosystems in their current form to provide food to its population and beyond has not reached the limits.

4.2.2 Water and sanitation services

Surface water from streams, rivers (Nyabarongo) and lakes (Cyohoha and Mugesera) and the numerous swamps along the rivers, is the main source of freshwater in Bugesera. Freshwater is mainly used for domestic use. Productive use of freshwater is currently restricted to flood cultivation of wetlands; otherwise the entire agricultural production is rain-fed.

The severe and prolonged droughts that have resulted in food insecurity over the last seven years or so, despite abundant water resources, point to the need for increased technological capacity to improve the use of water as an ecosystem service. Access to safe water in Bugesera remains low, but the current large-scale water supply project promises to raise access to 100% in the next two years (MINITERE 2006, SOGEA 2006, personal communication with water and officials). However, in harnessing the water resources in Bugesera, two main concerns need to be voiced – the water resources of Bugesera are not quantified and ecosystem resilience in situations of low water availability is limited. In these circumstances, it's difficult and risky to plan large scale water-intensive development projects, because it might have adverse ecological consequences and economic losses (e.g. malfunctioning of irrigation facilities due to shortage of water). Moreover, all stakeholders met agree that the flow and quality of the water has declined (depth of rivers, speed of flow and colour of water were some of the physical indicators).

Access to safe water in Bugesera seems to be increasingly influenced by income and labour, as all water has to be paid for and many have to trek long distances and spend many hours. Poor households spend a bigger proportion of their incomes on water. At an average of Frw 15 per 20 litre jerry can and an average of three hours to and from the water source at the time of this assessment, safe water in Bugesera is among the most expensive compared to other parts of Rwanda. As a response, many households in Bugesera are foregoing essential domestic items to save to purchase bicycles in order to ease transport. Again, poor households who cannot afford water are the ones to trek long distances and spend more time in queues to collect the water. As most water fetchers are women and children, the children and women from the poorest families are likely to lose more productive time (for school and household chores, respectively) in the process of collecting water.

Access to sanitation in Bugesera is among the lowest in the country. More than 80% of the households visited during the household survey for this assessment did not have appropriate sanitation facilities and mostly used bushes. Awareness about good sanitation practices is generally low, and interventions are inadequate. For instance, the largest safe water supply project presently being implemented appears to be focussing on purely engineering aspects i.e. abstracting, cleaning and supplying water, with very limited efforts to sensitise the population on the importance of safe water and sanitation in the prevention of diseases. The interventions need to follow a more integrated approach by emphasising local participation and strongly emphasising socio-behavioural change issues, such as hand washing and cleaning of utensils and safe disposal of waste. Without this approach, the poverty reduction objective of increasing access to safe water as a means to combat preventable diseases and to promote better well-being will not be realised.

4.2.3 Wood fuel

The crisis of fuel-wood in Bugesera is clearly manifested in the struggles that local people make and the costs they have to incur. However, despite the importance of rigorous fuel wood situation analysis and projections for Bugesera, the lack of data on biomass makes a meaningful analysis of demand and supply very difficult. Availability of information therefore needs to be taken as a priority for decision makers. Nonetheless, the following are the key observations that can be gleaned from the analytical work conducted on fuel wood:

1. In Bugesera, forest ecosystems have been used unsustainably for agriculture production, resettlement needs, firewood and charcoal production. They have been degraded, such that the forest ecosystems existing today are much sparser woody savannas. The ecosystem loss has also led to a significant loss in biodiversity, due to habitat loss for especially larger and rarer animal species.
2. Most of the population of Bugesera relies on wood biomass as cooking energy. Given the scarcity of wood, they use costly and less efficient wood species (*Olea Africana* and *Euphorbia turcali*) which are normally grown in agricultural lands. *Euphorbia turcali* is traditionally used for hedges and for fencing households, animal stables and crop farms. In the past, it served well as boundary markers and resolved conflicts related to land and animals having to escape into other people's crop fields.
3. Alternative energy sources are less developed in Bugesera; only the prison of Rilima has recently adopted biogas energy and improved mud stoves are commonly used by households in Bugesera to reduce dependence on fuel-wood. Other institutional users such as the secondary and primary schools and the Military base still rely on firewood for cooking energy, posing further threat to the degraded forest ecosystem. There is an urgent need that these major fuel wood consumers adopt environmentally-friendly energy alternatives like biogas. Reforestation, agro-forestry and awareness raising on environmental management should be key priorities for local authorities.
4. The recurrent and prolonged droughts in Bugesera have been linked to extensive deforestation and

land degradation. To address the effects of drought, extensive reforestation campaigns are needed and implementing an appropriate policy for reforestation and ecological restoration.

5. Women and children are particularly affected by lack of firewood – children have to forego play and/or irregularly attend school. Women's household productivity is reduced.

4.3 Emerging Issues

A number of issues have emerged from the study, and due to their implications on policy, they need to be highlighted.

1. Household labour, off-farm employment and livelihoods

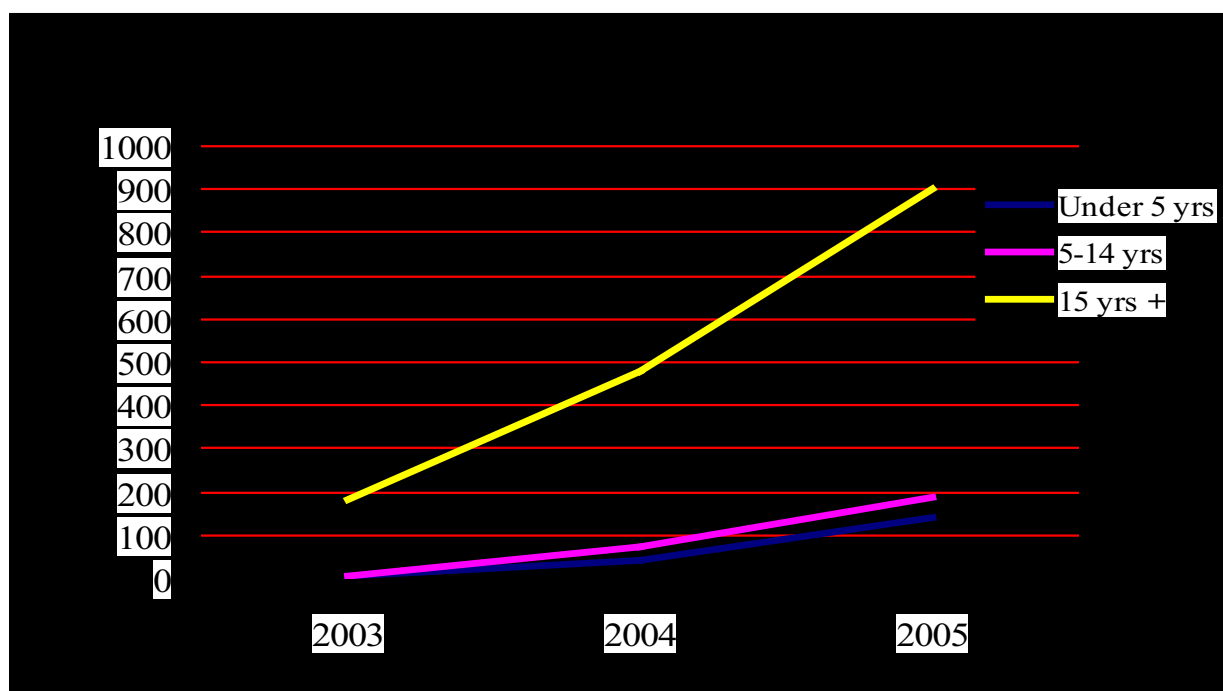
Wealth in Bugesera, like elsewhere in rural Rwanda, was perceived by households in terms of asset holding, particularly livestock and land. However, with the decline in livestock in the region and declining household land holding, ability to earn cash from means such as petty trade, and for the majority, labour has become crucial for livelihoods in Bugesera. With the long drought of 1999-2002 that made land unproductive, land no longer holds the perceived value it once had. Indeed local communities in Bugesera define "better-off" households as those which have a regular income in addition to agriculture (Save the Children 2000, IEA Household Survey 2006). The need to empower young people in Rwanda with productive skills, exposure to non-agricultural livelihood opportunities and access to credit has been raised as early as the 1980s (Kampayana, T., 1990, Twesigye – Bakwatsa, C., 2005). Certainly in Bugesera, young people need to be assisted to change livelihood perceptions and attitudes in the wake of declining income opportunities.

During a group discussion with local people, a married young man (in his early 20s) was asked how much land he had and, before he could even utter a word to say he had none, all the women and the other people in the group laughed and pointed to the lone middle-aged man (in his early 50s) as a member of the only age group that one can possibly expect to own some land. Villagers were asked: "How do you survive with wife and child then, do you have a job?" They argued that most young men and generally the poor households depended on their labour for a livelihood. This dependency on household labour has its own implications. One is that it is the underlying factor for escalating vulnerability of most households without such labour. One of the vulnerable groups that are affected most by the food insecurity crisis is the women and child-headed households who are too weak to work. Most of these are victims of HIV/AIDS and genocide survivors who have no relatives to help them. It is not uncommon to find lone old women in homesteads alone, barely surviving on the mercy of volunteers who, in the wake of drought, have become hard to come by.

Box 6: Food insecurity, migration and escalating HIV/AIDS: An inextricable linkage

Perhaps with the exception of pastoral communities who are reported to have been forcibly resettled in Bugesera (very few are left if any), nearly all the population that settled in Bugesera before 1994 reported to have been searching for productive agricultural land. The Bugesera rangelands and moist valleys supported livestock and agricultural production (including coffee, bananas, sorghum, cassava and sweet potatoes). However, since 2000 when severe and prolonged droughts forced people to the edge of **survival**, many people started migrating from Bugesera to other areas including equally drought-prone Umutara. As food security increasingly became a preserve for only those households with diverse sources of income (especially business people and wage earners), the poor who traditionally depended on their labour are reported to temporarily migrate to areas outside Bugesera especially neighbouring Kibungo and Umutara, to look for work and earn cash to feed their households. Women who stay behind are often forced into sexual activities in order to survive while they wait for their partners, and in the process, many contract HIV/AIDS. It's not only a problem for the women. Many of the men that "export" their labour tend to stay longer in their missions and squander their earnings on women, thereby exposing themselves and spouses back home to HIV/AIDS. The outcome is the increasing rate of HIV infections recorded at health centres (Figure 29). The situation was reported to be a potential catastrophe in Bugesera if no urgent measures to address employment and food security issues were undertaken.

Figure 27: HIV/AIDS Prevalence in Bugesera



2. Resolving land issues

This study, like a number of previous studies, observed that access to and ownership of land has, in the aftermath of the prolonged droughts and historical deprivation of most people, become increasingly less valuable for the livelihoods of people in Bugesera particularly due to declining productivity. Nonetheless, the assessment agrees with previous observations (Clay et al. 1999, Save the Children 2000, Musahara 2001) that while land may not account for all forms of poverty in Rwanda, any initiative focused on poverty reduction or ecosystem conservation must take into account the role of land in Rwanda to be meaningful. In this respect, the ongoing land tenure reform programme ought to go beyond land administration and market issues to resolve the historical problems associated with allocation and tenure. In the particular case of Bugesera, the panaysat system needs to be reviewed as does the use of public land such as hillsides and wetlands to balance production and conservation activities.

3. Managing Multi-sectoral interests in Water resources – Whose voice should be heard?

With the escalating drought, water bodies and wetlands in Bugesera are not just looked at as reservoirs in time of crisis but increasingly the only resource available to support food security and livelihoods. The interests in water resources are increasing and often conflicting, causing tensions. Many farmers come from distances and camp for months in the Kanyonyomba swamp in the eastern part of Bugesera. Others draw water for livestock and domestic use and yet for others, the swamps and open water bodies support artisanal fishing. These smallholder farmers have raised concern about the planned irrigation projects about which they have never been consulted. It is also not clear how the local smallholder farming communities, including the landless poor, would benefit from the irrigation projects. The SOGEA implemented large scale safe water supply project is expected to extract approximately 13,000 m³ of fresh water from L. Cyohoha south, to benefit about 60% of the Bugesera population. In addition, the Lakes and rivers (Akanyaru and Nyabarongo which converge in Bugesera to form the Akagera) are part of the critical watershed for the Lake Victoria, Akagera and Nile basins. This implies that Bugesera water is a trans-boundary resource, with stakeholders' interests transcending local and international boundaries. Thus, initiatives to enhance the sustainable use of the important ecosystem services provided by freshwater need to address the multiple interests.

The problem, however, is that neither the policy nor the institutional arrangements currently in place had provisions for addressing these issues, yet some policy makers interviewed agreed that they were a potential area of conflict. MINAGRI argued that the issue of enhancing food production through irrigation was beneficial to everybody but no one could explain how the likely negative consequences would be addressed. In a bid to increase cereal production as a means to address food security, unilateral policy statements or guidelines were drafted by Government directing that all wetland cultivation be limited to the restricted production of cereals – essentially maize and rice, a decision most smallholder farmers did not seem to be happy with. By the time of this assessment, a draft water law had not been passed, and a policy on wetlands was still to be developed. The National Environment law requires all development projects to be subjected to environmental impact assessment, but there was no record of approved IEA studies at

REMA for the planned irrigation projects in Bugesera. It would seem that part of the problem relates to absence of clear institutional jurisdiction for wetlands and water bodies. The Ministries for Agriculture and for Lands and Environment argue respectively for increased production and conservation and protection wetland ecosystems. A framework to harmonise the often conflicting interests is, therefore, urgent, as are appropriate mechanisms, tools and incentives to link these interests. At the regional level and local levels, the capacity to advance local people's interests either through local government or civil society is lacking.

Box 7: Coping with Eco-crisis: How the bicycle is enhancing human well-being in Bugesera.

In the aftermath of the drought that has affected Bugesera over the last 6 years, the population which was dependant on agriculture, suddenly plunged into a livelihood crisis – food had to be “imported” from outside the area, residents have to walk very long distances to look for water, and the many poor households whose able-bodied men and women depended on working on other people's farms (for food and incomes) lost their livelihoods. Because literary everything came from far, transport became a big limiting factor.

A bicycle is used to fetch water and firewood, carry produce to or from the market, and transport people to social gatherings such as marriage or community functions. Most importantly, these days, a bicycle in Bugesera is a source of employment for many people- young men operate bicycle transport (Kunyonga) to earn some money to purchase food and household items. Many use bicycles to trade in food items from neighbouring Kibungo and occasionally Umutara. Young men temporarily migrate to Umutara and other places to work but after raising enough money to purchase bicycles, they no longer migrate to look for temporary casual jobs, and they create their own jobs. Although in the Rwandan culture, it is taboo for women to ride bicycles, cycling women are a common site in Bugesera.

“In Bugesera district, every family has to own a bicycle for life to be easier,” says Theresa Musabyimana while riding a bicycle, her baby strapped onto her back.

Cycling in Bugesera is no shame for women, as most women claim, because women can take their children for treatment at any time, says a female bicyclist. A family man, John Habiwaremye, confirms this, saying his wife normally rides to the hospital to take their child for treatment.

Some women have gone as far as taking their harvest to the market and fetching water using bicycles, since the scarcity of water in Bugesera necessitates travelling long distances to fetch the golden liquid. It is even alleged that young girls and women carry heavier loads than some men do.

Most couples in Bugesera, when legalising their marriage, ride their bicycles to the wedding site and ride back on one bicycle after becoming husband and wife, an elderly resident said. The elder further recalled Rwandan culture which had forbidden women from riding bicycles to the point where it even looks weird - almost a taboo -- in some parts of the country for women to ride. But some women were quick to the defence of female bicyclists, saying women's emancipation has encouraged women and girls to do every kind of job to support themselves and their families. The key obstacle to women riding bicycles is that they are unable to fix the mechanical problems they encounter, leading to Bugesera women to call upon their men to train them on how to fix them.

The landscape being generally flat in the area, bicycle transport is the most convenient mode of transport for taking merchandise to the market. Riding the bicycle in Bugesera starts at an early age for both boys and girls. However, in mountainous areas of the country like in the Northern Province, it is common for men and boys to be unable to ride

And as some local authorities told Cool Sunday, Bugesera has more bicycles than any other district in Rwanda.

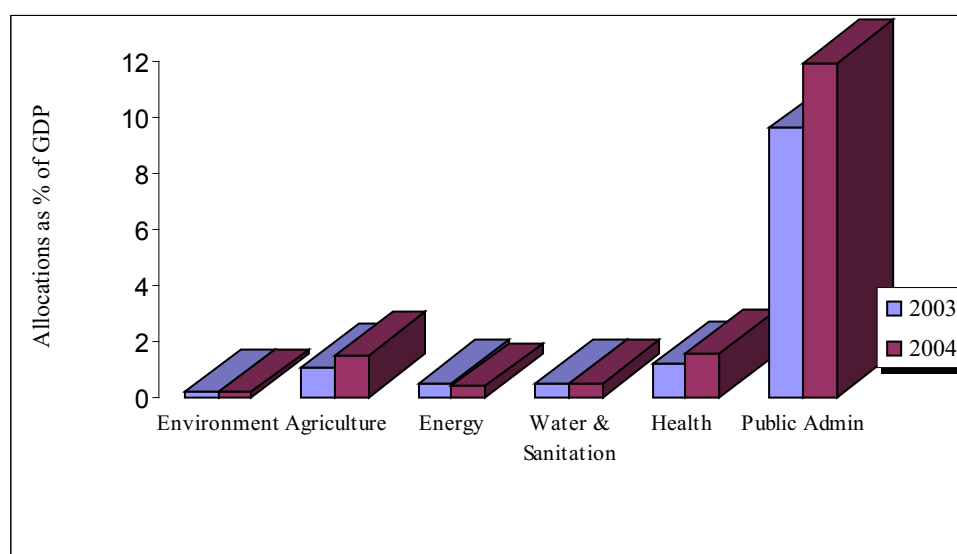
To date, the bicycle is so treasured in Bugesera that it can even determine the fate of marriage. One Nzamukosha says that when a girl is married she has to receive a bicycle as part of the wedding gifts to help her in the new life she is about to begin. Laughing, Nzamukosha alleged that some parents have even forced their sons to marry girls they do not want in order for the parents to acquire the bicycles.

(Source: Combination of field observations, personal communications & The New Times Publications,)

Policy priorities – does the health of ecosystems matter to policy makers??

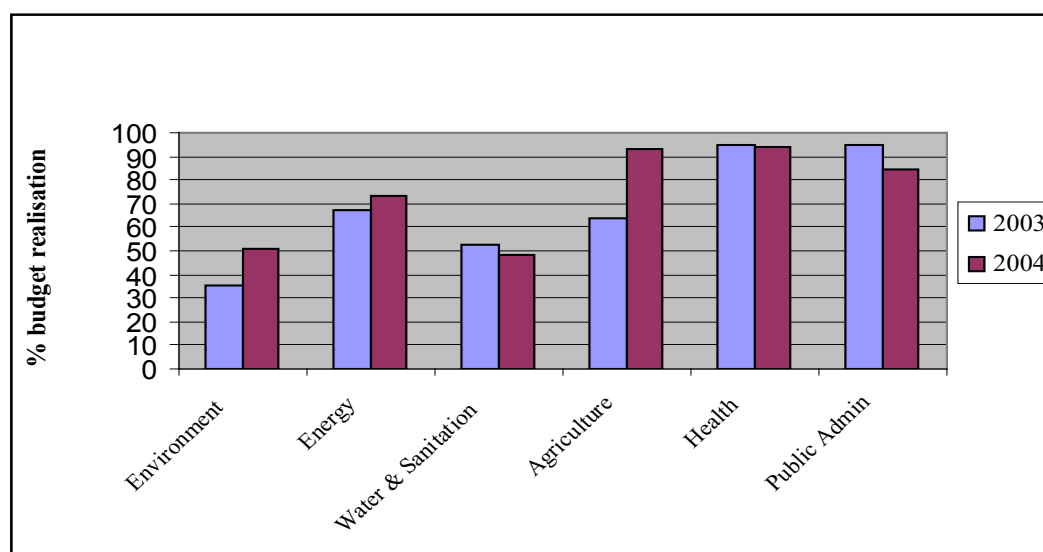
Although everyone has a role to play in promoting sustainable management of ecosystems, as public goods, it is the ultimate responsibility of Government to set appropriate policies and enforce their implementation. Public investments in environmental related sectors are often an indicator of the extent to which such sectors are a priority of Government (FAO 2005). A comparative analysis of budget allocations and actual performance in selected sectors⁵ is presented in graphs in figures 30 and 31, respectively. The information in the graphs indicates that such sectors receive very little support from the domestic budget, yet they account for the largest proportion of GDP. For instance, the budget for general public administration amounted to 9.6% and 11.9% of GDP in 2003 and 2004, respectively. By contrast the combined sectors of environment, agriculture, energy and water and sanitation were allocated an equivalent of 2.3% and 2.6% of GDP for 2003 and 2004 respectively. Moreover, the budget performance (actual realisation) for these sectors around 50%. The environment related sectors almost entirely rely on external funding through short to medium term projects, which are often conditional and unreliable.

Figure 28: Sector Budget Allocations as Percentage of GDP



⁵ Note that the four sectors of Environment, Energy, Agriculture, and Water and sanitation relate to the three ecosystem services assessed in this study.

Figure.31. Performance (Actual execution) of Approved Actual Budget for selected sectors (2003 and 2004)



Although many official documentations (including policies and ministerial statements) and personal communications with policy makers indicate that ecosystems conservation is among the top of GoR priorities, such statements of intention cannot be translated into real action without allocating considerable resources to the sectors.

4.4 Important Trade-offs in Ecosystem Services

This study has established that a number of trade-offs exist which need to be brought to the attention of decision makers, to inform policy decisions. It is important to appreciate that the ecosystem-poverty balance can only be realised if these trade-offs are properly managed. And, to analyse and manage these trade-offs requires adequate and accurate information. Important trade-offs that have been identified are summarised in the following sections:

4.4.1 Trade-offs between Biodiversity Conservation and Land based livelihoods.

Bugesera region is a high biodiversity area combining dry land biodiversity typical of the eastern savannah plains and central plateau in Rwanda. Its numerous wetlands and water bodies made the region a major genetic bank for some of the rarest wetlands fauna and flora species. However, over time, the destruction of fragile and biodiversity-rich ecosystems – in particular wetlands, hilly areas and dry land savannas, in favour of crop and livestock production and human settlements, has led to loss of important biodiversity. Aquatic ecosystems have also been affected by the introduction of alien fish species such as Nile perch as recently as late 1980s. Although such fish have high commercial value, they preyed on indigenous fish species, resulting in loss of many fish species.

Bugesera's trans-boundary position, without clear mechanisms for trans-boundary management of ecosystem resources, makes cross-border biodiversity a critical issue. The other main issues that make the trade-offs between biodiversity and livelihoods (especially agriculture based), even more complicated are:

- Species loss not adequately inventoried. Use of non traditional tree species for fuel-wood and construction work as opposed to what they previously preferred, indicates increasing rare occurrence;
- pristine and critical ecosystems (wetlands, dry land savannah woodlands, forests,..) continue to be transformed in favour of direct provisions for food and incomes, with little if any regard for their sustainability, and the debate at policy level is still skewed in favour of production;
- There is no protected area, so most biodiversity is found in managed ecosystems, requiring urgent measures for protection of biodiversity outside protected areas.

It appears, there is not enough information on the original or existing species and their importance, as no biodiversity inventory has been made. This makes it difficult even for conservation advocacy groups to communicate convincingly in favour of biodiversity conservation. In addition, since biodiversity has multiple benefits, most of which are of no immediate and visible utility, determining appropriate thresholds beyond which direct livelihood activities such as food production can be implemented without serious negative impact on biodiversity, remains difficult. Actions that determine the exact status of biodiversity and working backwards to assess the trends in impact of livelihood activities on biodiversity are therefore urgent. One of the immediate actions is to undertake a comprehensive biodiversity mapping in Bugesera and relating this to the status of ecosystem health. Only then shall meaningful discussions on what options appropriate for conserving biodiversity while enhancing people's livelihoods.

4.4.2 Trade-offs in Household Energy and food production

Another important area where serious trade-offs exist is in energy and agricultural productivity. With the shortage of fuel wood, many households have resorted to using agricultural residues and, for those with livestock, animal waste (dung cake) is being promoted as an alternative to wood fuel. This raises serious concerns for food production because crop residues and animal droppings are the main means of fertilising the soil. It is apparent that whether such interventions work, Bugesera farmers are still faced with difficult decisions to use these organic materials to augment soil fertility as a way of increasing or at least maintaining the current land productivity levels or to adopt them as alternative sources of household energy for cooking. This trade-off between energy and food requires holistic scientific solutions and policy actions. Ultimately, at least in the medium to long term, it will be difficult to avert the fuel wood problem. It might be more viable, therefore, to explore options to increase tree cover to provide fuel wood and other wood and non-wood products and ensure accessibility and affordability by poor landless households – increasingly the majority in Bugesera - than to rely solely on other forms of biomass energy.

5.0 Scenario setting for Bugesera

Bugesera region is naturally endowed with rich biodiversity and unique ecosystems with several lakes, rivers, forest and wetlands. People in the region depend on their ecosystem services and derive a number of benefits including small farmers, herdsmen, fish folk, crafts makers and Government demonstration farms run by Ministry of Agriculture and ISAR Karama station.

However, in the recent past, Bugesera region has been one of the most affected regions by droughts and famine partly resulting from a serious trend of ecosystems degradation that has led to diminished ecosystem services and increased poverty along with declining levels of human well-being among the local communities in the area.

The scenarios portray the plausible future of the region from 2 different perspectives; the business as usual scenario for Bugesera if the current trend is unabated and allowed to continue without any policy responses and interventions by year 2020.

The ICT scenario; application of information technology and how this could impact on Bugesera region, particularly on the local livelihoods and conservation initiatives of the local resources.

Finally, both scenarios bring into perspective the issues related to land use, water quantity and quality, longer droughts, depletion of natural resources like forests and lakes and ultimately trigger an interesting discussion and a debate on what could be the best policy options and responses by policy makers and Government in general in addressing such issues.

5.0.1 Business as Usual Scenario.

Poverty in Rwanda is largely perceived as a rural phenomenon where majority of the people depend on natural resources like water and land for survival. Bugesera is no exception with a majority of the rural population deriving food and income from Agriculture, particularly cropping, livestock and fishing. Cultivation of traditional cash crops like coffee has declined in the recent past as a result of limited external inputs such as fertilizers, pesticides and poor extension services. As a direct result, food crops like maize and beans are very important as a source of income, which consequently impact on house hold calorie intake. Trading in livestock and fish is also part of the local economy in Bugesera though on a very low scale. The majority of the food is produced by small holders, majority of whom own less than 1 hectare of land and are still using traditional farming methods.

The problem of declining food productivity and lowered yields is compounded by very high post-harvest yield loss caused by drying problems and microbial growth, pests and lack of adequate storage facilities. Further, lack of high yield varieties and improved breeds of livestock add to the decline of food production. The underlying trend for small scale farmers and especially women is the difficulty in gaining access to credit in order to invest in inputs such as improved seeds and fertilizers

The Government policy intervention in promotion of rice production in the wetlands using irrigation to boost agricultural production and increase food security is considered an appropriate option. There is however a concern about the potential danger of promoting monocultures as well as the loss of genetic diversity and increased dependency on methods that may be ecologically harmful and not affordable to poor farmers. The rice production has therefore proven to be neither a sustainable solution to food security nor a method for poverty alleviation in the region. Furthermore, this raises the issue of trade-offs among the local communities on the competing water uses for rice production, livestock watering and small scale farmers in the wetlands. Conservation concerns on the issue of excessive use of ground water as opposed to what the hydrological cycle can replenish and salinisation are areas of concern for sustainable use of water resources.

The drying up of lakes like Cyohoha in the northern part of the Bugesera region, which are the major source of drinking water to the neighbouring communities, aggravates the conditions of the poor and their livelihoods. The lack of safe drinking water becomes a major factor in the high rate of diarrhoeal diseases especially among young children, causing high infant mortality rates. Only a small proportion of the population has access to safe drinking water, usually from a public stand pipe and this often involves a considerable walk. Consequently, as poverty has persisted, the government's investment in water supply projects is rather limited due to poor return on investment and low cost recovery which negatively impacts on the economy and national economic growth.

The population is significantly increased and hence the farm sizes are reduced. Farming alone can not provide the means of survival and the poor families have to search for off-farm employment and alternative sources of income. Some of these are based on natural resources like charcoal burning, hand crafts and working as labourers on larger farms. As the survival in the areas has become increasingly difficult, part of the local population seek alternative livelihoods through migrations especially, men who semi-permanently move to the urban centres. This situation however creates other social problems like weakening of family ties and vulnerability to dangers like HIV-infection, marriage break-ups and related problems.

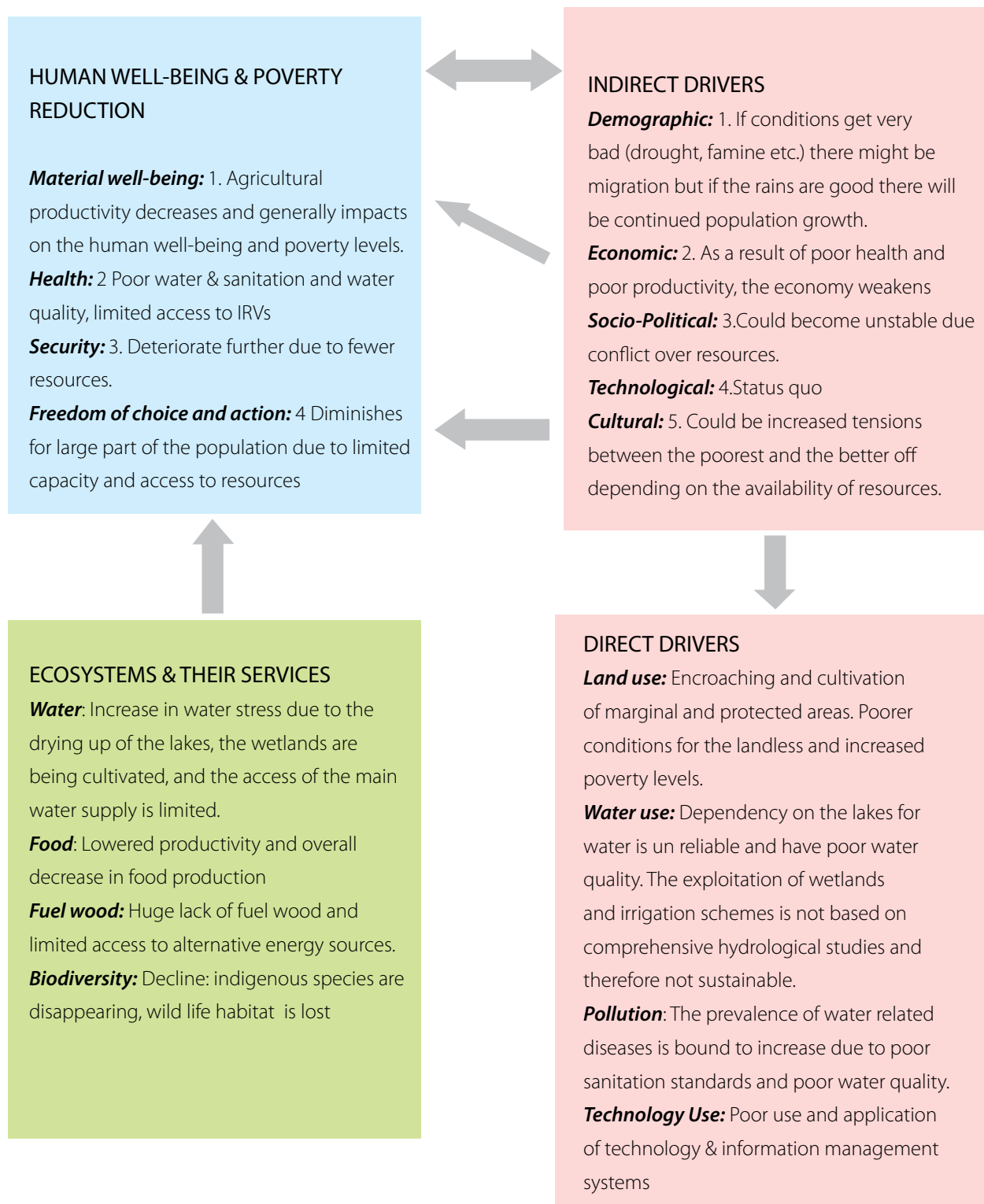
Increased production through irrigation schemes has not been matched with market promotion strategies. The risk of specialized cash-crop production like rice is not supported by existing market dynamics. This is causing food supply problems due to neglect of production of traditional food crops which has resulted into food import and soaring of food prices and a factor that increases food insecurity.

Policy Interventions:

In order to address the problems, policy interventions focused on some important issues like monitoring of ecological capacity particularly the consequences of population pressure and land use trends, creation of balanced and optimal utilisation of resources, measures for regenerating damaged ecosystems like rotational cultivation, temporally "no-go areas" planting of suitable foliage plants and trees, erosion control and setting up demonstration projects.

Further efforts have been directed to creation of alternative income opportunities like food processing projects to diversify the locally based income sources and reduce full dependency on land cultivation. Well

planned re-settlement policy like “IMIDUGUDU” clustered villages, have enhanced better land utilisation and provision of the basic social services. The issuing of land titles to small holders have facilitated access to micro-finance facilities and increased the capacity of farmers to modernise their production means.



5.0.2 ICT-Environment Linkage

A wave of investments primarily focusing on a globally connected society is seen as a result of Rwanda's efforts to achieve a stable economy and a political stability. A lot of attention is being given to a highly developed communication infrastructure, which supports an increased flow of information and exchange between different countries and economies. Overall efficiency of the ecosystem provision improves and improved technology is used to provide solutions to environmental problems. There is further seen a positive development in the use of ecological engineering approaches as well as biotechnology the latter however adding an inherent risk of modified ecosystems.

Investment in ICT has improved the population's general wellbeing through an enhanced understanding of the link between sustainable managed ecosystems and improved livelihoods. This has been achieved through improved education systems and access to information. These results have been achieved through e.g. use of the Internet and other communication tools provided by ICT. Through newly introduced policy reforms like decentralization, increased citizen participation and good democratic governance, there is wide-ranging improvement in the human wellbeing through policies that support increased investment in education and public health. However the illiterate, who do not benefit from this range of new services, will not be part of this positive trend as they cannot make full use of the tools and are therefore, being sidelined in this development process.

Innovation is stimulated through the access to all these new tools and this ultimately has a positive influence on the economy. The increased use of the different technologies which is further supported by the increased incomes has lifted a large proportion of the poor into the middle class. It has also reduced the heavy dependency on the natural resources. However, there is a steady decline of the social relations concerning human wellbeing due to erosion of local cultures and values caused by increased exposure from e.g. the Internet, international media and improved communication.

As a result of the increased income levels and improved access to advanced education, particularly for those using ICT, there is a raise in demand for cleaner technologies. There is also an increase in the demand of a protected environment and landscape with reduced pollution levels. However, rising incomes has created a change in consumption patterns boosting demand for selected ecosystem services like more and different agricultural products. This results into higher investments into agricultural production increasing productivity per acreage but with the potential environmental risks like extensive use of chemical fertilisers.

The agricultural sector has intensified the production and introduced a number of species, which has resulted in a decrease of production of more traditional crops. Food products have become more expensive and will further increase the gap between the part of the population who is in a position to benefit from the development and those who are not.

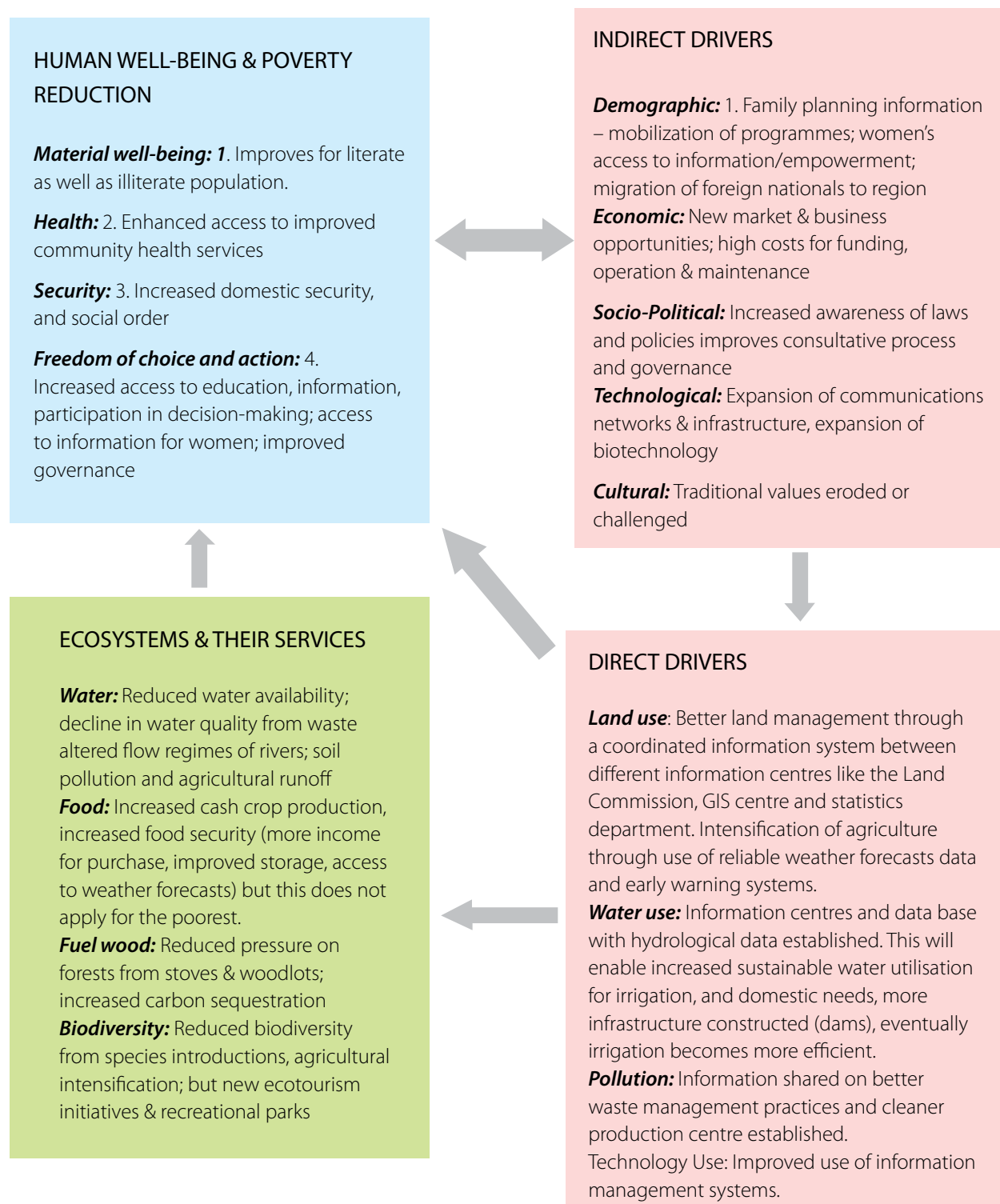
This situation affects the human wellbeing of the rural poor as they are removed from the ecosystem services on which they depended for their survival.

Although technological innovation may well improve the human wellbeing for a large part of the population, reliance on technological solutions at times can create new problems and vulnerabilities. In such cases new problems seem to emerge faster than the solutions. The application of technology as an indirect driver improves productivity and reduces pressure on the natural resources through intensive farming but with the risk of pollution and reduced capacity of the ecosystem to maintain their natural balance.

The Use of ICT insures successful implementation of family planning programs creating optimal balance between population growth and natural resources utilization.

Policy Interventions

Implement the environmental information management plan as stipulated in the national information communication infrastructure plan 2010. In order to capture the benefits of ICT application to the majority of the population and citizens, there is a need for strengthening informal adult education country wide, promote research in the areas of bio-technology and bio-safety and also implement a regulatory frame work.



CONCLUSIONS AND WAY FORWARD

6.0 Conclusions

The Bugesera IEA has revealed that ecosystem services are essential for maintaining human well-being in Bugesera. While it is clear that the recent droughts have brought to the fore the need to protect ecosystems, as part of the broader sustainable development strategy, the debate on the Bugesera drought and intervention programmes implemented thus far all seem to skirt around the problem. Few people, including the scientific community, seem to be interested in understanding the underlying factors and their connectedness, and the debate and interventions appear to have shifted focus to the water endowment in Bugesera and the need for irrigation as a remedy. The hard questions that are not being asked include: how much water is there and what options should be explored to ensure equitable utilisation; and how resource poor farmers who, in absence of effective disaster mitigation systems, have resorted to cultivating wetlands, will benefit from the planned investments in technology, etc. A number of concluding observations are made:

1. The degree of dependency on ecosystem services differs: Although dependency on ecosystem services in Bugesera is undeniable for all people, the degree and nature of dependency on ecosystem services is different. “One-size-fits-all” interventions cannot work in Bugesera, and any interventions to enhance human well-being through improved ecosystem services ought to be multi-pronged. For instance, improving land productivity through irrigation and use of external inputs, as is planned by MINAGRI, may increase food production and hence availability, but without improving labour productivity, many of the poorest households will still not access food.

2. The poor have suffered most: In Bugesera, the biblical “Matthew Effect” (“For unto everyone that hath shall be given, and he shall have abundance; but from him that hath not shall be taken away even that little which he hath”), is evident. Distress sales of assets including land, livestock and domestic possessions at “giveaway” prices, in order to survive in the aftermath of droughts and famine, only served to plunge the sellers into further poverty. This supports the argument that the poor are the most harmed by ecosystem degradation.

3. Poor people are innovative but appropriate public policy is one major missing link: The current low coverage of water and sanitation, low agricultural production linked to drought and low input use, as well as lack of physical infrastructure in Bugesera are directly linked to rampant poverty in the region, and these vindicate Government, as it is responsible for public investments. Lack of comprehensive pro-poor and pro-ecosystem policies, especially in the sectors of water and sanitation; agriculture and rural economy, and social protection, is a major problem for the poor ecosystem dependent communities.

4. Although there is evidence of a changing role of ecosystems in terms of the services they provide, decisions continue to be made without due consideration of the consequences on other services: The importance of various ecosystems as providers of different ecosystem services is changing. As arable land has become scarce and with persistent drought rendering it less productive, wetlands have progressively become critical providers of food. Two critical observations are:

(a) The increasing multiple interests may result in further degradation if a clear and equitable management framework (in which the interests of the poor dependant communities are recognised and respected) is not put in place;

(b) The present focus on expanding food production in wetlands appears to have almost completely ignored the other equally important services provided by the wetland ecosystems. The continued exploitation of wetlands without a clear and sustainable strategy for their management which specifies thresholds within which acceptable tradeoffs can be made, spells disaster for the sustainability of ecosystems and human well-being in Bugesera. The Biryogo wetlands (an extension of the greater Kanyonyomba wetland in the eastern part of Bugesera, is a case in point. In any case, it is the only sizeable wetland remaining in Bugesera.

5. There is very limited, if any involvement of local people or institutions closest to them in the decision processes regarding management of ecosystems: Lessons from many areas, including Rwanda (CRA 2005, IDS, ODI and CRA 2005), have indicated that sustainable environmental management cannot be achieved if the people with most interests or those most affected by the decisions are not given a voice in the decision making process. In Bugesera, the only local institutions that participate in decision making process appear to be local government authorities. There is little evidence of local people's participation and, because they have no voice, they have no power to question or challenge decisions. Most development decisions are made by actors who are external to communities, and this raises questions for ownership and sustainability of poverty reduction and ecosystem management interventions.

6.1 Recommended Options to Improve Human wellbeing and Ecosystem Sustainability

This study looks at ways to maintain the flow of ecosystem services as a way of maintaining or improving livelihoods. The livelihoods of the poor are improved by strengthening their capacity to cope with and recover from stresses and shocks, and by maintaining or enhancing their capabilities and assets (Carney 1998 in Ashley et al 1999). A number of policy actions are recommended:

1. Invest in integrated water and sanitation: the single most important public investment that can deliver results in poverty reduction in Bugesera is improving sanitation coverage and ensuring access to safe water. Access to basic sanitation and safe water will greatly reduce disease prevalence (since most of illnesses reported and observed were related to water or sanitation), thereby positively impacting on household incomes and freeing public investment resources to other areas. Healthy people will be more productive and children will be in school, the overall impact being improved wellbeing. Also, since integrated water resources management means managing water and sanitation from a holistic perspective, not just bringing safe water, but also how to use it and maintain it safe, the local people will become aware about disease prevalence and water quality, on one hand, and water quality and watershed protection on the other, a situation that could promote protection and conservation of ecosystems that maintain water quality and productivity.

2. Promote livestock production for the poor. Lessons from elsewhere (e.g. Ashley et al. 1999) suggests that livestock production has great potential for improving livelihoods and enhancing ecosystems sustainability.

Contrary to many points of view, the poor and landless can own and maintain livestock.⁶ In the case of Bugesera, it is within the current Government policy of ensuring at least one cow per household. In Bugesera, livestock will improve livelihoods and enhance ecosystem sustainability in a number of ways: Moreover, livestock and their services (such as milk and meat) used to form part of the livelihood strategies of the Bugesera population, until the rangeland conversion into agricultural lands and persistent drought forced most of the pastoralists to migrate to other areas; as well as distress sales by poor smallholder livestock keepers.

3. Invest in agro-forestry. Trees and tree resources on farms have for a long time formed part of the farming systems in Rwanda. However, as farm sizes became smaller, trees on farm gradually declined (Pimentel et al. 1997). Yet it is smallholder farmers, with no land to grow woodlots that are presently suffering more from the shortage of tree products and services (essentially fuel wood and unemployment). Improving agricultural extension services, would, for instance ensure that modern land productivity enhancing technologies can be adopted, thereby increasing food security and incomes.

4. Reactivate Livestock production: Agro forestry in Bugesera will also enable re-activation of livestock production that has progressively declined over the last decade. Trees and shrubs supply vital fodder for livestock, contributing up to 80% of livestock feed, making it possible to maintain livestock on subsistence farms (Pimentel et al. 1997, Ashley et al. 1999). Thus, this assessment recommends that agro forestry be integrated into the current GoR policy of transforming livestock production from intensive low production to intensive high value livestock that does not require vast expanse of land for pastures.

5. Restore and/or maintain biodiversity: One of the impacts of human pressures on the natural ecosystems in Bugesera has been the steady loss of biodiversity. And, as there is no protected area in Bugesera, there is need for appropriate and realistic measures to restore or maintain biodiversity in managed ecosystems. Tree and shrub shelterbelts, as well as hedgerows maintained along the edges of cropland and pastureland increase biodiversity. Pimentel et al (1997) observed that shelterbelts and hedgerows are a refuge for many forest species, including beneficial parasites and predators, which can invade crops and pastures to help control pest insects and weeds. A case in Indonesia where such technique was successfully used to coffee pests⁷ could provide useful lessons for Bugesera where pests and diseases have reportedly emerged with the changing climatic conditions.

However, for agro forestry to have an impact on the poor – both in terms of direct provisioning and restoring the ecosystem balance, there is need for a coherent policy on the multiple benefits provided by forest and tree resources as well as sufficient public investments in technical personnel and budgets.

6. Improve the framework for environment governance: A number of actions need to be taken.

- » Operationalise policy and institutional arrangements for decentralised environmental management: In particular, the organic law on environment establishes environment committees at all levels from district, sector to cell levels. These should be put in place and facilitated to provide advocacy of ecosystem-development balance at all levels. In addition, existing local government structures

⁶ Ashley et al. 1999

⁷ In Indonesia, a coccinelid beetle, introduced to control an insect pest on *Leuceana* trees interplanted in coffee plantations, effectively controlled a cottony-cushion scale pest of coffee, when it moved onto the coffee trees (Pimentel et al 1997)

should be strengthened by allocating more resources to sectors directly related to ecosystems management, by providing more technical personnel to lower levels (district and sector levels), and by strengthening capacity for bottom-up planning.

- » Improve coordination coherence in central government policy and operational work- vertical linkages (between central and local governments) and horizontal linkages (within and among sectors) should be reviewed with a view to making them coherent and coordinated around common policy goals. Enforcement of marketing through cooperatives when in fact strong formal cooperatives don't exist in Bugesera, and attempts to regulate agro-commodity prices through Government pronouncements, without a clear monitoring framework and formal agro-marketing systems, could result in a backlash and need to be reviewed. Better sectoral and institutional coordination is also urgently needed to resolve conflicting institutional or sectoral interests (e.g. agricultural production and wetlands conservation).
- » Strengthen human resource capacity for integrated policy analysis and management – understanding the ecosystem-poverty nexus is a complex task. But while this study has contributed to the wealth of knowledge and information on the ecosystem-poverty – development interface, it appears that there are very few technical personnel in ministries, agencies and districts, sufficiently trained to articulate these issues. For most ministries, the few existing personnel are either new or still trying to change from the programmes implementation arrangements to policy analysis and strategy formulation, under the decentralised governance framework. These issues constitute enormous challenges requiring urgent interventions especially in training and capacity support.
- » Empower local institutions through appropriate capacity building activities. Local cooperatives and associations; community based organisations (CBOs) and NGOs, farmers organisations and other informal groupings at local level provide social safety nets for the poor and are influential in determining their behaviours and livelihood strategies. Because they are indigenous and have in most cases emerged out of necessity, these structures are well grounded and institutionalised at local levels. If supported, they can propel pro-poor and pro-ecosystem growth. These local institutions should be given a greater role in decision making processes (e.g. managing marshlands under production), and provided with appropriate training and tools to enable them function as real catalysts of change and advocacy.
- » Improve security of land and resource tenure for poor farmers:

7. Invest in education and skills development. Non-agricultural employment is significant for livelihoods in Bugesera, as most of the poor people now depend on their labour for livelihoods. Investments in skills provision through both formal and informal training will increase the quality and consequently the productivity of labour. This will not only improve the wellbeing of the population through productive employment, but will also alleviate the pressure of over-dependency on ecosystems. For instance, a vocational school training youth in tailoring, bricklaying and/ or carpentry can provide many school drop outs with productive skills which can enable them create their own employment. And, the present trend of infrastructure development in Bugesera (schools, institutions, urban centres, highway and proposed airport,) could provide an enabling economic environment.

8. Invest in a package of incentives to free children's time: in the aftermath of the crisis for food, water, fuel-wood, and everything tangible from the ecosystem, children in Bugesera are a big resource. They do everything from fuel-wood and water collection, looking after livestock, and helping parents in household

chores and operating petty businesses. In these circumstances, it is remote to expect to reach the MDGs particularly on achieving universal primary education even though there is fee-free education in Rwanda. The most obvious and practical interventions would be those that increase basic infrastructure at household level among the poor. Ensuring that poor households have access to cheap and affordable fuel and potable water can make children less important as income earning assets (Monasinghe 1993). The on going interventions to extend safe potable water to households, should, in this respect, adopt a more integrated water resource management model that addresses the socioeconomic issues implications of water including impact on children's schooling.

9. Adopt more holistic, integrated and trans-boundary approaches in intervention programmes. A combined analysis of food security, nutrition, water and health data, revealed that malnutrition amongst children was not just a result of poor access to adequate and nutrient-balanced food diet, but also insufficient access to safe drinking water and hygiene, which results in high incidence of diarrhoea (Chastre & Jeune 2001). Thus, access to food alone may not address the problems related to malnutrition. In addition, and more specifically for Bugesera, any interventions need to consider the trans-boundary nature of the agro-ecological zone in which it is located and related issues. The recent drought and food insecurity have also affected the Province of Kirundo (particularly an area called Bugesera) in Burundi with the effect that many Burundians moved into Rwanda in search of labour, creating competition for labour in the region. In addition, livestock movements across the borders have been associated with animal epidemics like foot- and-mouth disease (FMD).

10. Invest in improved information generation and management: Ultimately, as Brian Tracy⁸ counselled, the quality of policy decisions and actions will depend on the quality of information on which they are based. But there is another dimension to information which is relevant for Bugesera – policy makers must be willing to allow scientific information to inform and guide policy. This will become more and more relevant for Bugesera as ecosystem services such as water, food and fuel wood increasingly become scarce, and multiple interests result in escalating conflict. Box 9 provides more insights into what is at stake and what needs to be done with respect to evidence-based policy making.

Box 9. Evidence based Public policy reforms require information and political will

The rapid pace at which decentralisation has been implemented, at least over the last five years, signifies the commitment of the Government of Rwanda to promote good governance and poverty reduction. Good governance, including political will, transparency in decision-making and meaningful participation by stakeholders is also essential in maintaining the ecosystem-human well-being balance. But decision makers must have accurate and adequate information on the full value of ecosystem goods and services, the cost of remediation when degraded, and who is affected more by ecosystem degradation. This is important to ensure that stakeholders are aware of what would be at stake when terrestrial and aquatic ecosystems are degraded, what opportunities exist to promote socioeconomic growth while at the same time, enhancing the sustainability of ecosystems for inter-generational benefits. In Bugesera, the recent drought should provide an opportune learning moment to rethink what is likely to happen if the ecosystem resources, including water and land, are not properly and equitably utilised. In this regard, the ongoing initiatives in irrigation and full-scale utilisation of wetlands for intensive large scale agriculture must be reviewed to find optimal utilisation levels that will maintain a balance of ecological and productive values. These issues stand at the centre of the present desires to end food insecurity, improved livelihoods and reduced vulnerability to environmental disasters. Reforming public policy and generating political will including creation of an environment for participatory decision making, are, perhaps more than anything else, important and urgent. Investing in generation and use of information, as well as willingness of political and civic actors to let policy decisions and actions be guided by factual scientific information rather than populist sentiments, is part of the panacea for restoring Bugesera as a food secure region and reassert its status as a national food basket.

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