REPUBLIC OF RWANDA

MINISTRY OF LANDS, ENVIRONMENT,
FORESTRY, WATER AND MINES
P.O. BOX 3502, KIGALI-RWANDA
Fax: (250) 5 82629
Tel: (250) 5 82628

INITIAL NATIONAL COMMUNICATION

UNDER

THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

JUNE 2005

Rwanda
"Pays des Mille Collines"

Foreword

The Republic of Rwanda became Party to the United Nations Framework Convention on Climate Change (UNFCCC) and joined international community in addressing problems raised by climate change to achieve sustainable economic development.

Long before signing this Convention in Rio in 1992, Rwanda had already drafted her National Environment Strategy (NES) with its Action plan (AP) and taken measures in different sectors to combat environment degradation following soil erosion and deforestation.

Rwanda shares concerns with international community over effects of climate change as listed in the UNFCCC. She is also pleased with entry into force of the Kyoto Protocol in international interest, for a better global balance and sustainable development.

After the war and the genocide of 1994, which cast gloom over the country and the emergency period that followed, Rwanda has embarked in development phase that would reconcile both the needs of the population and ecological concerns. Commitments made in the framework of this Convention reinforce initiatives and priority actions undertaken by the Government of Rwanda through sector policies in order to achieve environment protection and management, poverty reduction and investment promotion. Depending on particularities of our country, policies and measures aimed at protecting climate against human-induced changes will be incorporated into future national development programmes.

The National initial communication has been prepared by experts appointed by the National Committee on Climate (NCC) whose membership includes different ministries, the private sector and non-governmental organisations (NGOs) directly concerned with aspects of climate change. These experts have learned the methodology of Intergovernmental Panel of Experts on Evolution of climate (IPCC) used in inventory of greenhouse gases emissions (GHGE) as well as techniques for evaluation of ecosystem vulnerability and development of strategies for adaptation to climate change. Their skill in the use of emission factors in various sectors will enable our country to fulfil her obligations towards regular updating of national inventories of anthropogenic emissions by sources and removal by sinks of all greenhouse gases non-controlled under the Montreal Protocol.

Rwanda shares with the international community the concerns of climate change effects included in the UNFCCC and is happy to welcome the Kyoto Protocol for the betterment of international interest for the planetary equilibrium and sustainable development.

The Ministry of Lands, Environment, Forestry, Water and Mines (MINITERE), on behalf of the Government of Rwanda, is grateful to all international and national institutions that have willingly contributed to the accomplishment of activities of this National Initial Communication. Our thanks especially go to:

- The Global Environment Facility (GEF) which funded the project : "Rwanda : Enabling Activities for the preparation of National Initial Communication related to the United Nations Framework Convention on Climate Change (UNFCCC);
- United Nations Environment Programme (UNEP) and the Secretariat of UNFCCC which have supported this project through training workshops to the benefit of national experts, funding of seminars and acquisition of equipment and relevant documentation;
- Public and private sector structures and NGOs which have supported the Project as well as all people who have monitored the whole process of drafting and validation of this document;
- National Focal Point of UNFCCC, the project staff and the whole panel of national experts who contributed the inputs to the drafting of the final report.

The Minister of State in charge of
Lands and Environment
Patricia HAJABAKIGA

GLOSSARY

ALICOMEC	*Alimentation, Commerce général des produits Chimiques*
APC Mashyuza	*Action pour la Promotion de la Chaux de Mashyuza*
Unité AST	Unité à Activité Scientifique et Technologique
CCNUCC	Convention Cadre des Nations Unies sur les Changements Climatiques
CDC	Comités de Développement Communautaire
CFJ	Centres de Formation des Jeunes
CIMERWA	Cimenterie du Rwanda
CNC	Comité National sur le Climat
CITES	Convention on International Trade of Endangered Species
COCOCHAUMA	Coopérative de Production de la Chaux de Mashyuza
DBO	Demande Biochimique en Oxygène
DSM	Déchets Solides Municipaux
DSRP	Document de Stratégies de Réduction de la Pauvreté
EH	Equivalent Habitat
ELECTROGAZ	Etablissement de Production et de Distribution d'Electricité, d'Eau et de Gaz
FAO	Food Agriculture Organization
FEM	Fonds pour l'Environnement Mondial
FEWS	Famine Early Warning System
FRW	Franc Rwandais
GEF	Global Environmental Facility
GBK	Gisenyi Butare Kibuye
GES	Gaz à Effet de Serre
GIEC	Groupe Intergouvernemental d'Experts sur l'évolution du Climat
GPL	Gaz pétrole lampant
HIMO	Haute Intensité de Main d'œuvre
IEC	Information, Education et Communication
INADES	Institut Africain pour le Développement Economique et Social
IRST	Institut de Recherche Scientifique et Technologique
ISAR	Institut des Sciences Agronomiques du Rwanda
IUCN	International Union for Conservation Nature
KIE	Kigali Institute of Education
KIST	Kigali Institute of Science, Technology and Management
MAB	Main and Biosphere
MINAGRI	Ministère de l'Agriculture et des Ressources Animales
MINALOC	Ministère de l'Administration Locale, du Développement Communautaire et des Affaires Sociales
MINEDUC	Ministère de l'Education Nationale, de la Recherche Scientifique et de la Technologie
MINERENA	Ministère de l'Energie, de l'Eau et des Ressources Naturelles
MINICOM	Ministère du Commerce, de la Promotion des Investissements, du Tourisme et des Coopératives
MINECOFIN	Ministère des Finances et de la Planification Economique
MININFRA	Ministère des Infrastructures
MINISANTE	Ministère de la Santé
MINITERE	Ministère des Terres, de l'Environnement, de l'Eau, des Forêts et des Mines
NEPAD	New Partnership for Africa Development

NMVOC	Non-methane volatile organic compound
ONG	Organisations Non Gouvernementales
ORTPN	Office Rwandais du Tourisme et des Parcs Nationaux
PAFOR	Projet d'Appui à l'Aménagement des Forêts du Rwanda
PIB	Produit Intérieur Brut
PNA	Parc National de l'Akagera
PNUE	Programme des Nations Unies pour l'Environnement
PNV	Parc National des Volcans
PRSP	Poverty Reduction Strategic Papers
PVC	Projet pour la valorisation du calcaire
SBV	Superficie du bassin versant
SWAP	Sector Wilde Approach
UNESCO	Organisation des Nations Unies pour l'Education, la Science et la Culture
UAAC	Université Adventiste d'Afrique Centrale
ULK	Université Libre de Kigali
UNILAK	Université Laïque de Kigali
UNR	Université Nationale du Rwanda

TABLE OF CONTENTS

h

EXECUTIVE SUMMARY

Chap 1. National circumstances

Rwanda is a mountainous and overpopulated country whose production mainly based on agriculture does not meet the needs of the population. This situation leads to excessive environment degradation following overexploitation of natural resources.

1.1. Political, institutional and legal frameworks

On administrative point of view, Rwanda is divided into 11 provinces and Kigali City, the political, administrative and economic capital. On policy side, Rwanda has developed Vision 2020, one of the bedrocks of sustainable development, environment protection and management, poverty reduction and investment promotion. Moreover, sector policies have been drafted and implemented.

On legal aspect, Rwanda constitution of 4th June 2003 stipulates in its article 49 that "*every citizen is entitled to a healthy and satisfying environment, every person has the duty to protect, safeguard and promote the environment. The Government shall protect the environment*". Beside, the three Rio conventions and other environmental conventions have been signed and ratified.

At institutional level, the Ministry of Lands, Environment, Forestry Water and Mines (MINITERE) is responsible for formulation of policies and laws aiming to achieve environment protection and rational use.

1.2. Geophysical characteristics

Rwanda is located in Central Africa between latitude 1°4' and 2°51' South and between longitude 28°45' and 31°15 East. Her total area is 26.338sq.kms with average density of about 321 inhab/sq.km, and physiological density of 433 inhab/sq.km.

1.1.1. Relief

Rwanda has mountainous and sloppy landscape with altitude varying from 900 m to 4,507 m over a territory of about 400 km wide.

1.1.2. Climate

Rwanda enjoys tropical temperate climate characterised by a series of four seasons, two of which are rainy and other two dry seasons. Average temperature is about 20°C, with no significant differences. Rainfall is abundant and regular with an average of ±1000 mm/year. We notice however that despite some irregularities, rainfall is generally well distributed over the year.

1.3. Natural Resources

1.3.1. The soil and the substratum

Land exploitation work force is 91.9 % of the active population. Over a total area of 26,338 sq.km, 52 % only is exploitable, i.e. about 1,385,000 ha. Marshlands suitable for farming would add about 100,000 ha to this area.
At present, available arable lands are about 0.60 ha per household. Rwanda substratum holds minerals such as tin, wolfram, colombo-tantalite, gold and quarries.

1.3.2. Water resources

Rwanda has dense hydrological network with ±2 km/sq.km. It is split up into two basins by a water divide line by the name of “Congo-Nile Ridge”: at the East of Congo-Nile Ridge is the Nile Basin covering 67 % of the national territory and at the West is the Congo Basin. The former comprises many small lakes and drain 90% of national waters through two major rivers, Nyabarongo and Akagera. The Congo Basin, covering 33% of the national territory, drains 10% of national water resources towards Lake Kivu (102,800 ha on Rwanda side).

Average surface water flow rates measured at major hydrological stations are 78cbm/s (Nyabarongo at Kigali), 100cbm/s (Nyabarongo at Kanzenze), 232 cbm/s (Akagera at Rusumo), and 256 cbm/s (Akagera at Kagitumba).
As for underground waters, data from some projects estimate at 66cbm/s the flow rate of available and renewable water resources.

In Rwanda, water quality is generally good with a pH ranging from 6 to 7.5. However, surface water is often full of soil sediments and, in mining and volcanic areas, water can contain arsenic, lead, mercury, fluorides, iodides and other toxic metalloids and heavy metals. Pollution of rivers and lakes by water hyacinth and other aquatic weed is a new and alarming phenomenon in Rwanda, which needs to be addressed.

1.4. Biodiversity

Rwanda is covered by diversified ecosystems: natural ecosystems comprising mountainous humid forests, gallery-forests, savannahs, wetlands, planted forests and agro-ecosystems. All these ecosystems host a rich variety of fauna and flora species.

1.4.1. Protected areas

Rwanda had three major forest ecosystems, namely Volcanoes, Nyungwe and Akagera National Parks.

Volcanoes National Park (PNV) is worldly well known because of the presence of the Mountain Gorilla (*Gorilla gorilla beringei*). Beside this spectacular animal, VNP hosts diverse communities of numerous fauna and flora species.

Nyungwe National Park (PNN) is the largest mountainous humid forest of Africa with an area of 101,500 ha. It contains more than 1,200 species of ferns, 140 species of orchards, 260 woody species among which 24 species of trees, 275 species of birds of which 26 endemics of Rift Albertin and 3 species (Bradypterus graueri, Crypto spiza shelleyi et Apdis argentea) are on red line of IUCN, 13 types of primates making 1/5 of primate species of Africa and 300 to 400 *Colobus angolensis*.ruwenzori.

Akagera National Park (PNK) covers an area of about 108,500 ha and hosts more than 900 plant species, 90 mammals of which 47 big mammals, 530 species of birds, 9 species of amphibians and 23 species of reptiles. 4 fauna species namely *Loxodonta africana*, *Sincerus caffer*, *Panthera leo* and *Tragelaphus oryx* are protected under CITES (Convention on International Trade of Endangered Species).

1.4.2. Relict forests and gallery-forests

Gishwati natural forest, which covered 21,000 ha before 1981, covers only 600 ha in 2002.
Mukura natural forest, which covered 3,000 in 1960, covers only 800 ha in 2002. It is similar to Gishwati with respect to tree species and altitude ranging between 2,000-3,000 m.
Relict-forests and eastern savannah situated around Akagera National Park host a wide range of endemic and rare species most of which are used in traditional medicine.
Gallery-forests host an important biodiversity of endemic and rare species. This is the case for example for *Blighia unijugata*, *Grewia forbese*, *Rhus vulgaris*, *Pterygota mildbraedri* and *Ficus sp*.

1.4.3. Forest plantations

Forest plantations have been established since the year 1920 and are mainly composed of *Eucalyptus* and agro forestry species such as *Grevillea*, *Cedrella*, *and Calliandra*.

1.4.4. Agro-ecosystems

Farming space covers more than 70 % of total area of the country. Food crops consist of beans, maize, sweet potatoes, Irish potatoes, sorghum, banana, etc. Some of the export crops are coffee, tea and pyrethrum.
Animal husbandry is largely extensive and traditional and is a family enterprise practiced in a family context. Most of the livestock in Rwanda is local breeds *"Ankole*" with a few exotic breeds of bovines as well as of caprine.

1.4.5. Wetlands biodiversity

About 104 flora species and many fauna species are nesting in Wetlands.

1.5. Socio-economic data

Rwanda ranks among most poor nations of the world. About 50% of the population is less than 16 years of age and 90% live in rural areas. In 2002, Gross Domestic Product of Rwanda by head at constant price was 77,870 FRW. GDP is dominated by agricultural sector. In 2002, the contribution of agriculture to the GDP was about 43%, 19% for industry and 37% for services. From 1999 to 2001 mining sector contributed to export earnings respectively for 5.9% in 1999; 12.58% in 2000, 42.64% in 2001.

1.5.1 Human settlements

Rural habitat in Rwanda has since long ago been and is still scattered. National policy on habitat aims at establishment of improved rural settlement model and clustered villages commonly known as “IMIDUGUGU”.
Urbanisation policy is being finalised and aims to discourage proliferation of slums. Commendable efforts were made in elaboration of urban master plans to address problems raised by the slums.

1.5.2 Energy and transport

In Rwanda, biomass makes the major source of energy since it provides for 94% of national needs. Wood products and plant residues provide energy consumed at household level, in industry and handicraft. Hydropower stations contribute for 4% of the total energy consumption. Imported petrol products are used at 80% in road transport. Importation of second-hand vehicles, mostly taxi minibus, is becoming more and more dominant and their mean age is 10 years. The capital Kigali counts for more than 70% of the cartage.

1.5.3 Industry

Rwanda industrial fabric is modest and young: 78% of industrial enterprises started between 1964 and 1987. In 2002, the contribution by secondary sector to GDP is about 19%, a majority of which comprises food processing and others in the category of small and medium-sized enterprises producing consumable goods as substitutes to imports, using simple technologies. The cement industry and lime production constitute the main source of greenhouse gases emissions.

1.5.4 Agriculture

Agriculture is the most important sector of Rwanda’s economy. While in 1995, agriculture contributed for 47%, it contributed for 43% to GDP in 2002. Coffee and tea are the major export crops, with about 49 millions US$ of export earnings in 1998. Agricultural production system relies on small family farms whose production is self-consumed at more than 80%.

Size of family farms varies from 0.5 ha (34% of farms) to 2 ha (16% - MINAGRI, 2001). Average size of family farms is 0.71 ha. In 2001, at national level, 63% of households had less than 0.75 ha.

Rice culture is exclusively practiced on mineral soils mainly irrigated and permanently flooded. Rice production has progressively increased according to cropping area, which has varied from 3,500 ha in 1997 to 6,500 ha in 2002.

About 10% of former Akagera National Park, i.e. 25,000 ha is the size of the herbaceous savannah burnt during the 1980's. After the year 1994, an area of pasturelands estimated at 15% is annually set on fire, i.e. about 26,500 ha.

Burnt residues are always proportional to the weight of consumable products. Banana is far the most important source of farm residues, seconded by leguminous plants and tubers.

Organic soils under cultivation are estimated at 7,600 ha and located in marshlands and valley-bottoms. Import of mineral fertilisers has significantly increased at more than 8,000 tonnes since the year 2000.

Animal husbandry, essentially bovines, is mostly extensive. Average dairy production is about one litre/cow/day for bovines during 180 days of lactation (MINAGRI, 2001). Permanent stalling, part-time stalling and free-range grazing are the three major types of cattle feeding.

1.6 Forestry

National forests cover were estimated at 527,863 ha in 2001, i.e. 20.05% of Rwanda total area. Over a period of 41 years, the area of natural forests shrank from 634,000 ha to 221,200 ha i.e. a decrease of 65.11 % between years 1960 and 2002. This situation originates from many factors among which encroachment for agriculture, wanton forest exploitation, mismanagement, etc.

1.7 Wastes

Solid wastes include municipal and industrial solid wastes. The former, which are 75% biodegradable, includes household garbage, commercial wastes and public wastes. The latter include wastes similar to municipal solid wastes and wastes specific to manufacturing processes and by-products.

1.8 Education, information and research

Rwanda has adopted a system of "education for all". However, environmental education is poorly integrated in primary, secondary and tertiary teaching programmes. Efforts and initiatives for environmental education are scattered. Most used channels to sensitise the population are radio, television, newspapers, posters and videos.

Environmental research is essentially carried out in the following public institutions: Rwanda Agronomic Science Institute (ISAR), Institute for Scientific and Technological Research (IRST), National University of Rwanda (UNR) and Kigali Institute for Science, Technology and Management (KIST), and Kigali Institute of Education (KIE).

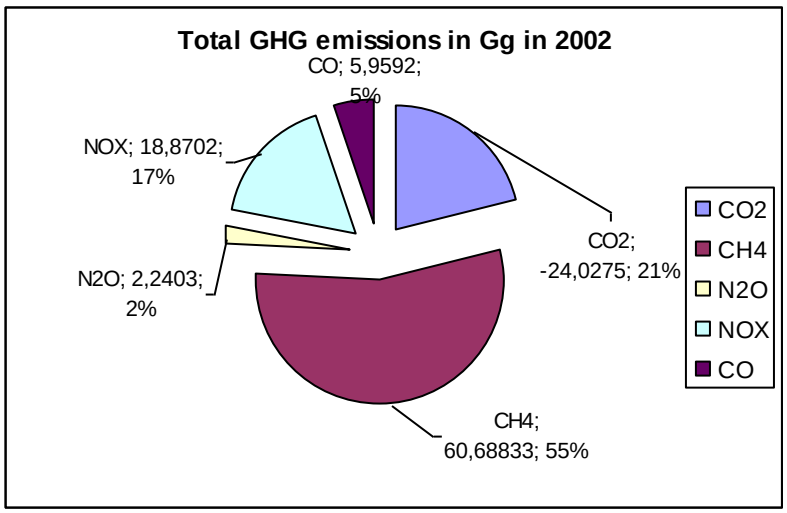
Chap 2. National inventory of greenhouse gas (GHG) emissions

Features of greenhouse gases emissions non-controlled under the Montreal Protocol show their sources and sinks. Inventory of these gases constitute the major part of the Initial Rwanda communication on United Nations Framework Convention on climate change (UNFCCC) and at the same time, the foundation for all other activities carried out in this work.

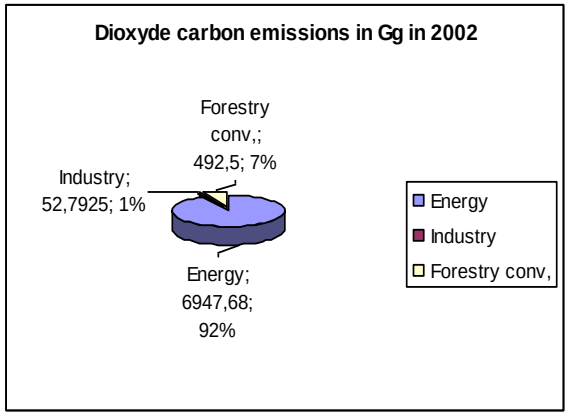
Methodology used is the one proposed in the simplified Manual of guidelines of IPCC-1996 revised version for national inventories of greenhouse gases. Following tragic events of war and genocide that cast deep gloom over Rwanda from 1990 to 1994, year 2002 was chosen as reference instead of 1994. Therefore, estimate of greenhouse gases emissions was done according to default factors of the year 2002.

Greenhouse gases emissions in Rwanda are largely compensated by sequestration capacity of forests: 7,517 $GgECO_2$. This means that balance of CO_2 emissions in 2002 is in favour of the removal of -24.0275$GgECO_2$

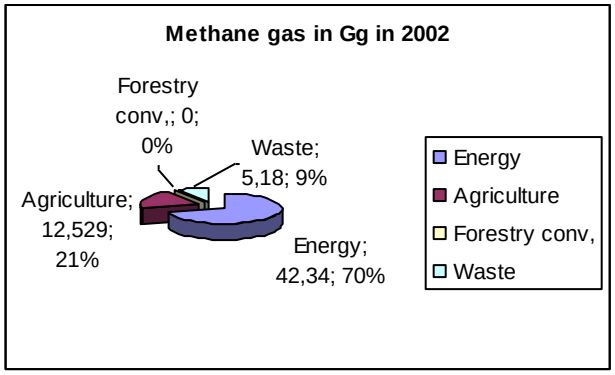
Total greenhouse gas (GHG) emissions (Gg) in 2002					
GHG Categories	**CO_2**	**CH_4**	**N_2O**	**NO_X**	**CO**
Total National GHG Emissions	**-24.0275**	**60.68833**	**2.2403**	**18.8702**	**5.9592**
1. Energy	**6947.68**	**42.34173**			
A. Emission from petroleum products	259.68	0.04173			
B. Emission from fire wood	5918	32.5			
C. Emission from charcoal	770	9.8			
2. Industrial process	**52.7925**				
A. Emissions from cement production	50.740				
B. Emissions from lime production	2.04				
C. Emissions from tin production	0.0125				
3. Agriculture		**12.529**	**1.876**	**18.7**	**0.38**
A. Enteric fermentation		10.91			
B. Fertiliser management			0.41	0.43	
C. Rice farming		0.35			
D. Cultivated soils				1.813	
E. Savannah burning		0.113		3.01	0.05
F. Wastes from harvest burnt		0.746	0.02	15.69	0.33
4. Land use and forestry	**-7024.5**	**0.6376**	**0.0043**	**0.1702**	**5.5792**
A. Sequestration in forestry	-7517				
B. Emissions from forest conversion	492.5	0.6376	0.0043	0.1702	5.5792
5. Wastes		**5.18**	**0.36**		
A. Emissions from waste waters		0.2			
B. Emissions from domestic and commercial waste waters		3.48			
C. Emissions from human wastes		1.5	0.36		



Dinitrogen monoxide (N_2O), mainly released by the sectors of agriculture (1.876Gg) and wastes (0.36Gg), is about 2%.



Energy sector is the first responsible for CO_2 emissions (92%) followed far behind by the sectors of land use and forestry (7%).



As for methane gas (CH_4), sectors of energy and agriculture contribute mainly to its emission. Energy sector releases 69%, i.e.; 42.3 Gg of CH_4, against 21%, i.e. 12.53 Gg for agriculture, 9% i.e. 5.18 Gg for sectors of wastes and 1% i.e. 0.64% Gg of CH_4 for shift of forestry conversion.

Chap 3. Measures and strategies to reduce greenhouse gas emissions

In the case of Rwanda, Government has defined policies and measures to prevent and reduce causes of climate change and curtail their negative impacts for sustainable socio-economic development.

3.1 Energy sector

Vision 2020 forecasts that Rwanda will have reduced the contribution of wood energy from 90% to 40% generation by the year 2020. Hydraulic potential combined with methane gas energy would meet needs in electricity for the whole country development activities with additional production of 125 MW compared to year 2000.
In the poverty reduction strategy paper (PRSP), Rwanda has set the objective to ensure increase rate of electricity consumption by 9.6% per year, to ensure rural electrification rate of 30% and to increase from 6% to 35% the population having access to electricity.

3.1.1 Policy options and specific measures to reduce greenhouse gases

In the field of energy, Rwanda has already set forth policy options to develop the sector and at the same time to contribute to reduction of GHG. These options aim to:

- Increase access rate to modern energy resources such as hydropower and new and renewable energies;
- Produce large quantity and quality of energy for urban and rural areas while improving security of electricity and petrol products supplies;
- Meet needs of domestic energy while protecting environment.

3.1.2. Strategies to reduce GHG in energy sector

Energy policy that focuses on sustainable development is based on the following elements and strategies:

- To intensify regional cooperation in matter of electricity generation and integration of electricity supply networks as well as promotion of exchange of energy at regional level so as to increase electricity, reduce production costs and prices of electricity;
- To decrease the use of fuel wood and charcoal by 50% in 2020 horizon, thanks to substitute energies (methane gas, solar power, peat, biogas, etc.);
- To increase the number and capacity of hydropower dams;
- To increase the number of mini-hydropower stations particularly in rural areas;
- To set up measures to improve energy saving systems in manufacturing industries.

Many technological options likely to contribute to reduction of greenhouse gases have been proposed by IPCC in energy sector. Options applicable to Rwanda are described in the table below:

Strategies and actions to reduce GHG in energy sector	
Strategies	**Actions**
Use of alternative sources of energy	- To promote and extend use of biogas ; - To promote the use of solar power; - To promote water solar hitters; - To construct micro-hydropower stations ; - To intensify regional collaboration in electricity generation and integration of supply network as well as promotion of commerce of energy at regional level ; - Feasibility studies and promotion of pit use - To promote the use of some types of wastes as combustibles.
Promotion of effective energy programmes	- To promote the low consumption lamps
Improvement of wood combustion efficiency	- To extend use of improved cooking stoves at household level ; - To introduce efficient wood-charcoal making technologies.
Efficiency in the sector of transports	- To impose installation of fuel ionisation system on motor vehicles ; - To promote importation of new vehicle with low fuel consumption/regime through access to loan and decrease of taxes on vehicles aged less than 5 years; - To discourage importation and circulation of old vehicles through high taxes levied on import and use ; - To impose norms of regular control of technical maintenance ; - To encourage public transport through incentive tariffs.

3.2 Industry sector

3.2.1. Cement production

In order to reduce quantity and intensity of CO_2 emissions from industrial processes of the cement factory in Rwanda, it is recommended to CIMERWA to support programmes involved in the preservation of biodiversity and Nyungwe natural forest and in a forestation programmes for Bugarama region in general.

3.2.2. Lime and tin industry

As for lime industry, it would be necessary to sequestrate CO_2 by Kabuye sugar works, ELECTROGAZ, construction and public works enterprises. It would also be necessary to plant trees near factories producing lime and use algae for small lime production units.

For tin industry, it is required to choose appropriate industrial site and use algae to convert CO_2 since generated quantities are small.

3.2.3. Strategies to reduce greenhouse gases from industrial processes

For cement production

- To replace clinker partially with alternative binders free of $CaCO_3$ (slag and volatile ashes);
- To plant trees in the farmlands and support biodiversity and forests conservation.

For tin and lime industry, it will back reforestation programmes in order to multiply carbon sinks.

Important tools to be used in order to achieve expected results are training, education, sensitisation, tax exemption, low interest loans and other financial incentives.

3.3 Agricultural sector

3.3.1 Measures to reduce N_2O emissions

Options to reduce emissions of N_2O in agriculture are:
- To improve effectiveness in the use of nitrogen contained in chemical fertilisers;
- To ensure that nitrogen is released as N_2 instead of N_2O by acid soils liming.

3.3.2 Measures to reduce CH_4 emissions

- ***Enteric fermentation***

Potential production measures would target reduction of cattle herds to respect the carrying capacity per unit area of pasturelands, improvement of productivity and feed content.

- ***Manure management***

Potential measures to be adopted for the reduction of methane emissions deriving from anaerobic fermentation in manure pits are the use of digesters and reduction of fermentable matters.

- ***Controlled burning of savannah and on-site burning of farm residues***

Efforts to reduce emissions of GHG will target supervision, training and information of farmer as well as research-development on innovations for agriculture modernisation.

3.3.3. Strategies to reduce GHG in agriculture

Strategies and actions set up to reduce GHG in agriculture are shown in the table below:

Strategies and actions

Intensification of agriculture and animal husbandry	-To extend the use of selected seeds and improved livestock breeds; -To extend soil conservation techniques and use of farm manure; -To sensitise the population in the use of micro-technologies to maximise profit from farm manure; -To promote the use of farm inputs; -To promote livestock stalling system.

3.4. Land use and forestry sector

Measures to reduce GHG can be grouped into various clusters which are related to technical aspect of conservation and management of forestry ecosystems, agro-ecosystems; those related to sector and institutional policies, and the legislation in force.

3.4.1 Technical and technological options

Technical and technological options proposed for the maintenance and increase of present forest cover are conservation of natural forests, restoration of degraded forests and promotion of new plantations, as well as extension of agro forestry and adoption of alternative sources of energy.

3.4.2. Policy options

- ***Regional development***

In the framework of regional development general policy, rational land use and proper wetland management are considered, given their role in the regulation of the water cycle.

- ***National water policy***

A policy that aims saving and management of water will have impact on erosion control, following rational rainwater management, maintenance of vegetation cover around the year, notably through irrigation and increased plant and animal productions.

- ***National forestry policy***

National forestry policy aims to preserve enough forest areas in order to protect biodiversity, to conserve critical ecosystems and to maintain the functions of forests and trees in the environment, particularly in water catchments areas.

- ***Modernisation of agriculture and animal husbandry***

Agricultural policy targets promoting animal husbandry through stalling for up to approximately 500,000 heads and animal productivity. It also targets to increase carbon sequestration on farmlands through better management of residues and rehabilitation of degraded hillside soils.

3.4.3. Institutional framework

The role of the central government is to formulate policies and laws and to provide guidelines. Inter ministerial coordination committee was set up according to three key domains namely economy, social affairs and infrastructures.

3.4.4. Strategic options

Strategy for management of organic fertilisers intends to reduce GHG emissions through effective organic fertilizer spreading on farmlands and improvement of liquid manure storage. This would increase revenues to farmers, ease pressure on forestlands (CO_2 sinks)

and lead to a decrease in number of farmers in favour of skills involving less use of land and thus forests.

Strategies and actions to reduce GHG in land use and forestry sectors

Strategies	Actions
Reduction of deforestation rate	- To sensitise the public opinion on importance of conservation; - To build required capacities to intervene in the field of education for conservation; - To enforce legislation in force in the field of conservation of protected areas; - To initiate income generating projects in the vicinity of protected areas (apiculture, basketry, medicinal plants);
To increase surfaces of forest plantations	- To develop community based forestry management; - To promote the use of alternatives to direct or indirect use of wood in construction works; - To reforest bare or almost bare lands on hillsides; - To identify and introduce tree species adapted to dry lands of the East. - To develop and extend agro forestry techniques; - To create green spaces (parks) in urban zones and extend tree planting on roadsides.

3.5. Sectors of waste and wastewater disposal

3.5.1. Waste disposal

Options to reduce GHG in the sector of waste disposal are related to biological treatments (biogas production, composting, manure spreading and landfill) and thermal treatment (incineration, thermal plasma, cracking and vitrification), recycling, reuse, physico-chemical treatment and deep landfill.

3.5.2. Wastewater disposal

Options to reduce greenhouse gases in the wastewater sector are:

- Banning wastewater flows on public roads and areas;
- Banning use of cesspools for disposal of residuary urban waters;
- Imposition of a water treatment tax;
- Extension of purification technology by lagoon.

3.5.3. Strategies to reduce GHG in waste and wastewater sectors

3.5.3.1. Strategies to reduce GHG in waste sector

Policy/ measure	Type of instrument	Objective and/or emissions reduction method
National communication programme on climate change	- Sensitisation - Information - Education	Campaign to inform the public on climate change and other problems of the atmosphere, coordination by MINITERE
Workshops, symposia, public consultations on possibilities of wastes management in	Idem	To assist the urban population, industries, enterprises and communities to take measures in order to reduce wastes and greenhouse gases they generate by encouraging prevention

Policy/ measure	Type of instrument	Objective and/or emissions reduction method
towns and free-will measures		rather than rectification
Programme of studies of greenhouse gases	Idem	Greenhouse gases and global warming are subjects to be considered in curricula of primary and secondary schools
Toll free telephone line about wastes disposal	Idem	A toll-free telephone line allow residents in towns to obtain information and brochures on elimination of wastes
Reduction and/or prevention from sources	Idem and free-will measures	To promote individual management of wastes (zero generation of wastes, discharge of purified effluent, individual composting, reuse of containers, recycling of various objects, creation of products generating less wastes, to put a deposit on drink containers, transformation of wastes in animal feeds, etc.)
Sorting and selective collection of wastes	Laws and regulations	To create an industrial cleaner production centre .It is a simple and flexible system of solid wastes management on small scale including the following integrated components: sorting, storage, collection, transfer and transportation.
Capturing and recovering of methane from landfills and its use for energy	Laws and regulations	To regulate in order to authorise capturing and use of methane released from landfills (generation of energy for cooking, lighting, electricity, etc.) in order to reduce CH_4 emissions and impose fines.
Criteria for future landfills	Laws	To authorize only landfill of ultimate wastes to reduce CH_4 emissions
Burning of wastes in countryside and towns ; incineration of wastes in towns	Laws and regulations	Wastes management plan must limit quantities of wastes to burn or incinerate by prevention, reuse and recycling
Loans for greenhouse gases reduction programme	Financial incentive programme	To provide low interest rate loans to industries, communities, associations or cooperatives and even families to help them build units for greenhouse gases reduction (bio-digesters, composting mechanisms, etc).
Joint implementation	Free-will measures	Industrialists (or others) generating same kind of wastes can work together to treat their wastes or to share costs of treatment by a special subcontractor

3.5.3.2. Strategies to reduce GHG in the wastewater sector

Policy/ measure	Type of instrument	Objective and/ or method to reduce emissions
Promotion of lagoon	Legislation	To acknowledge lagoon as sanitation system for individuals or community not larger than 2,000 people
Criterion for septic tanks	Legislation	To encourage Rwandans to equip their houses with septic tanks connected to a lagoon system or other wastewater treatment systems
Criterion for industrial wastewaters	- Legislation - Norms on industrial effluents	To treat on pre-treatment sites all industrial wastewaters before the discharge in ordinary wastewater collection canals or sewage system
Wastewaters Recycling	- Information	As there is sometimes water shortage in towns and

Policy/ measure	Type of instrument	Objective and/ or method to reduce emissions
	- Sensitisation - Education	water price is a bit high, wastewaters can be reused and sold at low price either for cleaning of city, windows, houses or use in toilets, in construction works, etc.
To improve efficiency of wastewater disinfections	Legislation	To reinforce « polluter pays » and « cleaner is assisted » principles
Programme of loans to public and private enterprises and districts, sectors and cells	Financial incentives	To set up a programme that offers low interest rate loans to help industry (or other private or public enterprises, districts, etc.) to install their purification treatment units or to associate themselves in order to buy treatment units so as to reduce investment and operational costs.
Wastewaters management plan for each town	- Planning - Legislation	- Formulation of action plans - Drafting of a law on urban management taking into account wastewaters management
Environmental management in each private or public institution	- Sensitisation - Information - Education	To encourage public and private enterprises to create an environmental management position whose incumbent will have a mandate of wastewater management on enterprise's compound

Chap.4. Vulnerability and adaptation to climate change

In Rwanda, we witness climate change related to general circulation of airstreams and variation of temperature in Central Africa region where our country is situated. In the last 30 years, Rwanda has undergone climate change with regard to frequency (number of occurrences), intensity and persistence of extremes such as heavy rainfalls, waves of heat, drought and climatologic parameters such as El Niño and Nina. Occurrences of rainfall deficit have reached 16%.

Frequencies of rainfall deficits and excesses have significantly increased these last years. Evolution of climate during the very same period has had impact on the environment, the economy and human lives.

4.1. Vulnerability

4.1.1. Human settlements, energy and industry sectors

In the sector of human settlements, energy and industry, Rwanda lacks services which can quantify losses due to climate change. Most of the time, figures on human casualties are given, but it is difficult to precise economic losses due to climate change related catastrophes.

Capacity for generation of energy by hydropower stations suffers from climate change. Decrease of water level in lakes Bulera and Ruhondo has already significantly affected electricity production on Ntaruka power station, which underwent important drop in the year 2003 and 2004, resulting in serious consequences on socio-economic activities.

Most of Rwanda industries operate in Kigali City and the majority of them is located in the valley of river Ruganwa as well as the valley of river Nyabugogo.
These valleys are characterised by very high vulnerability to flooding which causes serious damages during rainy seasons, as this was the case in September – December 2001 and May 2002.

Most common direct risks due to evolution of climate on human settlements, to energy and industry in Rwanda are related to flooding, landslides following long rainfalls, prolonged drought periods and erosion. Indeed, Rwanda has a very mountainous relief giving landscape with sloppy hillsides where rainfalls cause erosion on soils that often lacks anti-erosion systems. These heavy rainfalls sometimes bring about deadly landslides that damage road infrastructure or sweep away houses.

In Rwanda, drought often affects the East and Southeast of the country and sometimes some zones of the Central Plateau. Effects of drought on food security and cattle constitute major risks and create conditions, which cause famines resulting in displacements of the population and transhumance of cattle.

4.1.2. Vulnerability in food security sector

In Rwanda, most frequent direct risks encountered in agriculture are related to flooding, landslides and erosion. These phenomena result in the decrease of agricultural production that sometimes leads to widespread famines, of which most recent cases occurred in the years 2000 and 2004 in Bugesera and a certain number of other regions of the country. Recurrence of famines and cyclic droughts has contributed to occurrence of increased crisis periods and losses of human lives and economic resources.

Valley-bottoms crops often suffer decreased production and are sometimes destroyed by flooding in marshlands. Each year, we witness loss of production of maize and beans ranging from 20 to 30% in the marshlands of Nyabarongo and Akanyaru watershed due to flooding.

In Rwanda, drought is the result of drop in rainfall and very high evapotranspiration. It mostly affects agro-bio climatic regions of the East and Southeast of the country and sometimes, zones of the Central Plateau. For example, Bugesera used to receive rainfalls between 700 and 800 mm per year before the 1990's, but today it receives about 300 mm per year, i.e. more than 70% of water deficit.
Production of leguminous and cereals, such as maize and beans, is now almost impossible. These conditions of drought have also favoured proliferation of parasites such as caterpillars on sweet potatoes and predators of beans.

4.1.4. Vulnerability of land and freshwater ecosystems

Land and freshwater ecosystems are subject to numerous pressures, among which shift in land allocation, deposit of nutrients and pollutants, intakes, pasture, introduction of exotic species and natural variation of climate. Negative impacts on physical environment observed following climate change are the result of natural hazards namely erosion, landslide, flooding, wind and drought, proliferation of competing species, diseases and pests.

4.2. Adaptation

4.2.1. Sector of human settlements, energy and industry

For human settlements and industrial plants, proposed measures are:

- To plan human settlements, industrial plants and related infrastructures by the use of master plans;
- To plan and implement allocation plans of clustered villages-*imidugudu* in rural areas;
- To provide the population and local authorities with capacity to set up anti-erosion works (anti-erosion ditches and radical terraces) and plant trees where forest plantations have been cut;
- To first identify very fragile (critical) zones and build breast-walls to protect roads;
- To stabilise streams running across towns and city and build protecting walls on both riverbanks where required;
- To develop laws prohibiting human settlements in fragile zones and quarters.

For energy sector, the following adaptation measures are considered:

- To invest more in energy generation infrastructures by building other hydropower stations. Potentials exist on river Nyabarongo (Bulinga, 28MW), on rivers of Rusizi and Akagera and on small streams where micro-hydropower stations can be built;

- To promote new and renewable energies;

- To control erosion on hillsides around lakes Bulera and Ruhondo to prevent sedimentation, which would, on the long run, lead to their death whereas they stand for compensating reservoirs for Ntaruka and Mukungwa hydropower stations.

Concerning industry, it is considered adaptation measures consist in moving to appropriate sites most of industrial plants presently located in valley of streams running across Kigali city and which are under constant threat of flooding in the event of heavy rains.

4.2.2. Sectors of agriculture and food security, land and freshwater ecosystems

Adaptation measures proposed in these sectors are:

Sector	Vulnerability impacts	Adaptation measures	Policy options	Political implementation framework	Answer strategies
Agriculture	**Heavy rainfalls** causing soil erosion, landslides, flooding in marshlands and pasturelands, plant diseases, loss of livestock, loss of fertility due to excessive rainfalls. **Prolonged drought:** decrease of agricultural production, loss of pasturelands and plant diseases, forest fires, severe loss of biodiversity, reduction in organic substances and minerals content of the soil, prolonged drought.	Improvement of soil conservation techniques particularly in highlands (Northwest of Rwanda and zones of Congo-Nile Ridge) and introduction of agro forestry practices. Introduction of new improved crop varieties particularly early-fruiting, resistant and adapted to climate (for example climbing beans in highlands, sweet potato, rice, Irish potato, sorghum and maize)	Set up and use of environment information system Institutional strengthening	Partnership (Synergy) among institutions in charge of agricultural production, environment and watershed management, conservation and processing of farm produces as well as catastrophes management	Creation of rainwater dams on purpose of farming and livestock activities Creation of anti-erosion works Preparation of varieties of drought resistant seeds (germoplasm); Irrigation
Food security and land and freshwater ecosystems	**Migration of populations**	Extension between researcher (ISAR) and farmer, use of fertilisers; use of improved agricultural and animal husbandry technologies (for example irrigated crops and livestock stalling); construction of valley-dams. Assistance to poor people; Construction of storehouses for foodstuff; Processing and conservation of farm produces; Formulation of land management plan	Institutional strengthening	Speeding up adoption of land legislation; Set up of hydrological and meteorological observation network	Creation of storage system of phytosanitary products; Creation of anti-erosion structures/works Irrigation

Chap.5. Programmes related to sustainable development, education, research and sensitisation of the public

Key orientations of national sustainable development programmes are written in major sector policy documents regarding sustainable development, in particular Vision 2020, Poverty Reduction Strategy, National Environment Policy, Land Policy, National Forestry Policy, National Policy on Management of Risks and Catastrophes, National Investment Strategy, National Agricultural Policy as well as National Strategy and Action Plan for Biodiversity Conservation. Chapter 1 gives a glimpse of their contents.

5.1. Sustainable development in the context of climate change and synergy among Rio Conventions

5.1.1. Vision 2020

Vision 2020 document guides Rwanda long-term sector planning. It gives major orientations for social and economic development and management of natural resources in 2020 horizon.
In Vision 2020, efforts are made to establish mechanisms for rational management of natural resources and the environment. However, this document gives no clear solutions concerning management of natural resources and the environment with regard to climate change.

5.1.2. Poverty Reduction Strategy Paper

According to Participatory Evaluation of Poverty Report written in October 2001, climate hazards occupy the third place among 10 most important causes of poverty in Rwanda. Report of the Comprehensive Survey on Households Living Conditions in Rwanda (2000-2001) published in March 2002, discloses major characteristics of poverty in relation with access of the population to services directly dependent on climate phenomenon. Activities for mitigation or adaptation to climate change in the PRSP are found in many sectors.

However, the said paper should have mentioned the industrial sector among sources of carbonic gas, which is listed among greenhouse gases.

5.1.3. National Environment Policy

The document of the NEP proposes measures to be taken and strategic actions which have direct impact on climate change in water resources, forestry and protected areas, biodiversity, agriculture, animal husbandry and fishing, transport and communication, commerce, industry and tourism, energy and mines, atmosphere and natural catastrophes.

5.1.4. National Forestry Policy (NFP)

Some orientations of the NFP, such as promotion of agro forestry, conservation and rehabilitation of forests and reforestation of lands unsuited to agriculture, are good to support adaptation to climate change.

5.1.5. National Strategy and Action Plan for Biodiversity Conservation

Major planned actions that include aspects of climate change are those related to restoration of damaged environment in protected areas, measures for conservation and sustainable use of biodiversity. Other actions are related to promotion of modern farming and animal husbandry techniques and promotion of use of new and renewable energies as well as energy saving technologies.

The strategy also proposes promoting the use of environment friendly technologies for mining, trees cutting, fishing, agriculture, etc. It also shows efficient and sustainable traditional production systems and proposes to formulate policies and laws favourable to conservation and sustainable use of biodiversity and equitable sharing of benefits from use of biological resources.

5.1.6. Agriculture Policy

Agricultural policy suggests a strategic plan for transformation of agriculture and indirectly deals with climate change. Most proposed actions aim conservation and protection of the soils against erosion and restoration of their fertility.

5.1.7. Energy policy

Planned activities in the context of rational management of energy resources will certainly influence positively the climate.

Strategies	Programmes	Activities
Reduction of fuel wood and charcoal consumption rate	Research for alternative energies	Assessment of potentials in renewable resources, need and demand; Promotion of alternative energy projects (biogas, peat, etc.); Extension of improved cooking stoves; Use of methane gas.
	Diffusion of energy conservation technologies	Extension of energy saving cooking techniques; Sensitisation to rational management of energy; Extension of improved charcoal making techniques.
Extension of electricity grid	Rural electrification by extension of existing grid	Study of rural electrification master plan; Project identification; feasibility study; project implementation.
Isolated electricity grid supplied by micro-hydropower stations	Rural electrification by micro-hydropower stations	Project identification; feasibility study; project implementation
Isolated electricity grid supplied by solar power	Rural electrification by solar power stations	Electrification of remote public institutions: health centres, schools, district headquarters, telecentres and water pumping stations in rural areas.
Environmental section integrated in all energy generation projects	Environmental impact assessment prior to projects implementation	Review of current standards; conformity studies; studies of lake Kivu monitoring system during methane gas extraction; Environmental impact assessment for all energy related project.

5.1.8. Risks and catastrophes management policy

Policy on management of risks and catastrophes suggests an institutional framework in order to ensure better management of risks and catastrophes, including those related to climate change. Proposed structures are placed at national and local government levels and are composed of emergency or crisis structures.

5.1.9. Remedial measures

Assessed documents on sustainable development contain many orientations that can positively influence adaptation to climate change. Concrete actions to implement sustainable development policies are among others management of wetlands, reforestation of all free lands and likely to be freed. Programmes of erosion control, all initiatives of sustainable management of water resources, protection of riverbanks and lakeshores, control of desertification in all its aspects and other actions favourable to maintenance of quality of environment have to be encouraged.

5.1.10. Relationship between sector strategies and Rio Conventions

By comparing Rwanda strategic actions to those incumbent upon parties to Rio conventions (Biodiversity, Desertification and Climate change), there is a strong correlation between measures required from parties to these conventions and national sector strategies adopted to reduce poverty.

In order to induce more synergy among Rio conventions and integrate environment in all socio-economic sectors, it is important to act according to multi sector programme approach rather than project approach. This requires provision for programmes of adaptation to climate change or mitigation of their devastating effects in provincial strategic plans including highly vulnerable areas.

In order to make Policy Reduction Strategy and sector strategies more relevant to address climate change related vulnerability, in the way of mitigation or adaptation, while observing clauses of Rio conventions, some additional elements suggested are:

For PRSP

- To add information to chapter on environment referring to environmental and land policies which are related to climate change.
- To show existing cause-effect relationship in each sector when proposing strategies to be part of the PRSP for mitigation or adaptation to climate change;
- To add research activities, technological transformation, use of organic fertilisers, promotion of agribusiness;
- To insert industrial sector in PRSP not only to promote private sector but also food processing units and conservation of farm produces.

For sector strategies

- When analysing sector problems, indicate problems of gas emission originating from sanitation sector (solid wastes, domestic and industrial wastewaters), transport and industry sectors;

- To use SWAP approach to harmonise complementary sector strategies. This particularly concerns agriculture, where possible overlap exist with the Ministry in charge of environment, lands and forestry; the Ministry of infrastructures; the Ministry in charge of commerce and industry and the Ministry in charge of community development. This is valid for water resources, which require consultation with the Ministry in charge of water, the Ministry in charge of agriculture and the Ministry in charge of infrastructures.

5.2. Education and Research

5.2.1. Formal education

Education plays an important role in development process particularly in dissemination and assimilation of information, including information on climate change.

Primary education

Curricula of geography and environment should include concepts of environment balance, causes, effects and manifestations of climate change as well as adaptation measures.

Secondary education

In general, curricula are characterised by lack of cause-effect relationship. This leads us to recommend that it should emphasize erosion factors and the causes of environmental degradation could be among factors of climate change and therefore introduce climate change phenomena.

Higher learning

Organisational structure of tertiary education does not refer in anyway to climate change. In fact, beside courses and/or environment related branches (ex: regional development, environmental sciences, ecology and environment, etc.), more or less deeper concepts are found in branches of natural sciences and technology, commerce and environment, agronomy, medicine, research & development, industry, hygiene and sanitation, pollution and wastes management.

5.2.2. Strategies to integrate aspects of climate change in formal education

While considering existing programmes in primary, secondary and tertiary education, the following priority actions could be considered:

- To integrate environmental education in curricula at all levels of learning;
- To multiply systematic monitoring networks in order to allow better understanding of the climate at local and regional levels and make available weather forecasts;
- To diversify educational means: material, audio-video, newspapers, prize competitions such as poetry, theatres, radio and television reports in order to sensitise the public and the youth in particular on devastating effects of climate change.

5.2.3. National activities of scientific research

Research activities are conducted in public and private research institutions and centres of higher learning. In 1999, 86.9% of research units were active. Among operating units, industries and STA units (Units with scientific and technological activities) hold an important position if we compare them with research or higher learning institutions.

5.3. Informal education, information and sensitisation of the public

Education, Information and sensitisation of the public on the environmental issues, on climate change in particularly, remain a challenge. Indeed, climate change is among the major environmental problems facing Rwanda today.

Education and sensitisation programmes to the benefit of the public exist at national level. However, these programmes remain few and inappropriate. This results in such a situation that the majority of Rwandans have no access to information on climate change and particularly on the phenomenon of greenhouse gases emissions as well as their socio-economic impacts.

The poor rely more directly on natural resources for their subsistence and are therefore much affected by environmental degradation due to climate change. Education and sensitisation of the public and poor people in particular are therefore important for adaptation to climate change vulnerability.

5.3.1. Informal education

Ongoing permanent programmes of informal education, which are likely to contribute significantly to education and sensitisation of the public, should be extended to training of the population on climate change and its effects. These programmes include functional basic literacy teaching and appropriate technologies, as well as professional training by Ministry of Education, Science, Technology and Scientific Research.

5.3.2. Training, information and awareness creation of the public

Programmes of information and awareness creation of the public in the context of climate change are available and include information and sensitisation in matter of:

- Production and diffusion of tools for information and sensitisation of the public;
- National, regional and international weeks and days of environment, water, meteorology, tree planting, biodiversity, etc;
- Radio and /or televised magazines on environment protection and conservation;
- Sensitisation campaigns or tours organised in vulnerable zones.

In this context, activities are oriented towards production and dissemination of extension material (posters, booklets, documentaries, magazines, leaflets), and tools made of publications and printed matters, sketches, political speeches, radio programmes, video, media and advertising banners related to environment.
These tools are very important to education and sensitisation of the public on effects of climate change, mitigation and adaptation measures in order to induce attitudes and behaviours favourable to natural resources and environment protection.

5.3.3. Development of tools to create public awareness through mass media

In order to be able to educate, train and raise awareness of the public of devastating effects of climate change and adaptation measures, involvement of official and public media stands to be the best strategy. In fact, the media such as television, radio and others notably advertising agencies, have all methods and communication techniques enabling them to reach effectively and quickly a large public.

It is in this context that the project of “Enabling activities for preparation of the initial national communication on UNFCCC” has made translation into Kinyarwanda of texts and documents of international conventions and protocols on environment having synergy. These are the conventions and/or protocols on climate change, biodiversity, control of desertification and protection of the ozone layer. Translated documents will serve as main tools to sensitise the public on environmental aspects in general and on climate change in particular.

5.3.4. Training of members of the National Committee on Climate

From 15 October to 15 November 2002, during mission of UNISTAR expert, M. Monti MASSIMO in Rwanda, training sessions on methods of inventory of emissions and removals of greenhouse gases were organised to the benefit of the National Committee on Climate (NCC) and the team in charge of multi-sector studies.

Moreover, M. Ravi SHARMA and Miss Liza LECLERC, both representatives of UNEP/GEF, gave presentations on occasion of national workshop for evaluation of reports on technical studies written in the framework of the “Initial National Communication” project. These presentations were concerned with guidelines of the Intergovernmental Panel of evaluation on Climate Change for elaboration of national communications and vulnerability, impact assessments and measures of adaptation to climate change.

Chap.6. Other relevant information to achieve objectives of the Convention

6.1. Research and systematic observation

6.1.1. Data collection systems and meteorological databanks in Rwanda

At present, the meteorological service is not active because of inadequate staffing and lack of data collection, capture and processing equipment. Since it resumed its activities after the war of 1994, the service does not have update climatic yearbook and no agro-meteorological bulletin has ever been published. Consequently, recent data needed by various users in their daily activities are not available.

The meteorological service manages a large historical databank dated way back in 1906 collected from all stations operating before 1994 and those whose activities were resumed from 1998 to 2000 for civil aviation needs, and still operating to date. This databank is managed with climatic software (CLICOM) and includes many meteorological parameters such as precipitations, temperature, humidity, sunshine, cloud covering, wind, pressure etc.

However, a major part of data is not yet computerised and is still referred to in technical documents. We shall note that the major constraint of the meteorological service is the lack of a comprehensive weather observation network.

6.1.2. Data collection systems and hydrological databanks

The national hydrological service is a Division of the Ministry of Lands, Environment, Forestry, Water and Mines. Before tragic events of 1994, this service managed 47 hydrological stations. Since 1994, the number of stations has decreased following the aftermaths of the war and little importance given to water resources assessment. Special efforts to reorganise the service, to rehabilitate the network, to train staff and to collect and use data are required.

Thanks to FAO assistance, the hydrological service has received modern equipment to automatically measure height and flow rate at some stations on Nyabarongo at Kanzene, on Akanyaru and on Akagera at Rusumo.

Beside height and discharges of rivers, the service also has data on water quality in some regions where non-governmental organisations implement pilot projects. ELECTROGAZ also manages a databank on water quality, particularly potable water.

Major problems that thwart observations, data collection and processing are little importance given to hydrology, lack of qualified staff, scattering of data and budget constraints.

6.2. Financial and technological needs related to studies of vulnerability to climate change at national, regional and/or sub-regional levels

Appropriate technologies of adaptation to climate change hereafter proposed can be adapted to Rwanda socio-economic and environment contexts. Nonetheless, for any technology, there will be need to carry out environment and socio-economic impact assessments before extension.

6.2.1. Energy sector

In the sector of energy, identified technologies are stove with improved fireplace (cost: 800 to1,000 RWF), Kenya ceramic stove (cost: 2,000 RWF), Nada Chula stove (cost: 50,000 to 75,000 RWF), Nofie stove (cost: 2,000 RWF) and wood-charcoal making. These various technologies can profit rural, urban and semi-urban populations, clustered settlements and communal establishments (schools, prisons, etc.). Other options of these adapted technologies, always in the energy sector, are for industrial use, for example MANGIEN and NAVARE ovens as well as brick making by densification, whose target group is rural and urban populations, for a cost estimated at 7 millions RWF.

6.2.2. Human settlement sectors

In human settlements sector, identified technologies are appropriate for the field of making construction materials and are divided up into dry pressing (cost: 5 Millions RWF); extrusion (cost: 6 Millions RWF); ″ countryside stove with vertical wells (four de campagne à murs verticaux)″(cost: 1.5 Millions RWF), improved ″ countryside continuous stove "(four de campagne amélioré continu)″ (cost:75,000 RWF); ″four à tirage par le haut″ (cost: 15,000 RWF), four tranché (cost: 5 Millions RWF); Hoffmann oven (cost: 2 Millions RWF) and Tunnel oven (cost: 40 Millions RWF). These technologies can be applied for urban and semi-urban populations, and rural populations in clustered villages (*imidugudu*).

6.2.3. Agriculture and food security sectors

In agriculture and food security sectors, technologies selected are related to making of fodder silos for cattle (cost: 700,000 RWF) as well as traction farming (cost: 300,000 RWF) for rural areas.
In the field of food security, technologies which are likely to be more adapted to our country are peanut or palm oil press (cost: 750,000 RWF) and indirect solar drier (cost: 250,000 RWF) in use in urban areas or rural areas in clustered villages.
As for transport, only animal traction in clustered villages of rural areas seems to be viable at a cost of about 300,000 RWF.

6.2.4. Wastes and wastewaters management

In waste and wastewaters management sector, suggested technologies are bacterial bed (cost: 150 Millions RWF/1000 EH); biological disk (cost: 125 Millions RWF/1000EH); activated sludge (cost: 160 Millions RWF/1000EH); trickling filtration on sand (cost: 130,000RWF/1000 EH); up-flow plants filters (cost: 130 Millions RWF/1000 EH); advection-flow reeds filters (cost: 130 Millions RWF/1000EH); natural lagoon (cost: 130 Millions RWF/1000 EH); aerated lagoon (cost: 80 Millions RWF/1000 EH), but also improved latrines with ventilated pit (cost: 90 Millions RWF and 200,000 RWF/8EH, 50,000 RWF), composting by Indore method and biogas production (cost: 1 Million RWF per medium-size system).

6.2.5. Hydrology and water resources

In the field of hydrology and water resources, listed technologies are irrigation pump with pedal (cost: 700,000 RWF), animal traction pump (cost: 700,000 RWF), solar-geared pump (cost: 3.65 Millions RWF) as well as basket-shaped water reservoir (cost: 150,000 RWF/m^3) for roof rainwater harvesting. These technologies can be adapted for the rural population in clustered villages.

6.2.6. Industrial sector

In the case of industry related technologies, for better adaptation to climate change caused by greenhouse gases emissions in cement and lime factories, envisaged adaptation measures for developing countries consist of producing slag-based cement, which is beyond Rwanda's economic reach. As for corrective measure, reforestation near those factories training and provision of means for reduction of pollution are recommended.

6.2.7. Sectors of land and freshwater ecosystems, forestry and health

Technologies related to the sectors of land and freshwater ecosystems, forestry and health are respectively land use techniques and master plan, green belts around lake zones, grafting and treated mosquito net against malaria. The target group is specifically the population living in lakes zones, the rural population, and eventually the whole population when considering treated mosquito net.

∞ ∞ ∞ ∞ ∞

CHAPTER 1: NATIONAL CIRCUMSTANCES

Rwanda is a mountainous and over populated country with an essentially agricultural production insufficient for the needs of the population.
The overexploitation of natural resources leads to an excessive degradation of environment. Hence, a sustainable environmental management and socio-economic development cannot be analysed as separate phenomena but as an integrated and multi sector approach including aspects of climate change.

1.1. Political, Institutional and Legal Aspects

Administratively, Rwanda has eleven provinces and Kigali City which is the political, administrative and economic capital. Provinces and Kigali City are subdivided into106 districts divided into 1536 sectors subdivided into 9025 cells.

On policy aspects, Rwanda has developed 2020 Vision which is one of the pillars of sustainable development including, environmental protection and management, poverty alleviation and investments promotion. From there, the Government wants to build a nation where pressure on natural resources such as lands, water, biodiversity, is highly reduced and the process of environmental pollution and degradation are reversed.
On the other hand, sector policies have been prepared and implemented including environmental policy, land policy, energy policy, agricultural policy, habitat policy, decentralisation and good governance policy and disaster management policy.

On legal aspect, the Rwandan Constitution of 4th June 2003 stipulates in its article 49 that every citizen has a right to a sane and clean environment and that every individual has the duty to protect, safeguard and promote environment and that the State has the duty to environmental protection.
Similarly, organic law on environmental protection, conservation and management aims at improving the living conditions of the population and viable environment.

The three RIO Conventions and related Conventions including those on wet zones, vegetal protection, ozone layer protection, persisting organic polluting agents, international trade of fauna and flora species under extinction threats, boundary movements of dangerous wastes have been signed and ratified. Rwanda also participates to regional initiatives in environmental protection and management such as Nile Basin Initiatives, Lake Victoria Biodiversity Programme, and the New Partnership for African Development (NEPAD).

At institutional level, the Ministry of Lands, Environment, Forests, Water and Mines (MINITERE) is responsible for the formulation of laws and policies aimed at rational utilisation and environmental protection.
MINITERE closely collaborates with some ministerial departments, public institutions, research and educational institutions, international and non governmental organisations dealing with sectors related to environment including agriculture, meteorology, transports, communications, energy, industry, tourism, health and local administration.

1.2. Geophysical characteristics

Rwanda is geographically situated in Central Africa between 1°04’ and 2°51’ latitude south and 28°45’ and 31°15’ longitude east. It has an area of 26,228 km sq with an average density of 321 inhabitants per km sq and 433 inhabitants per km sq for physiological density.

1.2.1. Relief

Rwanda has an accidental and mountainous relief whose altitude varies between 900 m and 4,507 m. Elements of this relief are:

- Congo-Nile Crater overhanging Lake Kivu with an altitude varying between 2500 m and 3000 m. It is dominated to the North West by a range of 5 volcanoes of which Karisimbi is the highest with 4,507 m.
- The central plateau presents a relief of mountains with an altitude varying between 1500 m and 2000 m.
- The low lands of South west in the Bugarama plain of an altitude of 900 m which constitute an integral part of African Rift Valley tectonic depression.

A range of mountains "ibisi bya Huye"

1.2.2. The climate

Rwanda enjoys a moderate tropical climate due to its high altitude. Average temperature turns around 20°C with no significant differences. The rainfalls are abundant and we notice however that despite some irregularities. Wind is generally low about 1 to 3 m/s.

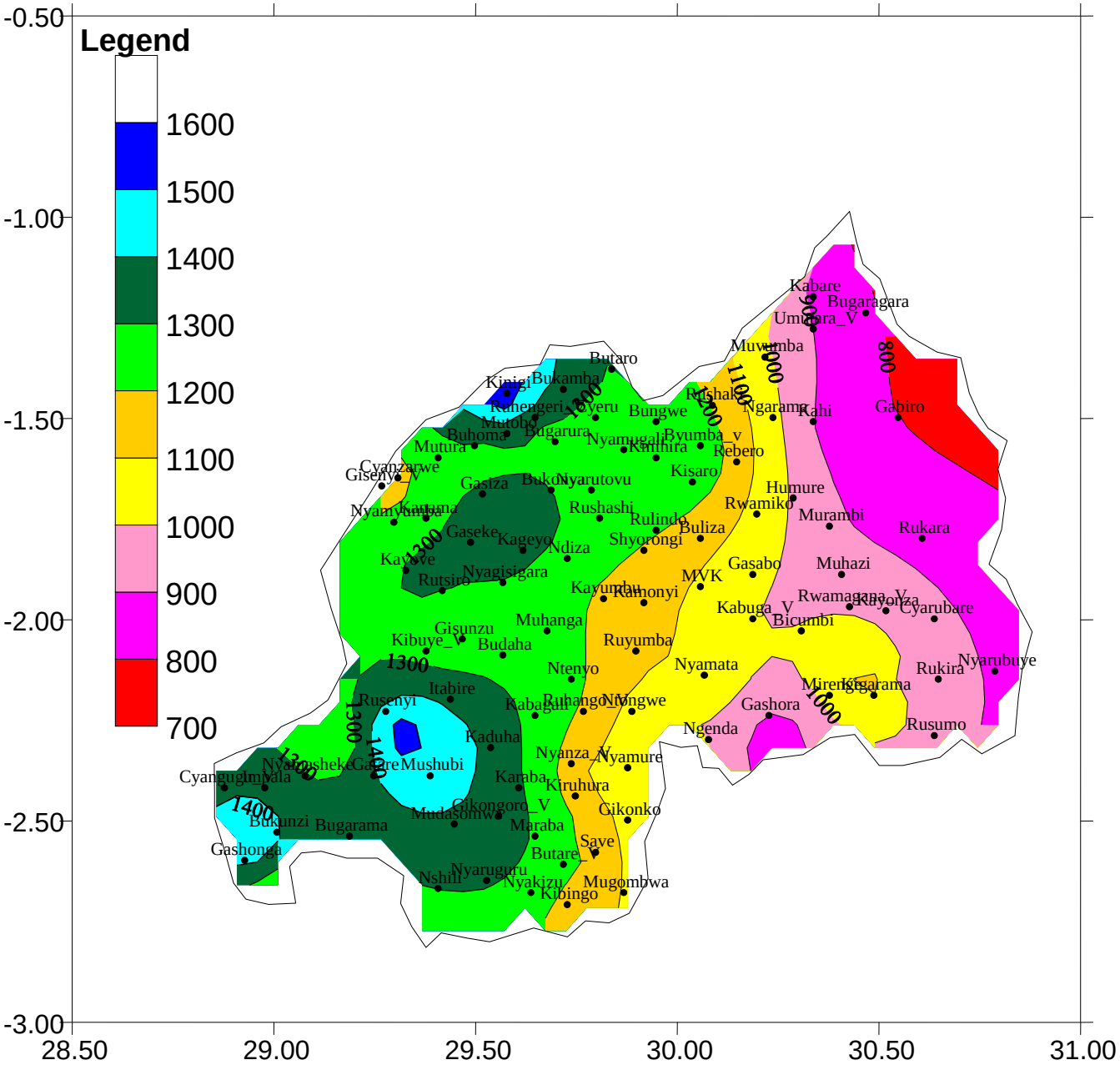
In high regions of Congo-Nile crater, temperatures vary between 15° and 17°C with abundant rains. The volcanoes region has lower temperatures reaching less than 0°C in some areas.

In intermediary altitude zones, temperatures vary between 19 to 29°C with an average rainfall of about 1000 mm/year. Rainfalls are less regular which sometimes lead to dry periods.

In low altitude zones (East and South East), temperatures are higher and the highest can reach 30°C in February and July-August. Maximum absolute temperature of 32.8°C was registered at Karama–Plateau station in South East at 4th September 1980. Temperature contrasts are more pronounced comparatively in the rest of the country. Rainfalls are less abundant (700 to 970 mm/year).

It is the rhythm of rainfalls which determines seasons in Rwanda. Hence the climate of the country is characterised by an alternation of four seasons, two rainy and two dry seasons. There is however a fact that rains are generally distributed on the whole year regardless of some irregularities.

Diag 1: Annual distribution of average rainfalls (1961-1990)[1]



[1] Service météorologique national

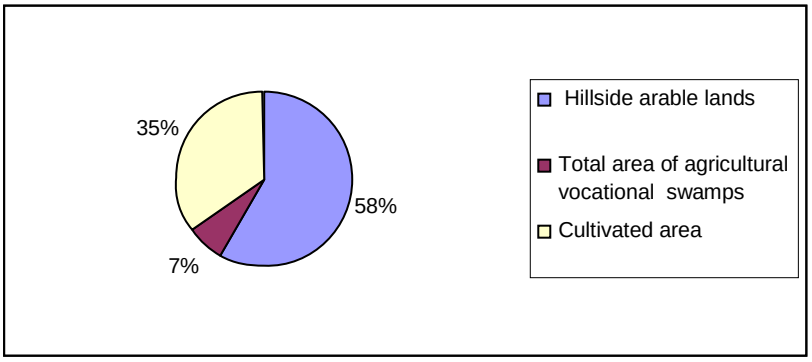
1.3. Natural Resources

1.3.1. Soil and subsoil

Lands exploitation employs 91.9 % of active population. On a total area of 26,338 km sq, only 52 % are arable i.e. about 1,385,000 hectares (diag 2). Agricultural vocation swamps add to this area about 100,000 hectares land resource is therefore very limited and very precious.

Currently, viable land available is about 0.60 ha per family agricultural exploitation and this leads to overexploitation and often poor land use with negative consequences on land resources and environment in general.

Diag 2: Distribution of arable land in 2002



The pedology of Rwanda is characterised by six types of soil including:

- Soils deriving from schistose formations, sandstone and quartzites (50%);
- Soils deriving from granite and gneiss (20%);
- Soils deriving from intrusive basic rocks (10%);
- Soils deriving from recent volcanic materials (10%);
- Soils deriving from old volcanic materials (4%);
- Alluvial and colluvial soils (6%).

Rwanda stratum contains mineral deposits such as cassiterite, wolfram, Colombo tantalite, gold and quarry. From 1999 to 2001 mine sector played an important role in the national economy. It contributed to exports revenues in the following proportions[2]: 5.9 % in 1999; 12.58 % in 2000; 42.64 % in 2001.

1.3.2. Hydrology

Rwanda has a very dense hydrographical network $\pm$ 2 km/km sq (Diag 3). It is divided into two hydrographical basins by a land mark line of waters known as Congo-Nile crater from North to South and more or less perpendicular to volcanoes line, natural obstacles towards North Kivu and South west Uganda.

At the East of Congo-Nile crater is the Nile basin which covers 67 % of the total national territory and drains 90 % of Rwandan waters through two main water streams namely Nyabarongo and Akagera. The latter is the main affluent of lake Victoria with an average flow of 256 m^3/s hence, considered as the main source of Nile. Nile basin overflows many small lakes

[2] MINECOFIN, Indicateurs de développement du Rwanda, Août 2002

(Bulera, Ruhondo, Cyohoha South, Mugesera, Muhazi, Rwampanga, Mihindi, Mirayi and others). These lakes are not deep (5 to 7 m depth) except Bulera and Ruhondo which are 50 to 70 m depth.

Congo basin (33% of National area) drains 10 % of Rwandan water resources. It comprises of Sebeya, Koko, Rubyiro rivers as affluents of Lake Kivu (102,800 ha of the Rwandan part) Ruhwa, Rusizi and other small rivers.

Lake Kivu (altitude 1463 m)

Average flows tryearsiting through hydrologic stations are mainly :
73 m^3/s (Nyabarongo at Kigali), 100 m^3/s (Nyabarongo at Kanzenze), 232 m^3/s (Akagera at Rusumo) and 256 m^3/s (Akagera at Kagitumba).

During high waters taking into account the widening of Nyabarongo valley with a slope of swamps about 1 %, there is a serious water flooding.

Diag 3 : Nyabarongo basin slope at Kigali

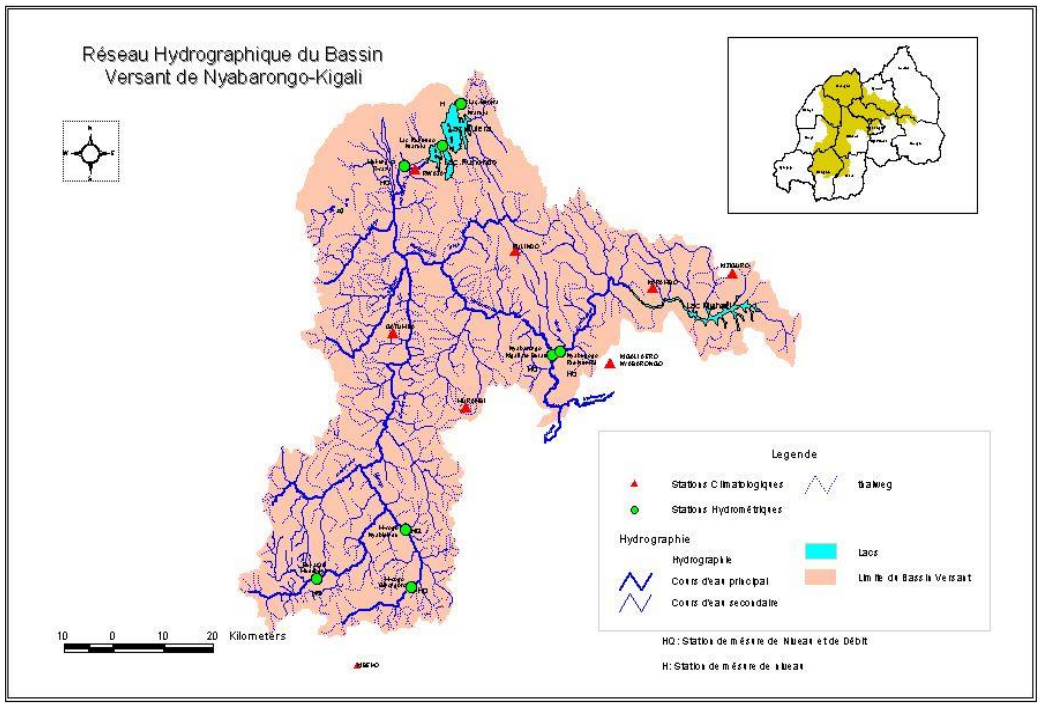
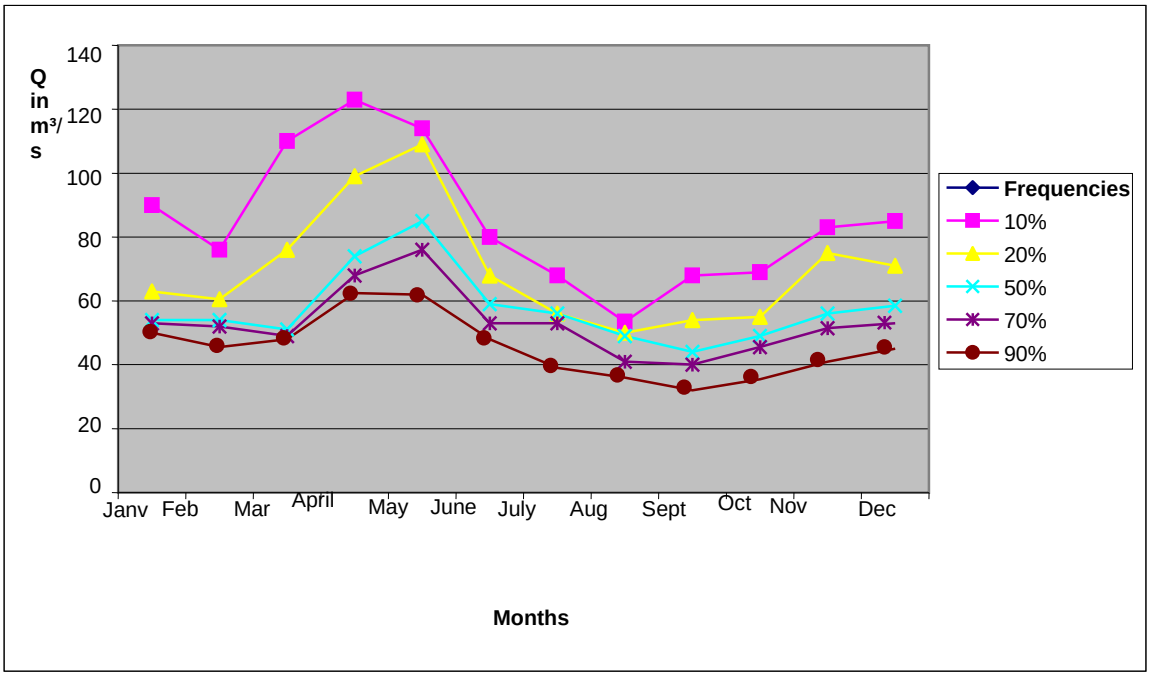


Table 1 : Morphometric characteristics of basin slopes of Nyabarongo – Kigali and Sebeya - Gisenyi

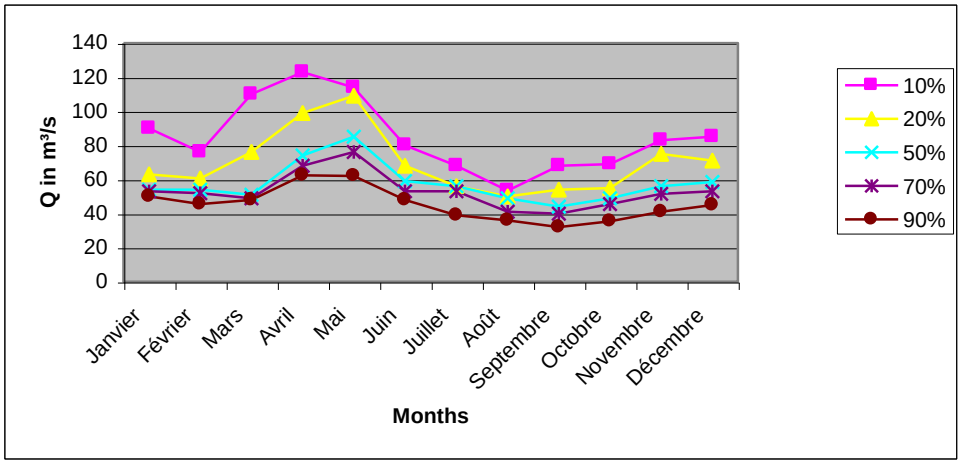
River	Receiver	SBV in Kmsq			Perim in Km	Kc	Altitude in m			Pluvio in m	Slope %	Qmoy m^3/s	H in mm	Cr %	Qs 1/s/Km sq
			L	l											
Nyaba- Kigali	Akagera	8900	207	43	500	1.5	3000	1352	2176	1350	0.8	83	294	22	9.3
Sebeya/Gisenyi	Lake Kivu	320	25	13	76	1.2	2700	1460	2080	1300	5	3.3	325	25	10.3

N.B. : **Nyaba** : Nyabarongo, **S.B.V.** : Area of basin slope, **L** : Length in Km, **l** : Wide in Km
Perim : Perimeter in Km, **Kc** : Compact coefficient, **Pluvio** : Rainfall on BV,
Qmoy: Average flow in m^3/s, **H** : Flowing water strip, **Cr** : Flowing coefficient, **Qs** : Specific flow

Diag 4: Frequency curves of monthly maxima flows at Nyabarongo – Kigali (1974-1990)



Diag 5: Frequency curves of monthly minima flows at Nyabarongo–Kigali (1974-1990)



Diagrams 4 & 5 show the behaviours of maxima and minima monthly flows on a serie of 17 years. Taking into account the heights of river banks which are 4 m, the flood limit is reached and corresponds to a flow of 210 m^3/s with a frequency of 50% during the big rainy season. Flood can happen again during the small rainy season with a frequency of 10% and 20% of cases. During the big dry season from July to September, extreme minima flows reach 32 – 36 m^3/s with 90% frequency, which indicate a high drought and a strong need of water for socio-economic activities.

Table 2: Possible low water mark and floods of Nyabarongo at Kigali with confidence interval at 90 %.

Kigali Nyabarongo Station / Return time	2 years	5 years	10 years	25 years	50 years	100 years
Floods	236.0	289.8	325.5	370.6	404.1	437.3
Low water	56.5	43.4	37.2	31.5	27.8	25.4

Table 3 : Possible floods of Sebeya at Gisenyi with confidence interval at 90%

Kigali Nyabarongo Station / Return time	2 years	5 years	10 years	25 years	50 years	100 years
Floods	11.9	14.3	15.9	17.4	19.4	20.9
Low water	0.99	0.59	0.43	0.30	0.22	0.18

On the basis of maximal and minima [3] flows data on the river Nyabarongo at Kigali (1974 - 1990) and Sebeya at Gisenyi (1951-1988) , the tables 2 and 3 give the values of possible floods and low water mark for the recurrence period of 2 years , 5 years, 10 years, 25 years, 50 years, 100 years.

Concerning underground water, some project[4] data estimates are 600 m^3/s with a renewable flow of available resource.
Table 4 shows a summary of available resource after the dry season which represents quantities in underground water.

Table 4: water availability after the main dry season

River	Low water flows (m^3/s)	Flow from outside (m^3/s)	Flow from lakes & swamps(m^3/s)	Flow from aquiferous (m^3/s)
AKAGERA at Rusumo (Nyabarongo + Akanyaru)	81.2	16.2	8.1	56.9
KAGITUMBA at Kagitumba	4.0	2.0	-	2.0
Rivers flowing in lake Kivu	7.0	-	-	7.0
Total of available water resources (m^3/s)				65.9

Source : Water and Sanitation Directorate

Water quality

In Rwanda, the quality of water is good in general with a pH= 6-7.5. However, surface waters are often sedimented and in mining and volcanic regions these waters can contain arsenic, lead, mercury, iods and other toxic metalloids and heavy metals.

Nyabarongo at the border of Kibuye and Gitarama Provinces

Water hyacinth at Nyabarongo river

Water physico-chemical pollution is not frequent due to weak level of industrialisation and agricultural inputs use.
Microbiological pollution is often observed and comes from various wastes and house holds rejects from rains to natural areas.
Water banks and lake water pollution by water hyacinth and other raiding aquatic plants is a very recent and alarming phenomenon in Rwanda.

[3] Service hydrologique national
[4] Direction de l'Eau et de l'Assainissement

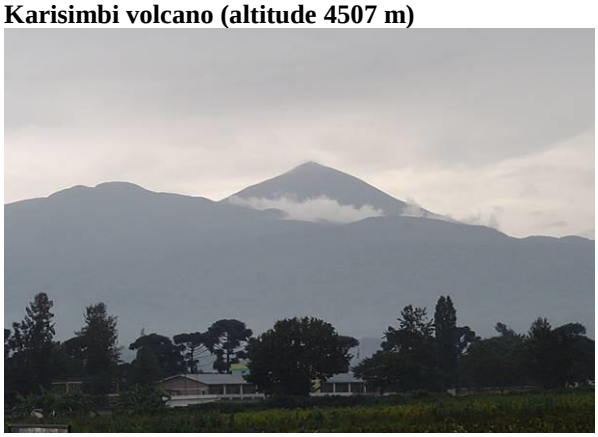
1.4. Biodiversity

Rwanda is covered by a diversified ecosystems : natural ecosystems constituted of ombrophile mountain forests, gallery forests, savannah, wet and aquatic areas, afforestation and agro-ecosystems. All these ecosystems host a rich fauna and flora.

1.4.1. Protected areas

The Volcano National Park (PNV) has become a worldwide celebrity due to the Mountain gorillas (Mountain gorilla beringeri) an endemic primate of the high mountain zone of Rift Albertin of which became among the World Biosphere Reserve in Main and Biosphere (MAB) UNESCO programme.
Apart from this spectacular animal, the PNV hosts a variety of many vegetal and animal population species.

Karisimbi volcano (altitude 4507 m)



The park hosts more than 245 species of plants including 13 orchid species, namely disastarsii, polystachya kermessia, calanthes sylvatica, chamaengis sarcophylla, cyrtorchis arcuata, habenaria praestyears, stolzia cupuligera, eulophia horsfallii, etc …

The PNV vegetation is strated :

- The first stratum is a mountain forest situated between 1800 and 2500 m following massif volcanic.
- Stratum of pure bambous of Sinarundinaria alpina which is situated between 2600 and 3200 m. At this level the dense subwood is limited to one herbaced stratum composed especially of senecio trichopterygius, gallium ruenzoriense, impatiens burtonii, rumex Abyssinia, urtica massaica and some grasses.
- Subalpin stratum starts from 3200 m and climbs to 3700 m or 4000 m of altitude depending on the inclination of slopes. At this point, two types of vegetation are clearly different : Ericetum, senecons and lobelies zones.
- Afro-alpin stratum comes after 400 m and few plants survive there namely ferns (asplenium, pterdium), immortals (hilichrysum erici-rosenii, guilelmii) and alchemilla (alchemilla cryptantha, alchemilla cinerea).

Nyungwe National Park[5] is the africa's largest mountain ombrophile forest with an area of 924 km sq (year 2000).
It hosts:

[5] Biodiversity surveys of the Nyungwe forest reserve in S.W.Rwanda, working paper N° 19, July 2002

- More than 1200 ferns species and 133 orchid species;
- More than 250 ligneous species including 10 tree species;
- More than 275 birds of which only 24 are endemic to Rift Albertin where the Nyungwe Park is ranked among the world most important zones for birds conservation;
- Thirteen types of primates constitute 1/5 of Africa's primate species;
- Angola colobus (colobus angolensis) is visible in stable groups from 300 to 400 individuals; it is an ecological attribute well known in Nyungwe that is found no where else in the world for arboreal monkey species.

Nyungwe National Park.

Akagera National Park is situated in the East of the country. It covers an area of about 90.000 ha and hosts many plants, mammals, amphibiyears and reptile species.
It has a whole vegetal formations diversity including more than 900 species of plants of which 6 orchids internationally protected. The major part of the space is covered by bushy and treelike savannahs with acacias cambretum where one finds local groves on termitaries.
Acacia senegalensis is generally dominant. In more arid zones of Akagera National Park, the vegetation tends to an association of Acacia – commiphora, while in the most wet zones, Acacia senegalensis tends to be replaced by Acacia polycantha and acacia sieberanna.
Grassy savannahs mainly include Themeda, Hyparrhenia, Sporobolus and Botriochloa. The Akagera National Park (PNA) fauna constitutes its main attraction. It comprises 47 species of big mammals more than 500 species of birds, 9 species of amphibiyears and species of reptiles.
In this park, 4 animal species are protected by the convention on International trade of Endangered species (CITES) including Loxodonta Africana, sincerus caffer, panthera leo and Tragelaphus oryx.

1.4.2. Relict and gallery forests

Gishwati forest situated at 2000 – 3000 m altitude was extended to 21,000 ha before being converted into pastures on 5,000 ha by sulvo-pastoral project GBK from 1981. With the return of old case refugees from 1995, this forest was illegally occupied at 95% by old case refugees.
In 2000, Rwanda Government decided to give 3000 ha for reinstallation of these refugees in organised plots of about 1 ha each. Hence remaining with only 13,000 ha of Gishwati natural forest.

Mukura Natural Forest[6] is similar to Gishwati in terms of tree species and its altitude situation of 2000 – 3000 m.

[6] Plan d'action pour la conservation de la réserve forestière de Mukura 2004-2008, ARECO 2004

In terms of biological diversity, Mukura is poorer than the remaining part of Gishwati. The reduction of its area leads to biological diversity in available micro organic varieties.

Relict forests and Eastern Savannah : situated around Akagera National Park host a number of endemic and rare species mainly used in traditional medicine.

Galery forests host an important biodiversity with endemic and rare species. The most important in area among those gallery forests is Ibanda-Makera. This presents a particular interest for the population because it hosts vegetal species used in traditional medicine, food and other survival activities for local population.
Some available plants in gallery forests are subject to research in modern pharmacopeia. This is for example the case of Blighia unijugata, Grewia forbese, Rhus vulgaris, Pterygota mildbraedii and Ficus species.

1.4.3. Afforestation

Afforestations have been put in place starting from 1920 and are mainly made of Eucalyptus and agro forestry species such as Grevillea, Cedrella and Calliandra.

1.4.4. Agro ecosystems

In Rwanda agro pastoral space covers more than 70% of the country. Cashcrops including beans, maize, sweet potatoes, Irish potatoes, Sorghum, banana, etc) and industrial products namely coffee, tea and pyrethrium.
Livestock is mainly extensive and traditional and practiced in the family. Among grown races in Rwanda include exotic races for bovines and caprines.

1.4.5. Wet zones biodiversity

About 104 species of flora and many species of fauna have been registered in wet zones.

1.5. Socio-economic data

Rwanda has currently 8,162,715 inhabitants[7] for an area of 26,338 km sq i.e. a physical density of 309 inhabitants /km sq (general population census of August 2002). It is ranked among the poorest countries in the world. About 50% of the population is aged less than 16 years and 90% live in rural areas. The gross domestic product of Rwanda is dominated by Agricultural sector. In 2002, the part of agriculture in the GDP was 43%, industry 19% and 37% for services.

[7] Recensement général de la population et de l'habitat, août 2002

Diag. 6: GDP composition, 2002

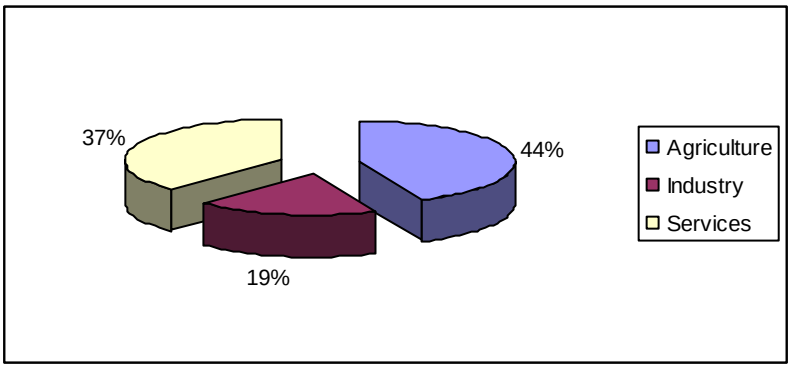


Table 5: Socio-economic indicators[8]

Socio-economic indicators	1980	1990	2000	2002
Population (million)	5 .163	6.879	8.5	8.162715
% female	-	51.3	53.5	52.3
Fecondity rate	8.3	6.9	6.5	5.6
Maternal mortality rate (for 100.000 births)	-	1300	1300	1071
Annual growth rate (%)	3.1	3.1	1.2	1.2
Poverty rate (%)	40	53	60	60
Life expectancy	46	49.5	49	49
Infant mortality (per 1000 births)	128	85	107	107
Mortality less than 5 years (per 1000 births)	224	150	198	196
VIH/SIDA prevalence (below 15-49 years)	-	-	13.7	
VIH/SIDA prevalence (more than 12 years) : in rural areas	-	-	10.8	
VIH/SIDA prevalence (more than 12 years) : in urban areas)		-	11.6	
Gross primary enrolment	63	70	100	103,7
% of girls total enrolment	48.0	49.6	49.6	50.2
Net primary enrolment	-	-	73.3	74.5
Gross secondary enrolment	3.0	8.0	10.2	13.9
% total girls enrolment	33.3	39.9	50.67	74.9
Higher education : % girls of girls in total enrolment	8.2	16.6	26.9	52.5

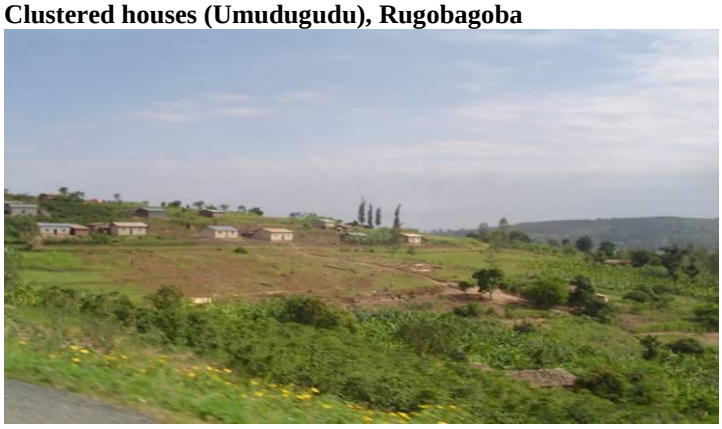
1.5.1. Social establishments

Rural habitat in Rwanda has been for a long time and remains dispersed. It has long been characterised by disorganised occupation of the space affecting environment by land misuse and soil erosion. In 2004, the government adopted a national policy on habitat aimed at improved clustered model commonly known as "Imidugudu" and fulfilling environmental viability criteria through national space reorganisation, land reform as well as to increase housing quality.

Urban development policy is under completion and is aimed at discouraging squatter's proliferation. Valuable efforts have been put in the preparation of town master plan, to solve problems caused by squatters.

[8] MINECOFIN, Edition n°5, août 2002: Indicateurs de développement économique

Clustered houses (Umudugudu), Rugobagoba



1.5.2. Energy and Transport

In Rwanda, biomass constitutes the major source of energy because it covers 94 % of national[9] needs. Firewood and plant wastes are the major sources used in households, industries and crafts.

Charcoal transport

However, the country has other sources of alternative energy not yet exploited including peat estimated at 155 million tons, methane gas in Lake Kivu which represents 57 billion m3 and solar energy.

Hydro electric stations in Rwanda produce only 4 % of total energy consumed while the country has an important hydroelectric potential from its rich hydrographical network.

Important petroleum products are used at 80 % in land transport including, petrol super, gas oil, lubrificants and others.

Transports sector is generally dominated by road transport which covers 14,000 km of roads and tracks. In the Air transport sub sector, the country has two international airports and three airstrips for internal transport. Maritime transport is mainly practised on Lake Kivu linking Gisenyi, Kibuye and Cyangugu provinces.

[9] MININFRA, Direction de l'Energie

At the end of the year 2002, automobile park[10] statistics were distributed as follows: 5 vehicles per 1000 people, 3 vehicles per road km, 1 passenger car for 1000 people, one bicycle for 1000 people, and 1 motorcycle for 3000 people. The total number of operational registered vehicles by 31/12/2003 was : 2925 motorcycles, 7846 small cars, 4759 pickups, 1145 lorries, 3458 jeeps, 2496 minibuses, 289 tracks, 61 semitracts, 24 tractors, 46 buses and 18 microbuses (source : Directorate of Transports, MININFRA).
Importation of second hand cars especially MINIBUSES is becoming more and more dominant and their average age is ten years. Kigali, the capital has more than 70% of the total vehicles.

Taxes on vehicle imports are based on some factors including the year of fabrication. In fact, the older the vehicle, the less the importation tax. Taxes on vehicle importation fixed by the Rwanda Revenue Authority depend on many factors but the basic is the power of the vehicle cc engine in terms of horsepower. The year of fabrication of vehicles has no impact on the taxes.
However, in determining insurance fee, insurance companies consider the year of vehicle fabrication as follows: A brand new vehicle up to 5 years pays less insurance fee. A car old from 5 to 10 years pays 10% less every year compared to the new vehicle of the same type and same category, etc

1.5.3. Industry

Rwandan industrial tissue is modest and recent: 78% of industrial enterprises were created between 1964 and 1987. The contribution of industrial sector to GDP is about 20% of which, the majority is agro-industry and others in the category of small and middle enterprises which produce consumption goods of imports substitution using simple technologies. Cement industry and lime production (table 6 & 7) constitute the main source of greenhouse gas emissions.

Cement production for the period between 1990 and 2002 is as follows:

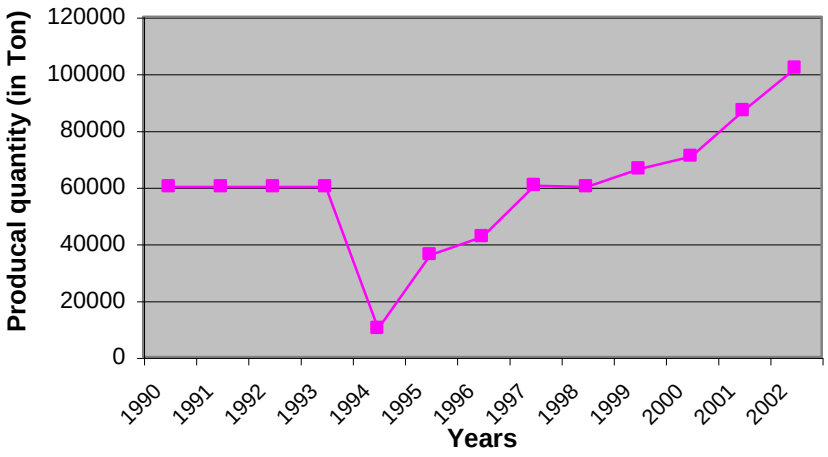
Table 6 : Cement production by CIMERWA (Rwanda cement factory)

Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Production (Tons)	60000	60000	60000	60000	10000	36000	42452	60505	60030	66291	70716	86828	101786

The diagram 7 shows how the annual production of cement has gone down from 60,000 tons in 1993 to 10,000 tons in 1994 due to war. After the war, the tendency of the production is increasing progressively to the extent of reaching 100,786 tons in 2002.

[10] MININFRA, Direction des Transports

Diag. 7: Cement production by CIMERWA



During the period from 1996 to 2002, the lime production (in tons) is as follows:

Table 7: lime production

Producer / Year	PVC	ALICOMEC	APC Mashyuza	COCOCHAUMA	Total quantity
1996	1214	-	-	-	1214
1997	1214	-	-	-	1214
1998	479	-	-	-	479
1999	763	499	268	270	1800
2000	824	895	333	211	2263
2001	664	1294	412	252	2622
2002	-	1929	450	203	2582

From 1996 to 2002, lime annual production doubled, from 1214 to 2582 tons.

1.5.4. Agriculture

Agriculture is the most important sector of the Rwandan economy and contributes for 43 % of the GDP. Coffee and tea are the major export products with about 49 millions US$ of 1998 export revenues. In 2002, export revenues of tea were 18 millions US$.

Tea plantation at Gisakura at the border with Nyungwe National Forest

The agricultural production system is based on small family exploitations for self consumption over 80 %. These agricultural systems are complicated, based on diversification of productions and associations of products. Seven major products including banana, beans, maize, sweet potato, cassava, sorghum, Irish potato of which the first five are found on 90 % of production units[11], constitute Rwandan staple food in all regions (MINAGRI 1998).
The poor utilisation of fertilisers (less than 3 kg/ha) and pesticides, the weak level of equipment, land limited application of technologies and research are translated into mediocre production very sensitive to climate hazards.

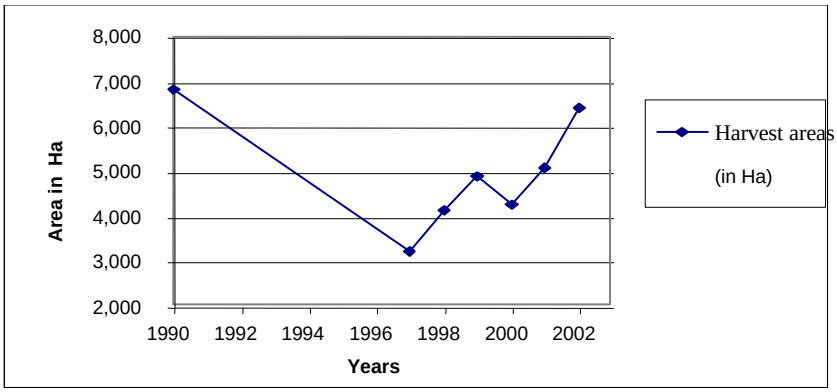
Dimensions of familial agricultural exploitations vary from 0.5 ha (34 % of farms) to more than 2 ha (16 %) (MINAGRI 2001). Average family agricultural exploitations is 0.71 ha. In 2001 at national level 63 % of households had less than 0.75 ha.

Family agricultural exploitation

1.5.4.1. Rice growing

Rice growing is exclusively practiced on mineral soils, mainly in permanent irrigation and floods. The analysis of evolution of harvested areas according to MINAGRI Report (2002) reveals a dramatic drop of rice growing during the social political crisis period between 1990 and 1994. However, rice production has increased progressively in relation to planted areas from 1997.

Diag 8: Evolution of harvested rice forms areas



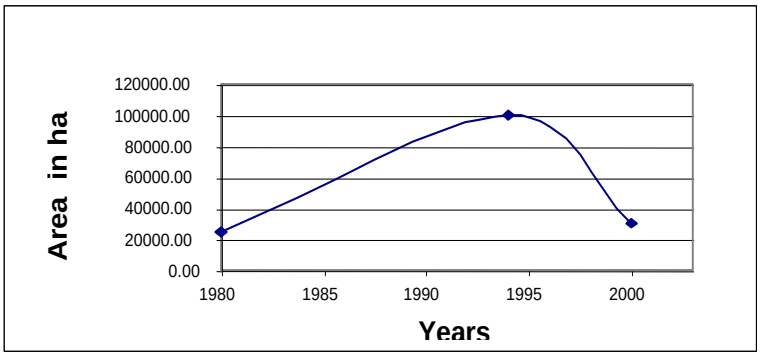
[11] MINAGRI, 1998

1.5.4.2. Controlled savannah burning

Savannah zone in Rwanda covers for the major part, the former Akagera National Park in its borders before 1994, i.e. about 250,000 ha[12].

About 10 % of former Akagera National Park i.e. 250,000 ha is the savannah area annually burnt during the 1980's year. After 1994, the area of pastures estimated at 14 % is annually put under fire about 26,500 ha.

Diag 9: Evolution of burnt savannah area

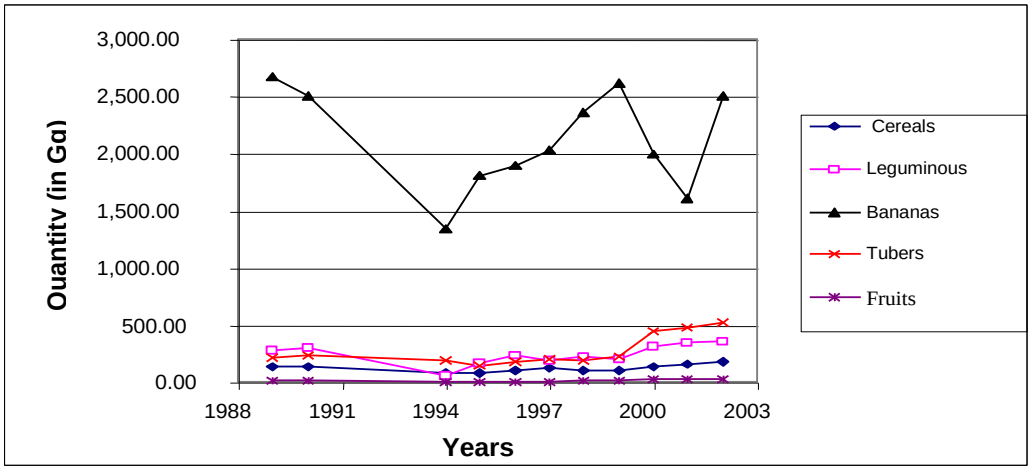


1.5.4.3. Burning of harvest wastes

Burning harvest wastes is one source of methane emissions, carbon monoxide, nitrous oxide and nitrogen oxide emissions.

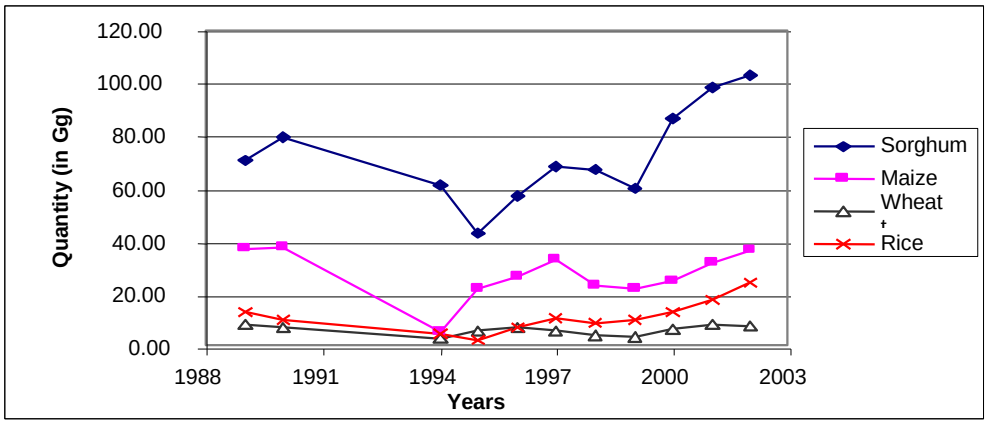
Diag. 10 to 13 show related parts to each group of cash crops assuming that burnt wastes are always proportional to consumable products tons, bananas are far more suppliers of agricultural wastes followed by leguminous plants and tubers.

Diag 10: Evolution of harvest wastes production, MINAGRI 2002

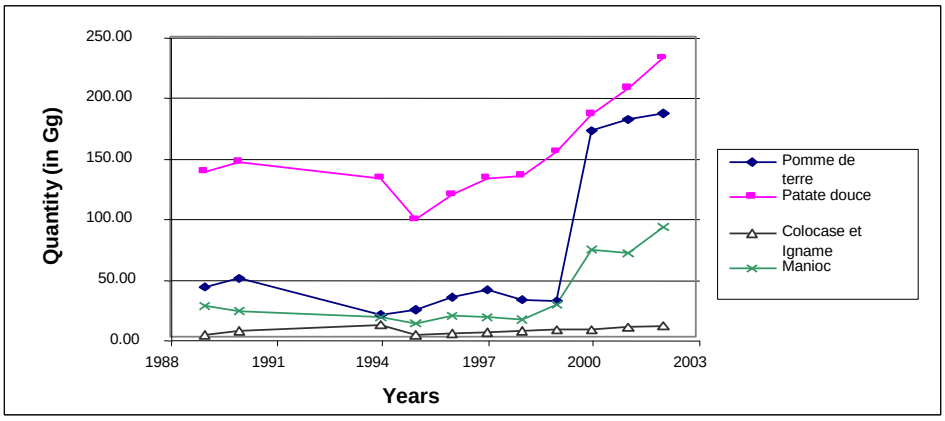


[12] MINECOFIN, 2001

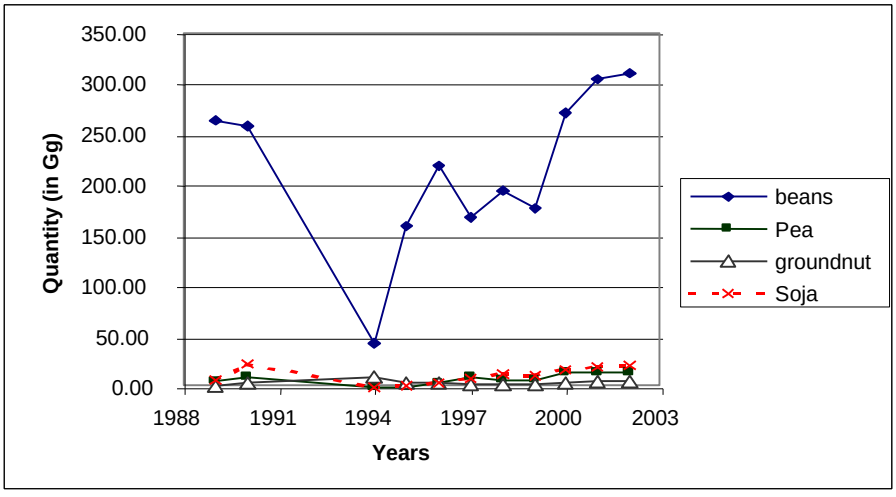
Diag 11: : Evolution of tuber wastes production, MINAGRI 2002



Diag 12 : Evolution de la production des résidus de tubercules, MINAGRI 2002



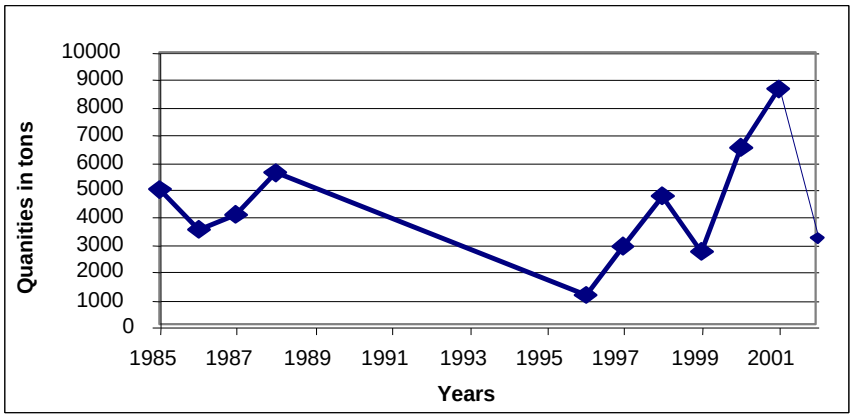
Diag 13: Evolution of leguminous wastes production, MINAGRI 2002



1.5.4.4. Cultivated soil

Exploited organic soil estimated at 7,600 ha and located in swamps and slums. Importation of inorganic fertilisers has considerably increased from the year 2000.

Diag 14: Evolution of artificial fertiliser imports in Rwanda
SEWS NET (1989 & 2001) and MINAGRI (2002



1.5.4.5. LIVESTOCK

Livestock especially bovines is extensive in major parts. Middle production is in average one litre/cow/day. For 185 days of milking (MINAGRI, 2001).

Ankole cows

Pastures are essentially constituted of family fallows and marginal lands considered appropriate for agriculture such as undergrowths. The demographic pressure grows progressively towards semi-intensification or intensification of grains resources used in animal feeding.

The little areas available for pastures remaining are misused because farmers do not master the management of pastures. This is translated in over pasturing and overexploitation leading to stagnation, degradation and disappearance of vegetal cover.
Permanent stalling, semi stalling and extensive livestock constitute the three main modes of livestock. The following diagram gives an idea of their distribution.

Table 8: Households practices per animal species (in % of households), MINAGRI, 2002.

Species / Mode de régie	Bovines	Caprines	Ovines	Porcines	Poultry	Lapines
Semi-stabulation or permanent	65.0	40.0	61.9	93.5	21.9	80.7
Out of stabulation	35.0	60.0	38.1	6.5	78.1	19.3

Diag 15: Evolution of domestic livestock between 1985 to 2002, MINAGRI 2002

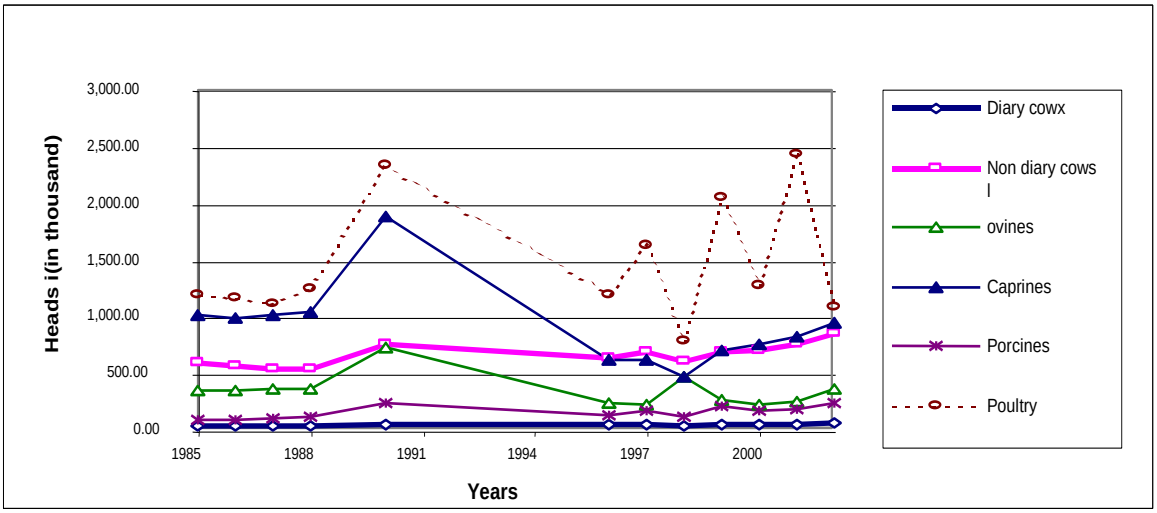


Diagram 15 shows an increase of the domestic livestock between the year 1988 and 1990. The following years, from 1991 to 1996, the number of the domestic livestock highly decreased due to war, genocide and their consequences.

1.6. Forests

The National Forestry cover is estimated to 527,863 ha in 2001 i.e. a cover rate of 20.05% of the total area of Rwanda. On a period of 41 years, the areas of natural forests have passed from 634,000 ha to 221,200 ha i.e. a decrease of 65.11% between 1960 and 2002. This situation results from many factors such as clearing the forest in search of arable lands, abusive exploitation of forests, mismanagement, etc.

Nyungwe National Park

Table 9: Evolution of big forests and forest plantations area in ha from 1960 to 2002, MINAGRI 2002

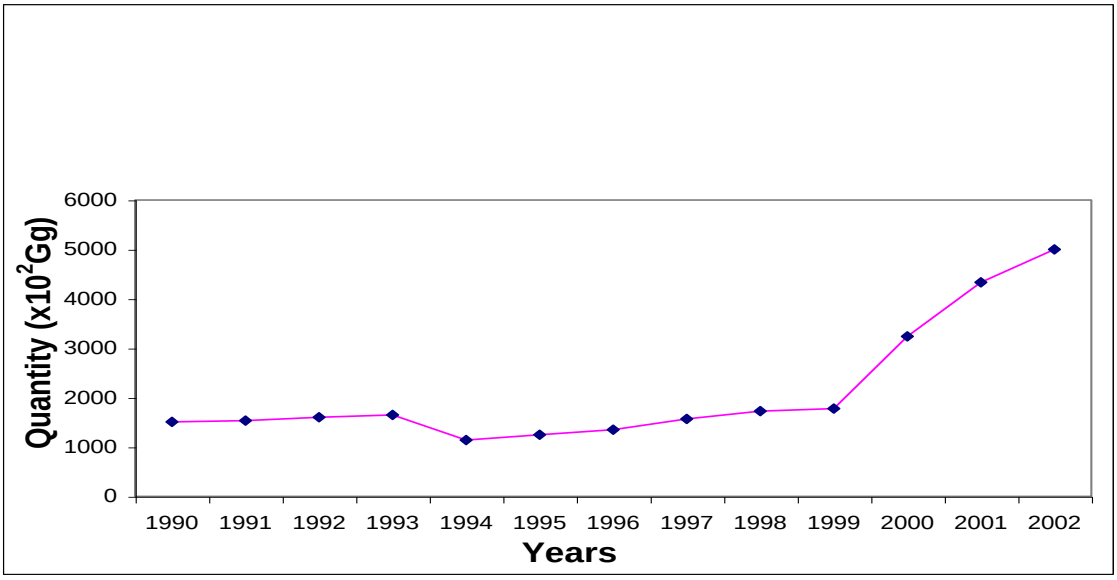
Categories	Forests type	Area in ha								
		1960	1970	1980	1990	1996	1999	2000	2001	2002
Natural Forests	Nyungwe+Cyamudongo	114,000	108,800	97,500	97,500	94,500	92,400	92,400	92,400	92,400
	Gishwati	28,000	28,000	23,000	8,800	3,800	600	600	600	600
	Mukura	3,000	3,000	2,100	2,100	1,600	1,200	1,200	1,200	1,200
	Volcano park	34,000	16,000	15,000	12,760	12,760	12,000	12,000	12,000	12,000
	Akagera park	241,000	241,000	241,000	241,000	241,000	90,000	90,000	90,000	90,000
	Hunting area	64.000	45.000	45.000	34.000	0	0	0	0	0
	Eastern gallery forests	150.000	150.000	90.000	55.000	30.000	25.000	25.000	25.000	25.000
Forest plantations	Forest plantations	24.500	27.160	80.000	247500	232.500	252.000	282.563	306.663	306.663

1.7. Wastes

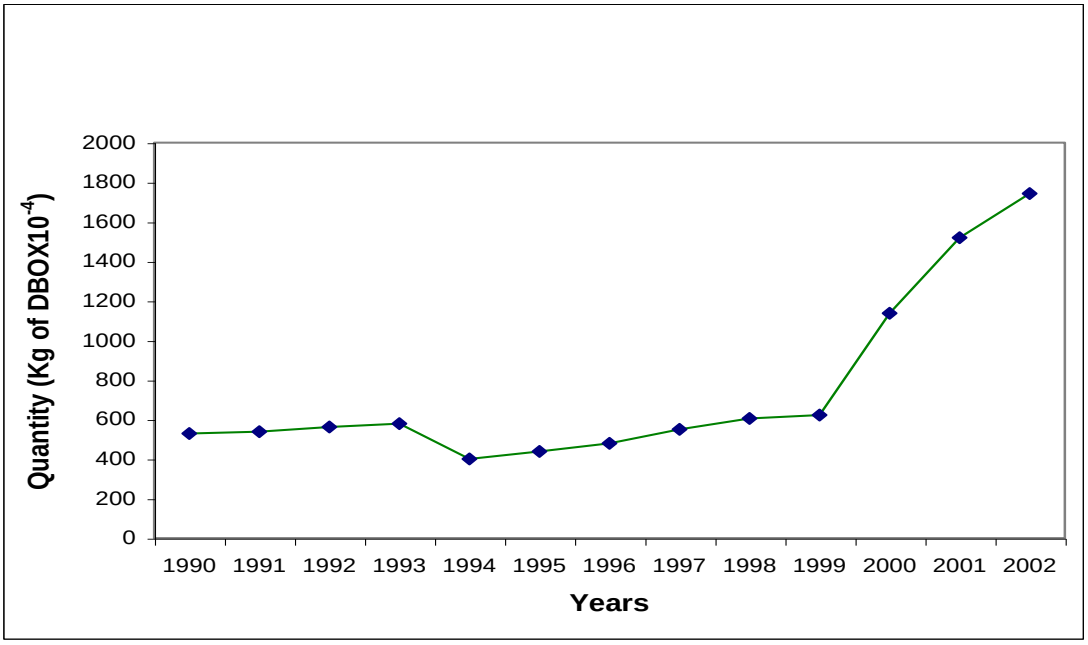
Solid wastes are distributed in municipal solid wastes (MSW) and industrial solid wastes. The former include household refuse, commercial wastes and public wastes, the second include wastes close to municipal solid wastes, specific wastes related to fabrication processes and fabrication of sub products.

Evolution of solid wastes production (kg/day/inhab.) and wastewaters (kg/DBO/1000 persons/year) from 1990 to 2002 in relation to urban population is shown on diag 16 and 17.

Diag 16: Evolution of solid wastes production from 1990 to 2002 in urban areas of Rwanda



Diag 17: Evolution of wastewaters production from 1990 to 2002 in urban areas of Rwanda



Figures 16 and 17 show that the quantities of solid wastes and used waters increased exponentially from the year 1995. This is justified by the 1990-1994 post war circumstances and the April 1994 genocide which provoked the rural exodus towards urban centres and the development after the rehabilitation period that followed the year 1999.

1.8. Education, Information and Research

Rwanda has adopted a system of education for all. However, there is poor integration of environmental education in primary, secondary and higher education programmes. Efforts and initiatives for environmental education are rare. There is neither a platform nor a forum of dialogue and coordination for environmental education activities.

Information plays an important role in sensitisation and awareness of the population to environmental problems and change of habits and attitudes vis-à-vis environment. The most used means to sensitise the population are radio, television, newspapers, spots and video-films.

Research in field of environment is essentially carried out in the following public institutions:

- Rwanda Institute of Agricultural sciences (ISAR);
- Technological and Scientific Research Institute (IRST);
- National University of Rwanda (UNR);
- Kigali Institute of Science, Technology and Management (KIST)
- Kigali Institute of Education (KIE)

CHAPTER 2: NATIONAL INVENTORY ON GREENHOUSE GAS (GHG) EMISSIONS

Features of greenhouse gases emissions non controlled by the Montreal protocol show their sources and sinks. Inventory of these gases constitute the major part of the Rwanda initial communication on the United Nations Framework convention on climate change (UNFCCC) and the same time, the foundation for all other activities carried out in this work.

The methodology used is the one proposed in the simplified handbook of guidelines of IPCC 1996 revised version for natural inventories of greenhouse gases. This methodology concerts of exploiting the existing documentation, data identification and collection, identification of human resources to be contacted, data analysis and validation.

Following tragic events of war and genocide from 1990 to 1994, the year 2002 was chosen as reference instead of the year 1994. Hence the calculation of greenhouse gases emissions was done according to default factors for the year 2002.

2.1. INVENTORY OF GREENHOUSE GAS EMISSIONS LINKED WITH ENERGY

2.1.1. CO_2 EMISSIONS

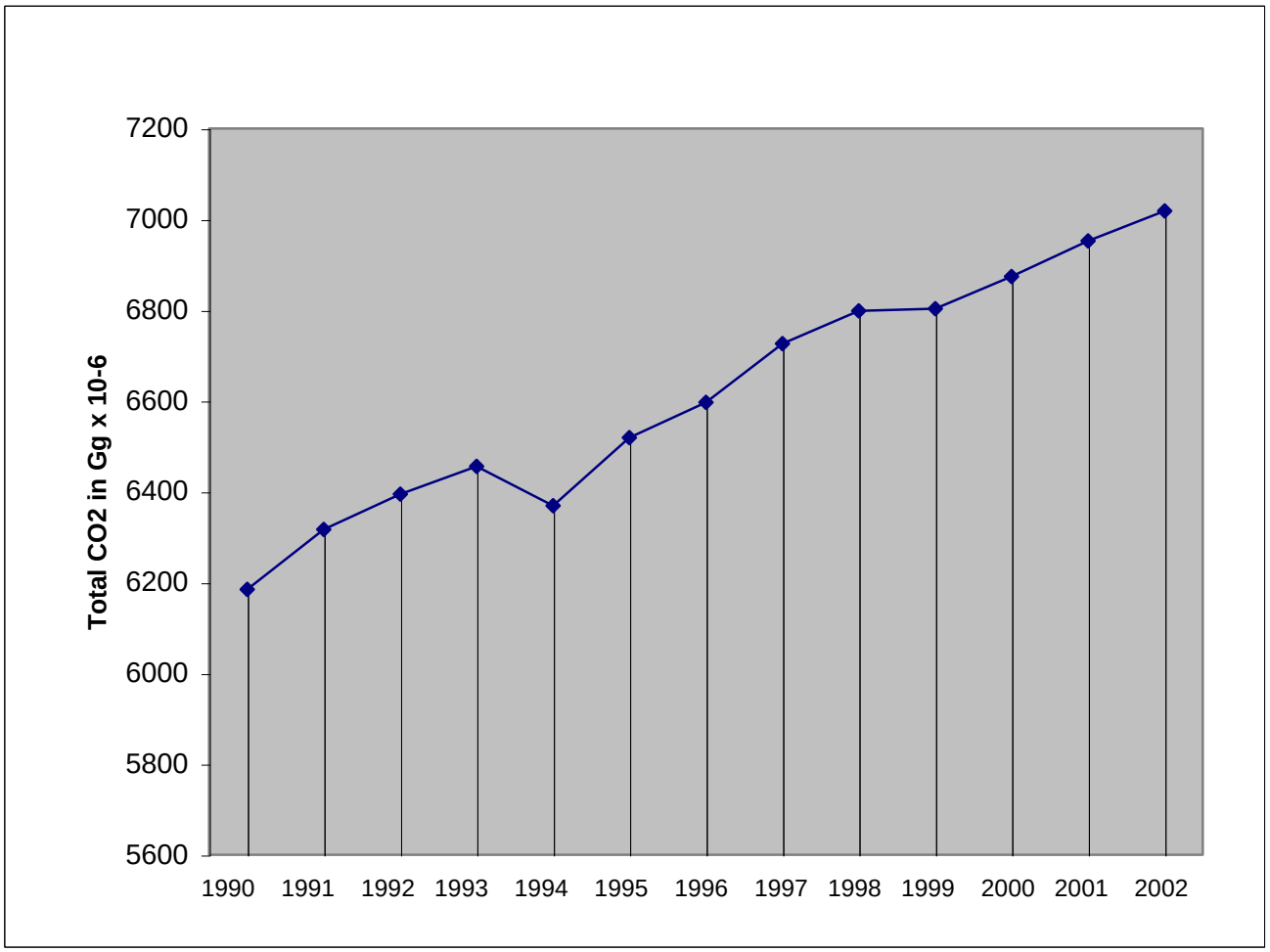
CO_2 emissions from 1990 to 2002 (table 10) taken into account deal with petroleum products used in land transport, household duties, industries and biomass.

TABLE 10 : CO_2 Emissions in Gg from 199 to 2002.

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Petroleum products	258.77	207.78	223.77	226.04	84.06	171.76	194.45	269.30	291.23	246.90	271.17	304.19	259.68
Fire wood	5713	5889	5922	5955	5977	5999	6013	6021	6019	6010	5991	5962	5918
Charcoal	213	220	249	275	308	348	389	436	488	546	612	686	770
TOTAL	**6184.77**	**6316.78**	**6394.77**	**6456.04**	**6369.06**	**6518.76**	**6596.45**	**6726.3**	**6798.23**	**6802.9**	**6874.17**	**6952.19**	**6947.68**

Inventory of CO_2 emissions from petroleum products shows an average increase of 12.33% of the phenomenon in time. The 1994 emissions decrease is justified by low imports of petroleum products during the April to July 1994 war. The more the automobile park increases the more the consumption of hydrocarbons increases.

Diag 18: Total of CO_2 Emissions in Gg CO_2 from 1990 to 2002



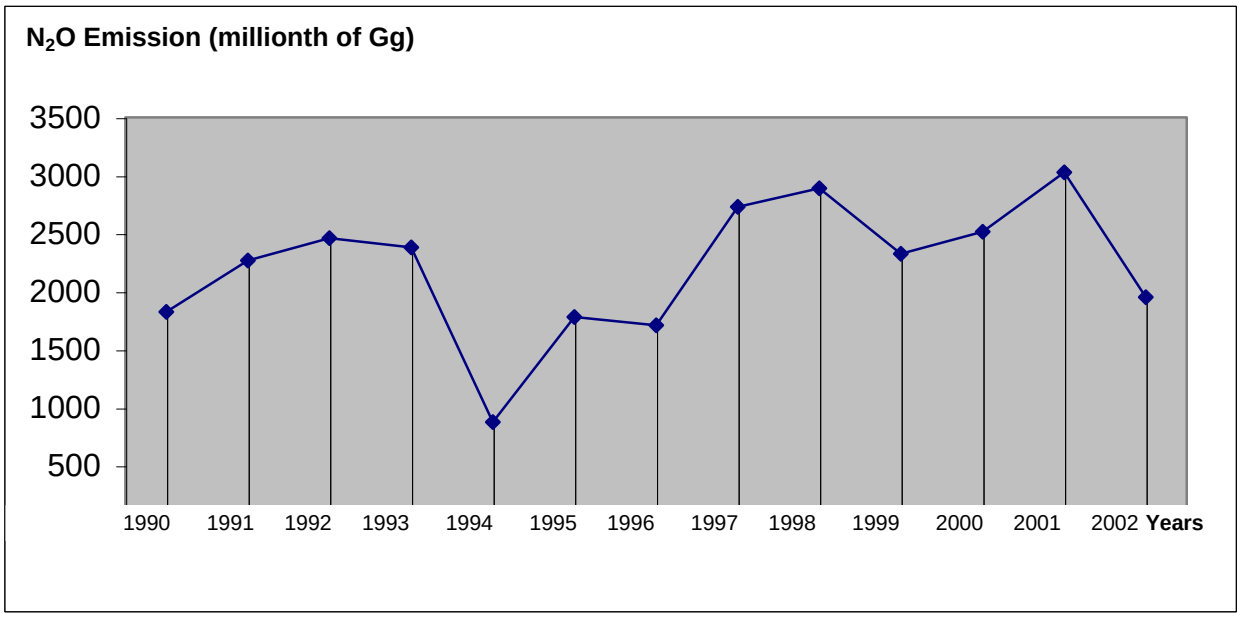
2.1.2. Emission of gas other than CO_2

2.1.2.1. N_20 emissions.

Table 11: N_20 Emissions from hydrocarbons

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Petroleum products (10^{-6}) Gg	1823	2268	10068	2381	874	1779	1709	2729	2890	2325	2515	3027	1950

Diag 19: N_20 emissions from hydrocarbons



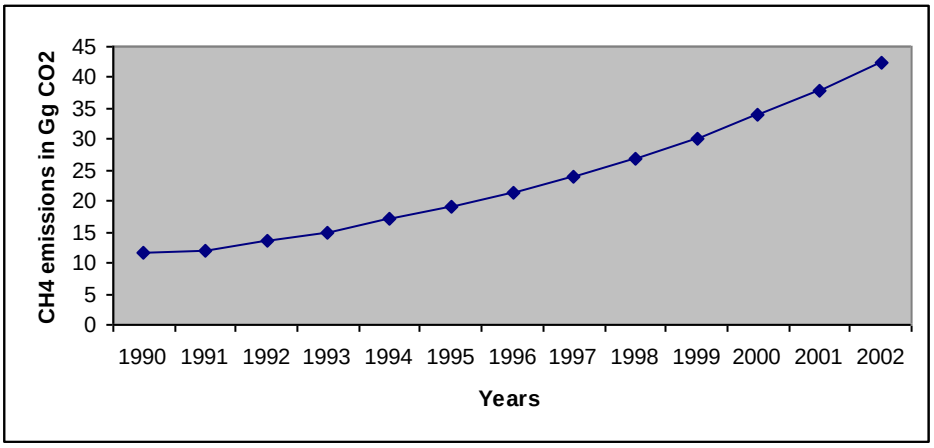
N_20 emissions from hydrocarbons use remain low as shown in the above diagram 19 and we realise a high variability of these emissions

2.1.2.2. CH_4 emissions in Gg

Table 12 : CH_4 emissions in Gg

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Petroleum products x 10^{-2}	0.035863	0.028029	0.03284	0.03148	0.01188	0.02309	0.03228	0.04028	0.038574	0.037806	0.044361	0.04411	0.04173
Wood charcoal production	2.68	2.8	3.14	3.5	3.9	4.4	4.9	5.53	6.2	6.9	7.8	8.7	9.8
Wood charcoal utilisation	8.9	9.3	10.5	11.5	13.1	14.71	16.4	18.4	20.7	23.1	26	29	32.5
TOTAL	**11.62**	**12.13**	**13.7**	**15**	**17**	**19**	**21.33**	**24**	**27**	**30**	**34**	**37.74**	**42.34**

Diag 20: CH_4 emissions (Gg CO_2)



Methane emissions show an increase of about 4% from 1990 to 2002 following the production and utilisation of wood charcoal.

2.1.2.3. FUGITIVE EMISSIONS

Fugitive emissions concerning methane gas dissolved in Lake Kivu are estimated at 175 Gigagrams of methane per year.

Data on wood energy utilisation in industrial sector are incomplete. According to the investigation conducted by the MINERENA/ World Bank in April 2002, in 886 industries and counted institutions, 103 were brickyards and 193 were restaurants distributed on six provinces.

The inventory of emissions due to aeroplanes has not been done due to lack of data on landing and taking off, frequencies of to aeroplanes. Only one company SN Brussels Airlines holds data for the year 2002.

Emissions of gas other than CO_2 remain very low in general. Major sectors of energy utilisation are house holds, transport with a very important domination of wood energy. This resource remains the major source of CO_2 emissions at 96% compared to petroleum products, while the contribution of others is still very low. From this predominance of wood energy resource there is an overexploitation of forest and the main consequence is excessive deforestation.

2.2. Inventory of greenhouse gas linked to industrial procedures.

Major emission sources from industrial procedures through which materials undergo chemical or physical transformations. Greenhouse gases produced include CO_2, CH_4 and N_2O.

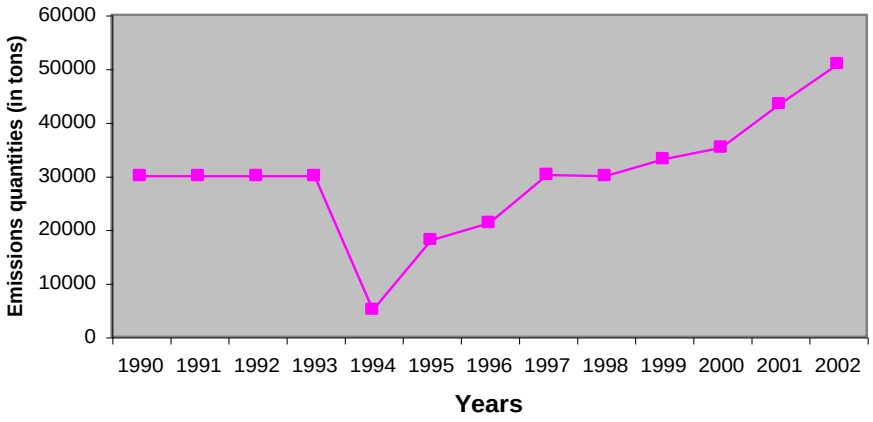
2.2.1. Inventory of carbon dioxide emissions (CO_2).

Emissions sources of carbon dioxide (CO_2) in Rwanda are mainly the fabrication of cement and lime. The carbon dioxide is equally given out during its production in relation to used industrial procedure during the production of silicum carbide, calcium carbide and their metal production (iron, steel, iron alloy aluminium, magnesium and other metals).

Table 13: CO_2 estimate given out during the production of cement in Gg

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total
Quantity of CO_2	29.210	29.210	29.210	29.210	4.985	17.946	21.162	30.162	29.925	33.046	35.252	43.284	50.740	**386.142**

Diag 21: Quantity of CO_2 given out during the production of cement



The quantity of carbon dioxide (CO_2) given out during the process of cement production during the period from 1990 to 2002 is estimated at 386,142 tons i.e. 386.142 Gigagrams of CO_2.

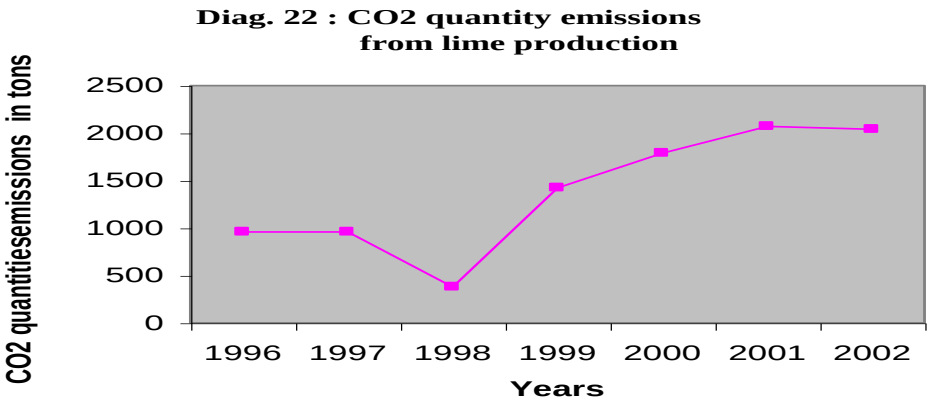
2.2.1.2. Inventory of emissions of CO_2 during lime production.

The produced lime comes from hit calcium , that is the reason why for the calculation of CO_2 quantity given out, the emission factor which has been used is 0.79 ton of CO_2/ 1 ton of produced quick lime.

Table 14 : CO_2 estimated given out during lime production in Gg

Year	1996	1997	1998	1999	2000	2001	2002	Total
Quantity of CO_2	0.959	0.959	0.378	1.422	1.788	2.071	2.040	**9.617**

The quantity of carbon dioxide (CO_2) given out during the production process of lime from 1996 to 2002 is estimated at 9,617.46 tons i.e. 9,617 gigagrams of CO_2 .



2.2.1.3 Metal production

Quantity of carbon dioxide emissions during the production process of tin *(Sn)* in 2002 is estimated at 12.5 Tons, i.e. 0.0125 gigagram of CO_2.

Table 15: Estimation of CO_2 emissions during the production process of tin *(Sn)*

	A	*B*	C	D=C/1000
Year	Mass suppressing agent (in tons)	Emission factor	Qty of CO_2 emissions (in tons)	Qty of CO_2 emissions (in Gigagrams)
2002	5	2.5	12.5	0.0125

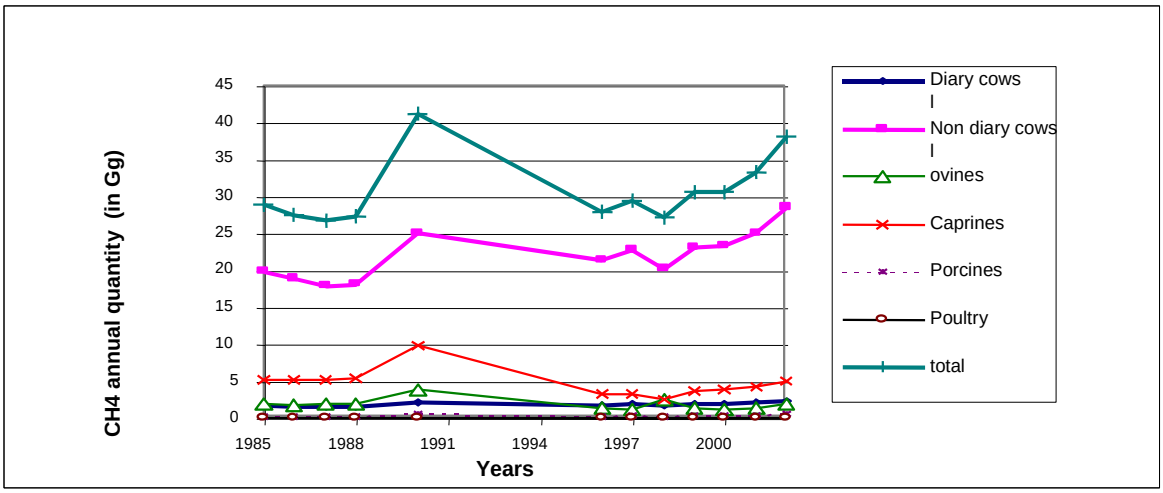
2.3. INVENTORY OF GREENHOUSE GAS EMISSIONS RELATED TO AGRICULTURE.

The analysis of Rwanda's agricultural conditions reveal that the interval 1990-2000 has been tough for natural resources. The space of fallowing lands, pastures and afforestation has highly decreased during this period. Burning of savannah as well as CO_2 emissions have been more severe during this period.

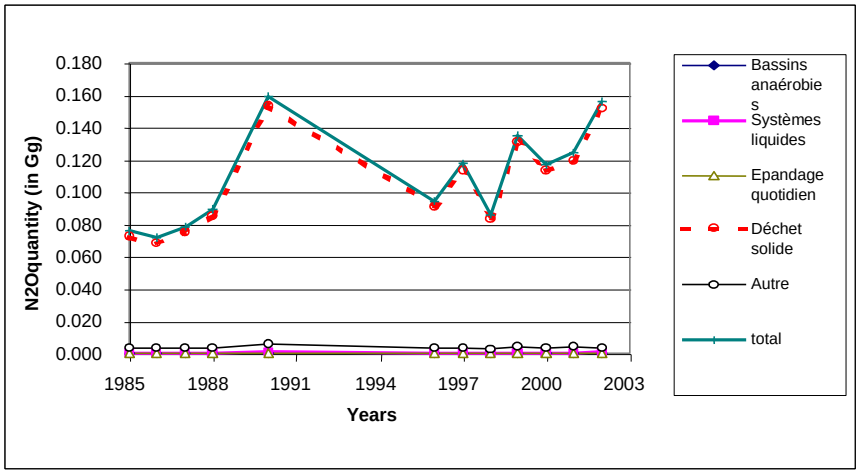
2.3.1. Emissions of GHG related to domestic livestock

In the case of Rwanda, the major part of methane from graft fermentation of domestic livestock comes from non dairy cattle. Dairy bovines are much fewer than caprines and ovines. The latter produce more methane than the former.
The diagram 23 shows that the years of war are characterised by a drop of slightly over than 10 Gg in emissions but the second half of the 1990 nineties saw a relatively rapid increase of CH_4 emissions. With the beginning of the 2000 year, we observe a comeback (and a surplus) in CH_4 emissions in 1990. This growth of CH_4 emissions reflects the reconstitution of troops of cattle at their level of before the war.

Diag 23: Annual emissions of methane from domestic livestock



Diag 24: GHG emissions from directed burning savannah

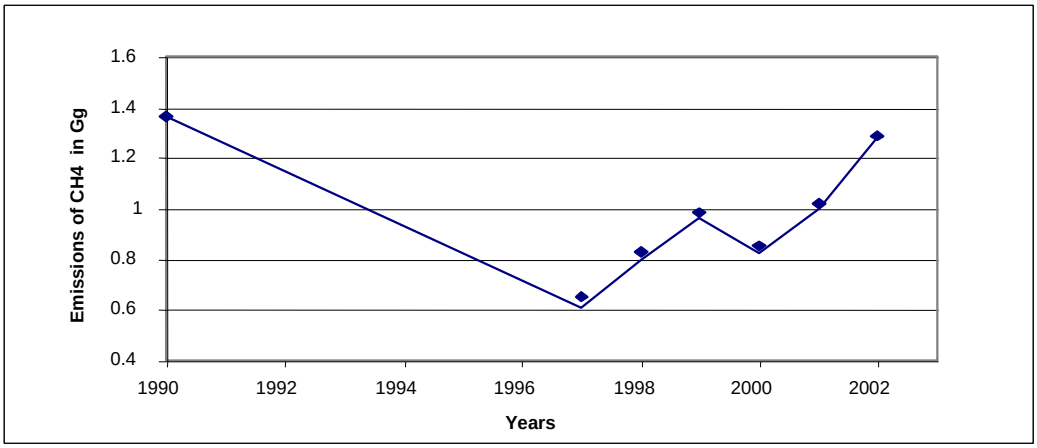


As CH_4, N_2O annual emissions are characterised by a decrease of 0.08 Gg between the year 1990 and 1994 as well as a rapid increase after the year 1997 which reaches 0.16 Gg in 2002, the level of the year 1990.

2.3.2. Greenhouse gas emissions from rice farming

Reflecting the evolution of rice farming area harvested through the years, methane emissions show a clear tendency to increase from the years 1990 (diagram 25). The beginning of the year 2000 shows a sign of returning to the level before the war for methane emissions from rice farms.

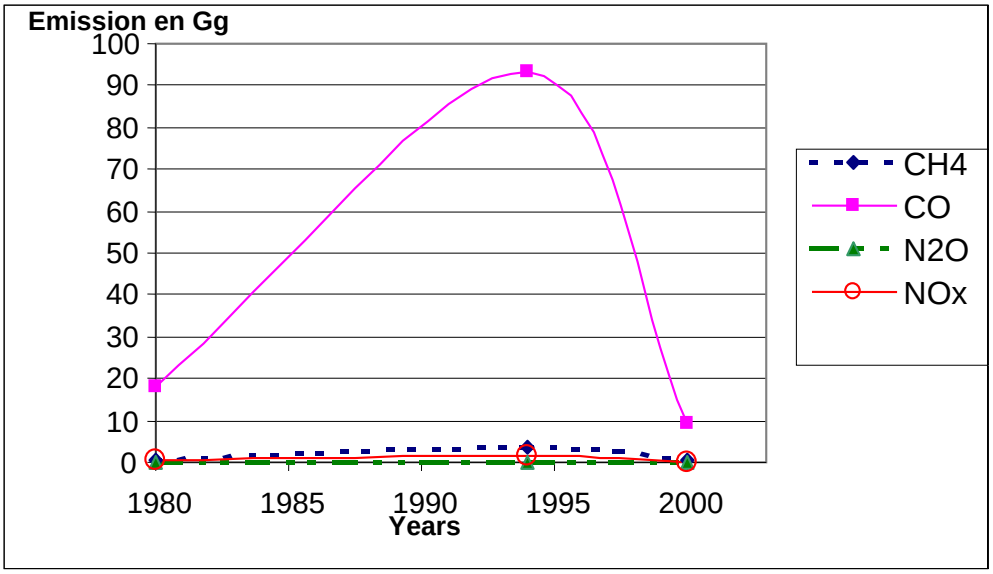
Diag 25: Methane emissions from savannah



2.3.3. Greenhouse gas emissions from savannah burning

Carbon monoxide is the major GHG emission deriving from savannah burning.

Diag 26: Greenhouse gases from savannah burning

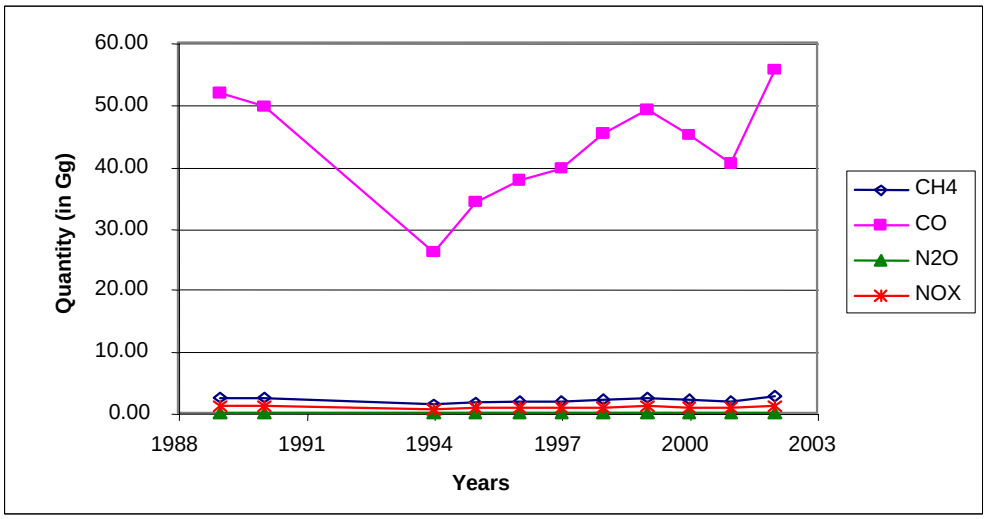


The curve describing the evolution of CO emissions from directed savannah burning takes a form of a curve showing the evolution of burnt savannah area.

2.3.4. GHG emissions from burning of harvest wastes

Estimated production of harvest of banana determine the level of emissions of carbon monoxide (CO) resulting from burning harvest wastes. CO is the most abundant GHG during the burning of harvest wastes.

Diag 27: GHG emissions resulting from burning harvest wastes.

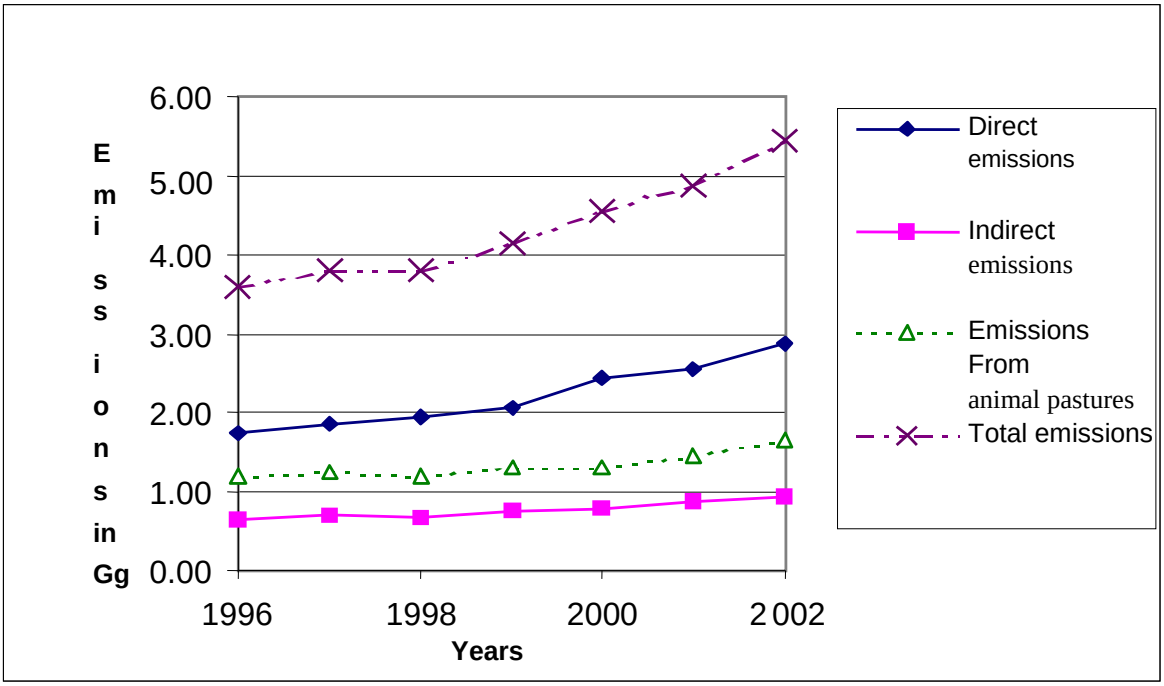


The diagram 27 shows a decrease of 25 Gg of CO emissions during the period 1990and 1994 and an increase of 25 Gg of CO2 emissions between the year1994 and 2002 .Emissions of other GHG(N_2O, NO_x et CH_4) are negligeable and remain almost to the same level of 1990.

2.3.5. GHG emissions from cultivated soils

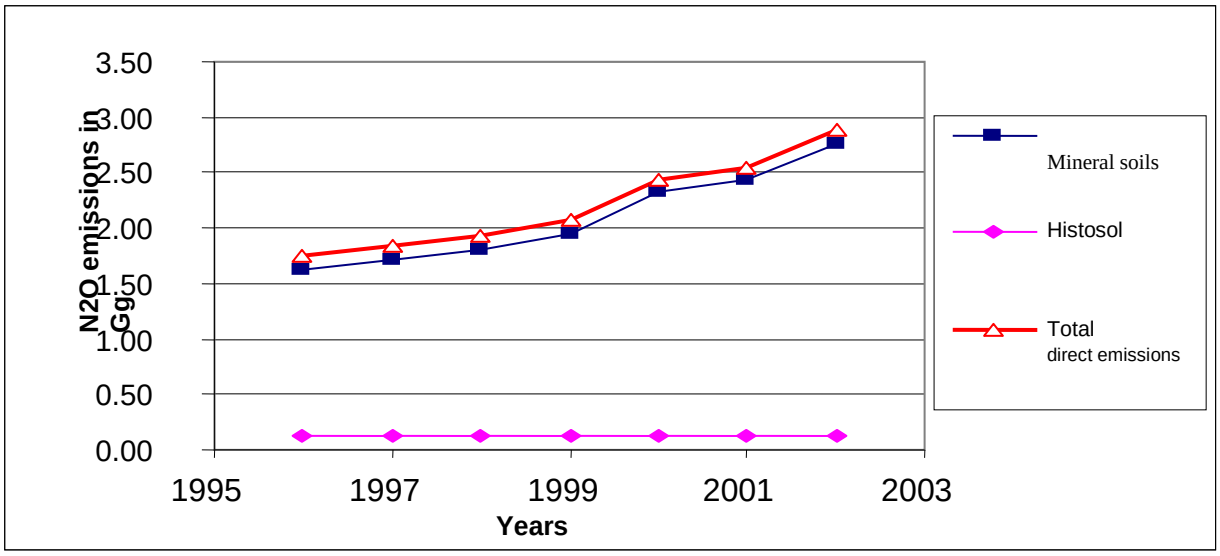
Direct emissions constitute the biggest contribution of N_2O of cultivated soils. The animal wastes from pastures are the second contributors of N_2O of cultivated soils. Organic and inorganic fertilisers as well as atmospheric reject of NH_3 and NO_2 contribute very little to the N_2O emissions of cultivated soils.

Diag 28: Nitrogen hemioxide emissions from cultivated soils (1996-2002)



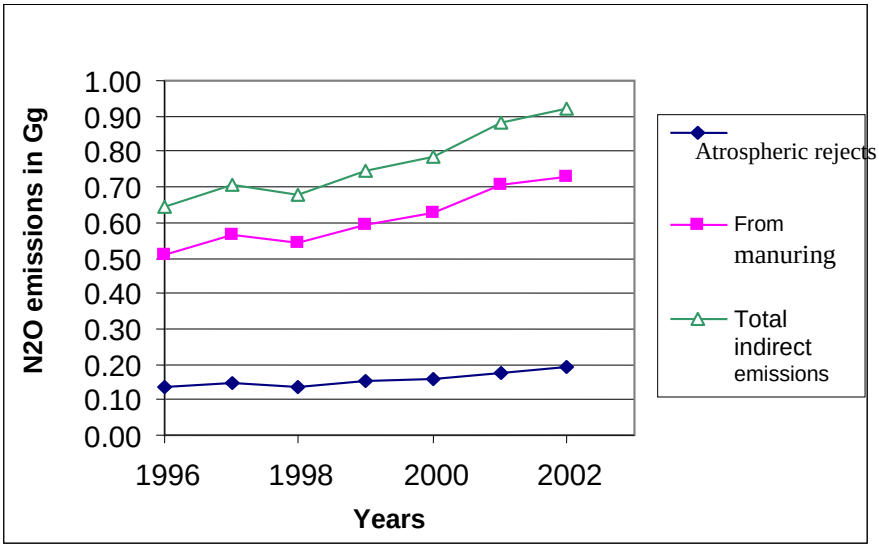
Mineral soils which constitute the majority of exploited soils of Rwanda contribute to the majority of N_2O direct emissions of cultivated soils.
N_2O indirect emissions essentially come after artificial manure and fertilisers on cultivated soils.

Diag 29 : N_2O direct emissions of cultivated soils.



During the period 1996 – 2002, we notice a steady increase of N_2O direct emissions from cultivated mineral soils of 1.6 Gg to 2.5 Gg.

Diag 30: N_2O indirect emissions of cultivated soils.



The methane constitutes about 37% of total GHG from Agriculture. The average quantity given out in 2000, 2001 and 2002 is 37.62 Gg. As the diagram indicates, the major source of methane in Rwandan agriculture comes from graft fermentation with an average annual production of 32.73 Gg (i.e. 87% of CH_4 total emission. Bovines contribute to about 71% of CH_4 total emission.

On the second rank comes the burning of harvest wastes with an average emission of about 2 Gg of methane per year (i.e. 6% of CH4 total emission). Rice growing and farm manure contribute each about 3% CH_4 total emission, savannah burning at about 1% while cultivated soils do not give out methane.

Nitrogen hemioxide with an average of 5.63 Gg given out between 2000 and 2001 constitutes about 6% of overall GHG from Agriculture. Cultivated soils constitute the biggest source of nitrogen hemioxide from agriculture (diagram 31) with an average annual production of N_2O equally 5.44 Gg (it means 97% of total N_2O total emissions. Farm manure contributes to about 2% of total N_2O total emissions and burning harvest wastes about 1%.

Nitrogen oxides contribute about 1% of GHG from agriculture with an average annual emission of 1.14 Gg. Burning of harvest wastes with 0.99 Gg of NOX per year (it means 87% of an average of three years emissions), contributes the major source of N_{OX}. The other source of NOX is the controlled burning of Savannah which contributes 13%.

Carbon monoxide, with an average of annual emission of 56.13 Gg constitutes about 56% of total GHG quantity from agriculture. Burning of savannah contributes about, 9.05 Gg of CO per year, i.e. about 16% of total CO emission.

Diag 31: Summary of GHG emissions in Agricultural sector in Gg, average for the year 2000-2002.

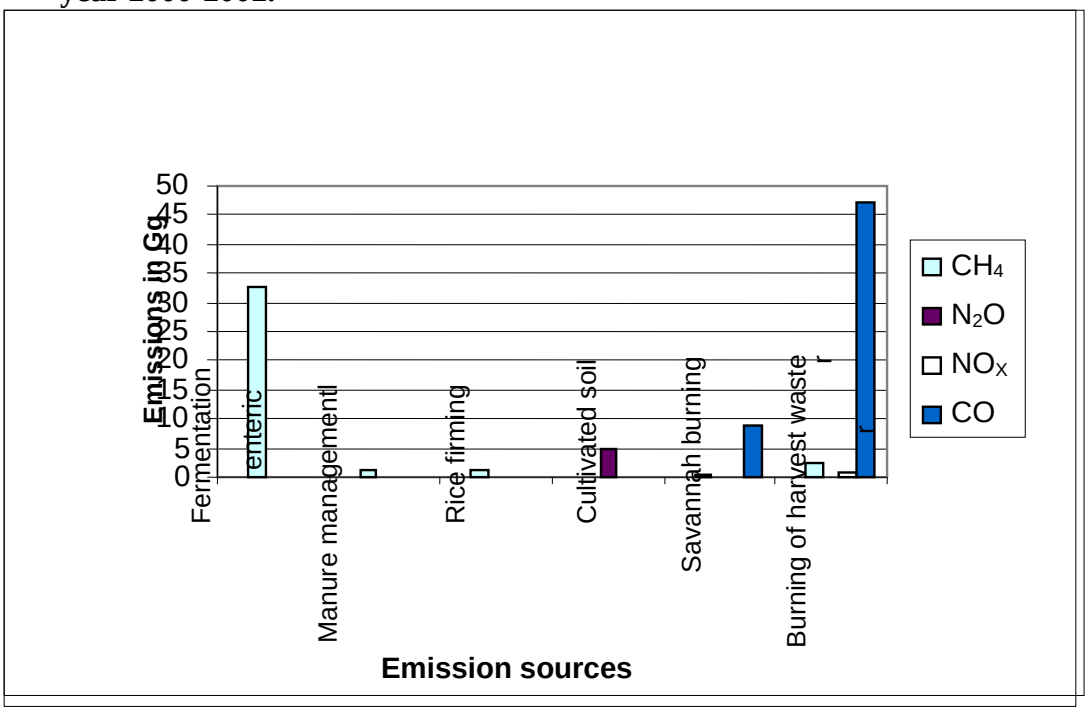


Table 16: Summary of national GHG inventory in agricultural sector for the period 2000 - 2002.

Category of sources and (sink) of GHG	(Gg)				
	CH_4	N_2O	NO_X	CO	NMVOC
Agriculture	37.62	5.63	1.14	56.13	
Enteric fermentation	32.73	-	-	-	
Manure management	1.25	0.13	-	-	
Rice farming	1.05	-	-	-	
Cultivated soils	-	5.44	-	-	
Savannah directed burning	0.34	0.00	0.15	9.05	
Harvest wastes burning	2.24	0.06	0.99	47.07	

Table 17: National GHG inventory in Gg CO_2 in agriculture average for the period 2000 - 2002.

Category of sources and sink of GHG	**In Gg**				
	CH_4	**N_2O**	**NO_x**	**CO**	**NMVOC**
Total agriculture	**37.62**	**5.634**	**1.14**	**56.13**	
A. Enteric fermentation	**32.73**				
1.Bovines	26.87				
2. Buffalos	-				
3. Ovine	1.42				
4. Caprine	4.23				
5. Camels/Donkeys	-				
6. Porcine	0.20				
7. poultry	0.00				
B. Waste management	**1.25**	**0.132**			
1. Bovine	0.83	-			
2. Buffalos	-	-			
3. Ovine	0.05	-			
4. Caprine	0.14	-			
5. Camels/Lamas	-	-			
6. Horses	-	-			
7. Donkeys	-	-			
8. Porcine	0.20	-			
9. Poultry	0.03	-			
10. Anaerobic basin	-	0.000			
11. Liquid systems	-	0.000			
12. Solid waste	-	0.128			
13. Other SGDA	-	0.004			
C. Rice farming	**1.05**	-			
1. Irrigated	1.05	-			
2. Rainfalls	0.00	-			
3. Deep waters	0.00	-			
D. Agricultural soils	-	**5.440**	-	-	
E. Directed burning of savannahs	**0.34**	**0.004**	**0.15**	**9.05**	
F. Burning of harvest wastes in farms	**2.24**	**0.057**	**0.99**	**47.07**	
1. Cereals	0.11	0.003	0.06	2.35	
2. Dry vegetables	0.25	0.007	0.12	5.28	
3. Tubers	0.34	0.008	0.14	7.10	
4. Fruits	0.01	0.000	0.01	0.31	
5. Bananas	1.53	0.038	0.65	32.04	

2.4. Inventory of Greenhouse gases related to land-use change and forestry.

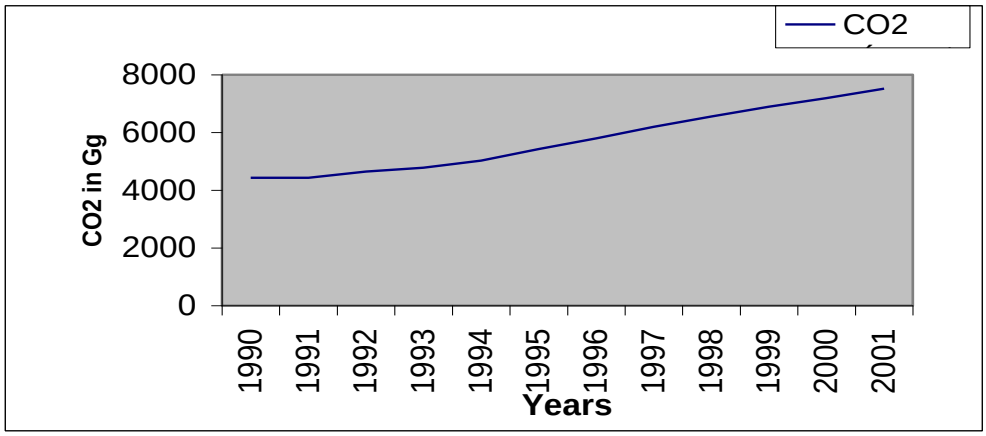
2.4.1. CO_2 emissions and other gases from the conversion of forest and grasslands.

To calculate the CO_2 net sequestration, the annual growth of biomass has been estimated in forest plantations, exploited forests for barks or forests of other forms of timber harvests, the growing of trees in villages, agricultural exploitations and urban zones and other important woody biomass stocks.

Table 18: carbon sequestration in Gg CO_2

Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Sequestrated CO_2	4432	4434	4646	4777	5025	5429	5797	6196	6553	6895	7186	7517

Diag 32: Carbon sequestration in Gg CO_2



The CO_2 sequestration has never stopped growing regardless of the conversion of natural forests between 1997 an 1999. This is explained by the fact that productivity of Eastern forests (5 m^3/ha /year) is very poor compared to trees outer forests (20 m^3/year/ha). Eastern dry forests consume less than CO_2 that trees outer forests which absorb more CO_2 to produce more woody material.

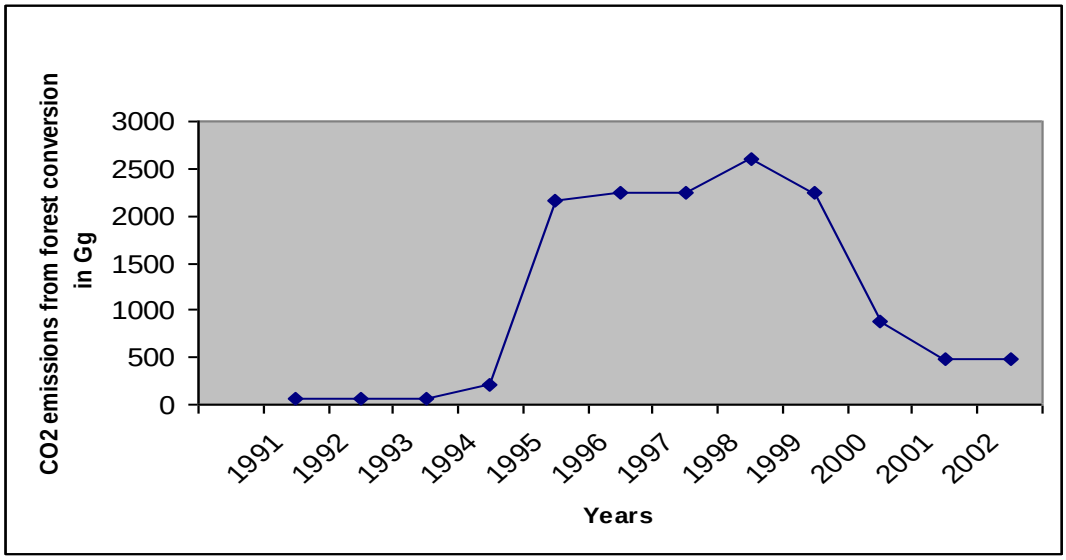
2.4.2. CO_2 emissions from forests conversion.

CO_2 emissions from forests conversion are shown in the table 19 below.

Table 19: CO_2 emissions from forest conversion.

Years	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Emission of Gg CO2	65.07	65.07	65.07	220.2	2167	2245	2442.4	2593	2442	870.87	492.5	492.5

Diag 33: CO_2 emissions from forests conversion



Between 1991 and 1993, CO_2 emission is relatively poor due to a more or less controlled conversion. Between 1994 and 1999 CO_2 emission raises up due to a conversion of the big part of dry forests which constitute Akagera national park and the almost total disappearance of Gishwati forest, and the gradual whittling away of Nyungwe forests, Mukura and Volcano park. Between 1999 and 2000, the CO_2 emission from forests conversion is nil.

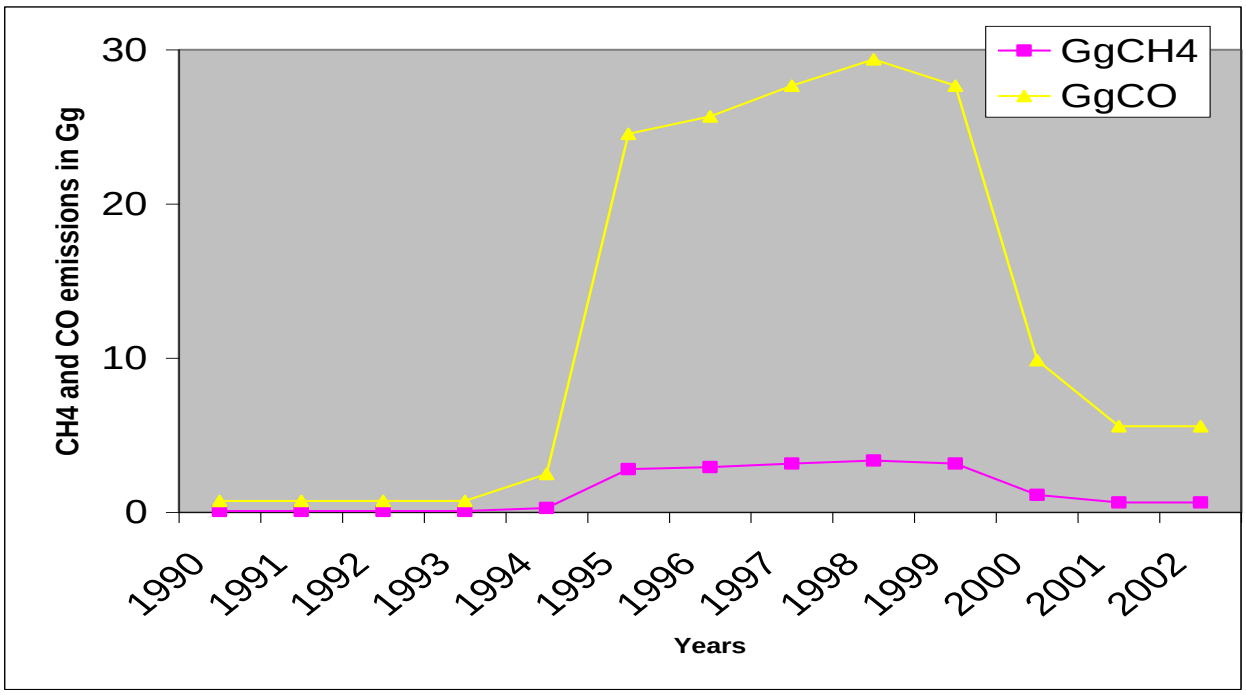
2.4.3. Emissions of gases other than CO2

CH4 and CO emissions are estimated under forms of ratio compared to carbon influx given out during the combustion. The total composition in nitrogen is estimated on the basis of nitrogen/ carbon. The NO_2 and N_{OX} are estimated under forms of ratio compared to the total nitrogen.

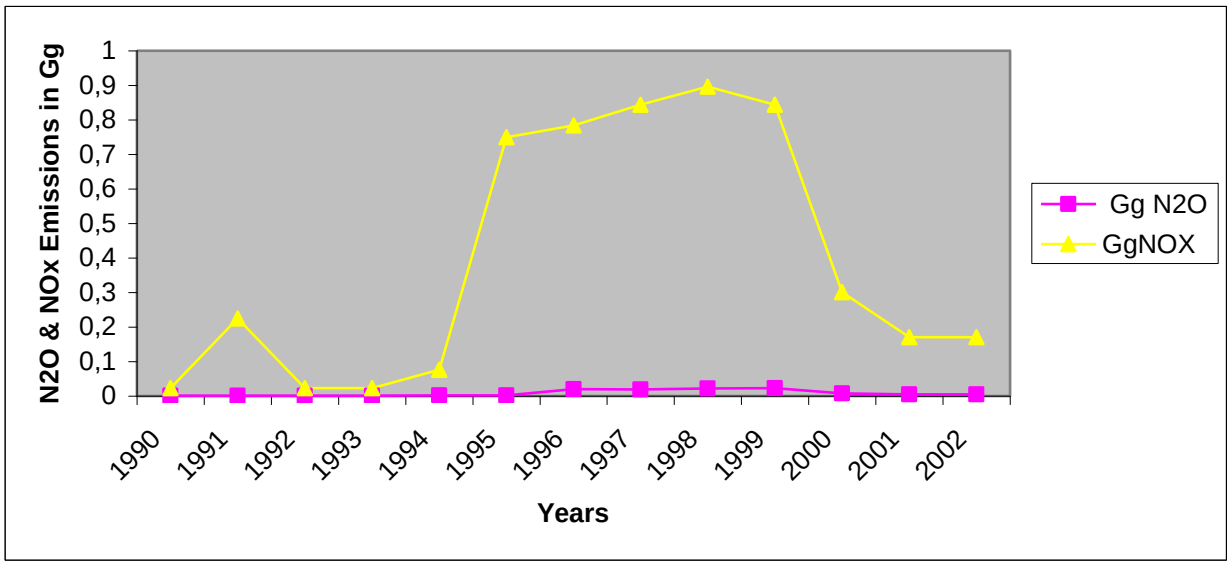
Table 20: Emissions of gases other than CO_2.

Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Gg CH_4	0,08424	0, 0842	0,08424	0,0842	0,28512	2,8058	2,9354	3,1622	3,3566	3,1622	1,1275	0,6376	0,6376
Gg C0	0,7371	0,7371	0,7371	0,7371	2,4948	24,551	25, 6851	27,6696	29,37	27,6696	9,8658	5,5792	5,5792
Gg N_2O	0,00058	0,0005792	0,00058	0,0005	0,00196	0,00196	0,0201	0,01929	0,02174	0,0230	0,007751	0,0043	0,0043
Gg NO_X	0,02249	0,02248	0,02249	0,0224	0,07612	0,74905	0,7836	0,844205	0,8961	0,844	0,301007	0,1702	0,1702

Diagram 34: Emissions of CH4 and CO gases



Diag 35: N_2O and NO_X gas emissions.



2.4.4. Emissions or sequestration of CO_2 and other gases due to land use change.

The choice of soils allocation to realise the inventory has been inspired by lands affectedness on which the quantity of soil carbon under local vegetation could be found, labour factors and inputs factors. Lacks of data, values by default were highly utilised.

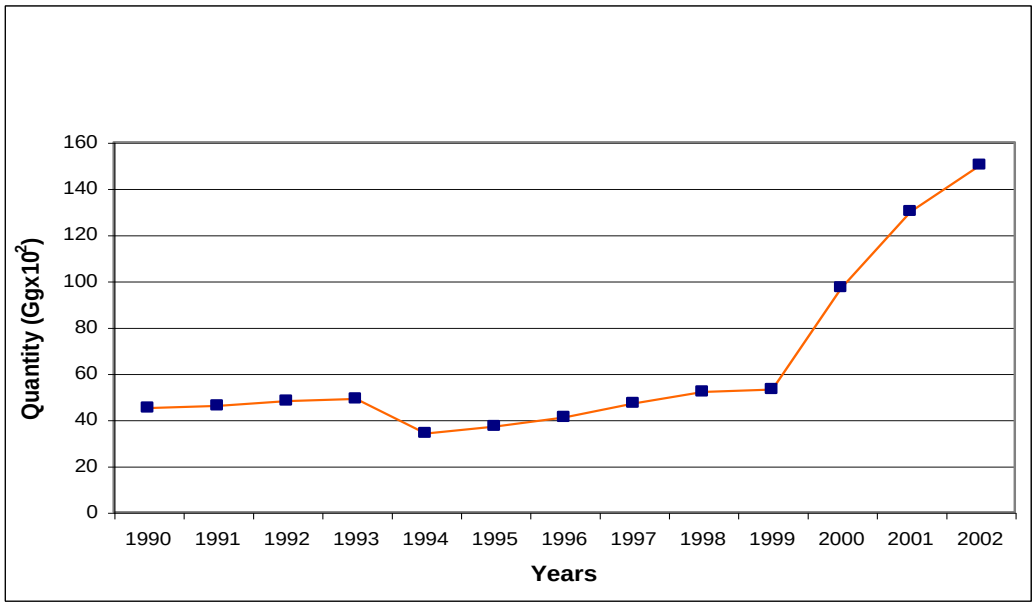
Calculating CO_2 emissions from mineral soils was based on the consideration of modifications of the carbon stocked in the soil (and the litter) which depend on the modifications of lands affectedness as well as agricultural management practices. Calculating carbon stocks changes requires an inventory period corresponding to twenty years.

For that matter, an estimate of lands affectedness systems distribution for different types of soil was done at the same time for the year 1980 and 2001. For the emissions, originating from treating agricultural phosphates, only quantity data were utilised.
A net variation of total carbon of agriculturally disturbed soils is translated by an annual emission of 1684.24Gg of CO_2.

2.5. INVENTORY OF GREENHOUSE GASES RELATED TO WASTES.

Diagrams 36, 37 and 38 show that the production of solid waste and waste waters in urban areas, as well as the deriving quantity of methane, is proportional to urban population. In fact, there is a slight increase from 1990 to 1993. However in 1994 the production of solid wastes, wastewaters and a quantity of methane decreased. From 1995 to 1999, the production slightly increased due to the return of refugees. From 1999 to 2002, the stability of the country favoured a significant increase of wastes production due to rural exodus.

Diag 36: Methane annual production from solid wastes from 1990 to 2002



Diag 37: Evolution of N_2O production from 1990 to 2002

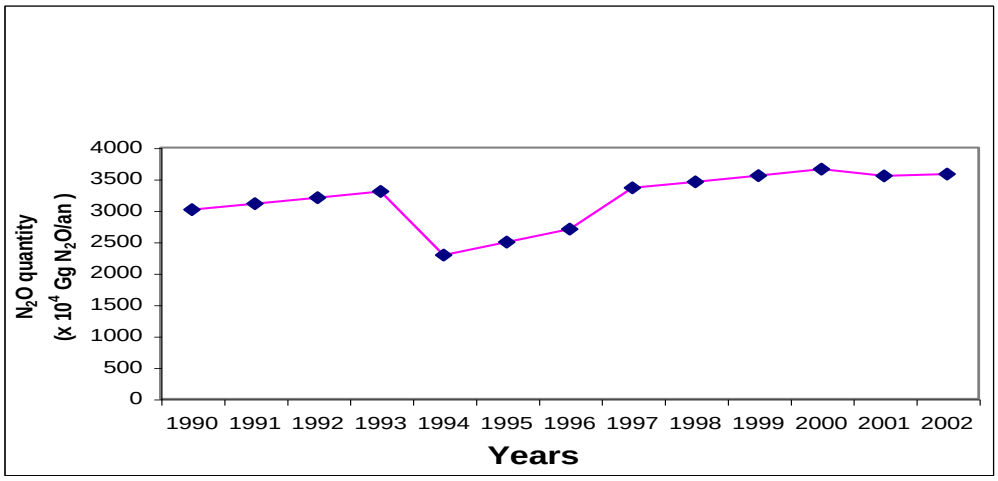


Diagram 37 shows an evolution of N_2O production from 1990 to 2002. In fact, it is drawn using the total population number and non urban population as it is the case of other diagrams. There is a sharp decrease in 1994.

Diag 38: Methane annual production from wastewaters since 1990 to 2002

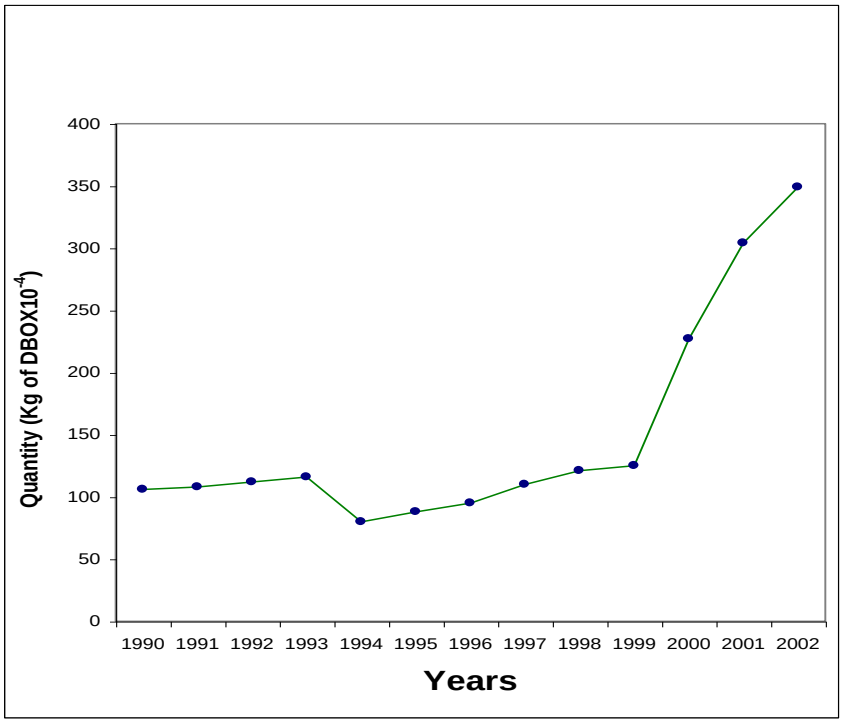


Table 21: TOTAL GREENHOUSE GAS EMISSIONS (Gg) IN 2002.

Categories of greenhouse gases	CO_2	CH_4	N_2O	NO_X	CO
Total national emissions	**-24.0275**	**60.68833**	**2.2403**	**18.8702**	**5.9592**
1. Energy	**6947.68**	**42.34173**			
A. Emission from petroleum products	259.68	0.04173			
B. Emission from fire wood	5918	32.5			
C. Emission from charcoal	770	9.8			
2. Industrial Process	**52.7925**				
A. Emissions from cement production	50.740				
B. Emissions from lime production	2.04				
C. Emissions from tin production	0.0125				
3. Agriculture		**12.529**	**1.876**	**18.7**	**0.38**
A. Enteric fermentation		10.91			
B. Fertiliser management			0.41	0.43	
C. Rice farming		0.35			
D. Cultivated soils				1.813	
E. Savannah burning		0.113		3.01	0.05
F. Wastes from harvest burnt		0.746	0.02	15.69	0.33
4. Land use change and forestry	**-7024.5**	**0.6376**	**0.0043**	**0.1702**	**5.5792**
A. Sequestration in forestry	-7517				
B. Emissions from forest conversion	492.5	0.6376	0,0043	0.1702	5.5792
5. Wastes		**5.18**	**0.36**		
A. Emissions from waste waters		0.2			
B. Emissions from domestic and commercial waste waters		3.48			
C. Emissions from human wastes		1.5	0.36		

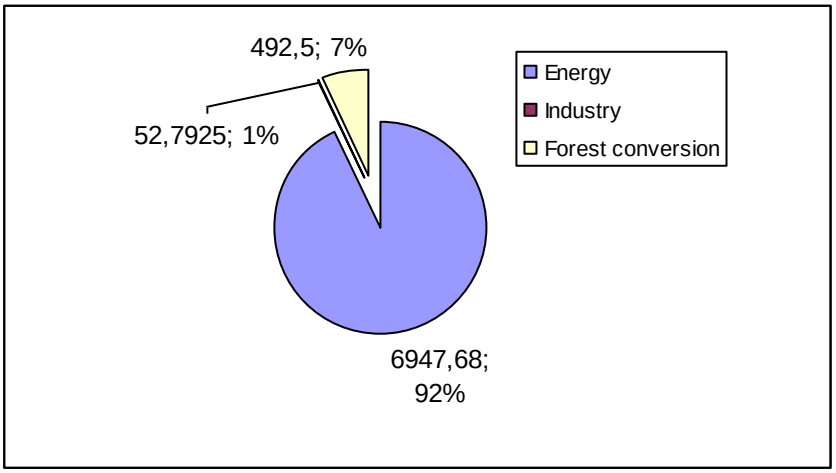
GHG emissions in Rwanda are largely compensated by the sequestration capacity of forests: 7517 Gg ECO_2. This makes the evaluation of CO_2 in 2002 in favour of 24.0275 Gg ECO2 of sequestration.

Sector energy is the first responsible of CO_2 (92%) emissions, far followed by lands and forestry affectedness (7%).

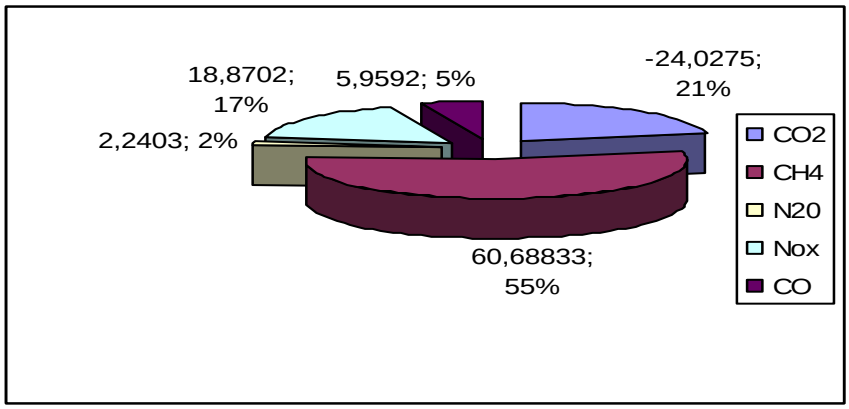
For methane (CH_4), energy and agriculture sectors contribute mainly to its emission. Energy sector frees 69% equalling 42.3 Gg of CH_4 against 21% i.e 12.53 Gg for agriculture, 9% i.e. 5.18 Gg wastes sector and 1% i.e.0.64% Gg of CH_4 for land use and forestry.

Nitrogen hemioxide mainly from by agriculture (1.876 Gg) and wastes (0.36Gg) sectors represents 2%.

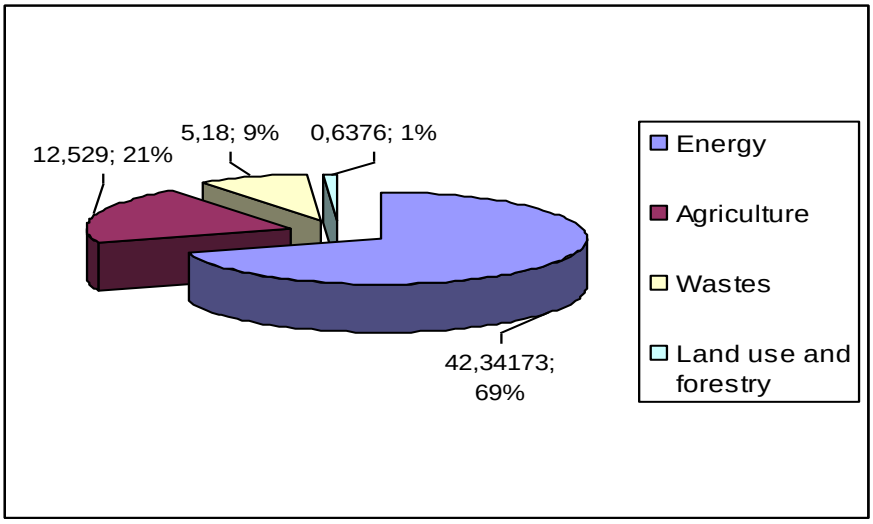
Diag 39: Carbon dioxide emissions in 2002 in Gg.



Diag 40: Total GHG emissions in Gg in 2002



Diag 41: Methane emissions in Gg in 2002



CHAPTER 3: MEASURES AND STRATEGIES TO REDUCE GREENHOUSE GAS EMISSIONS

In the case of Rwanda, Government has defined, policies and measures to prevent and reduce causes of climate changes and curtail their negative impacts for sustainable socio-economic development.

3.1. ENERGY SECTOR

Vision 2020 forecasts that Rwanda will have reduced the contribution of wood energy from 90 % to 40 % generation by the year 2020. Hydraulic potential combined with of methane gas energy would meet needs in electricity for the whole country development activities with additional production of 125 MWH compared to year 2000. In the poverty reduction strategy paper (PRSP), Rwanda has set the objective to ensure increase rate of electricity consumption by 9.6 % per year, to ensure rural electrification rate of 30 % and to increase from 6 % to 35 % the population having access to electricity.

The energy sector is mainly composed of three domains which are biomass that gives up to 94 % of the total consumed energy, petrol products 5 % and electricity 1 %. The country has considerable resources in new and renewable energies that are not yet exploited like peat, papyrus, methane gas, geothermic and solar energy.

3.1.1. POLICY OPTIONS AND SPECIFIC MEASURES TO REDUCE GREENHOUSE GASES

In the field of energy, Rwanda has already set forth policy options to develop the sector and the same time to contribute to reduction of greenhouse gas emissions. These options aim especially to:

- Increase access rate to modern energy resources such as hydropower, new and renewable energies;
- Produce large quantity and quality of energy for urban and rural areas while improving security of electricity and petrol products supplies;
- Meet needs of domestic energy while protecting environment.

To reach its objectives, the Government of Rwanda will have to rehabilitate the already existing network, install other hydropower stations, to promote technologies that save fuel wood as well as new and renewable energies. The big constraint remains lack of funds to finance this sector. In addition, the Government of Rwanda has taken measures to alleviate the cost for some equipment to make them accessible to industrials and households.

3.1.2. STRATEGIES TO REDUCE GHG IN ENERGY SECTOR

Any policy permitting the control and reduction of greenhouse gas should essentially pass by an equal distribution of electricity and the use of other less pollutant forms of energy.
Energy policy that focuses on sustainable development is based on the following elements and strategies:

- Disengagement of the Government for the profit of the private sector in the development of the sector;

- Intensify regional cooperation in the production of electricity and integration of electricity supply networks as well as promotion exchange of energy at regional level in order to increase the quantity of electricity, reduce production costs and prices of electricity for the consumer;
- Decrease of fuel wood and wood charcoal thanks to substitute energies;
- Exploitation of methane gas;
- Agreement with the population having small revenues in a view to allow them have access to electricity (mid term loans, grants);
- Photovoltaic equipment cost grants to allow development of decentralised electrification;
- Alleviation of investment cost to be consented by industrials for substitution of biomass and gas oil boilers by electric ones (tax exemption, taxes alleviation);
- Favour the use of solar energy by encouraging measures for a wider use of solar panels (tax reduction, local production of solar panels, research);
- Increase the number and capacity of hydropower dams;
- Increase the number of mini-hydropower stations especially in rural areas;
- Develop collection and valorisation of biomass as a source of energy;
- Increase research efforts in energy production;
- Rehabilitate and improve the existing network;
- Secure supply in electricity and petrol products;
- Accelerate the process of electricity production from methane gas, biomass without damage on environmental balance;
- Set up measures for improvement of energy saving systems in the manufacturing industries.

Many technological options capable to contribute to reduction of greenhouse gas emissions have been proposed by IPEC in energy sector. Options that seem to be applicable to Rwanda are described below:

- Decentralised electrification by solar systems for rural households;
- Extension of improved wood charcoal and cooking stoves;
- Efficiency in transport sector;
- Improvement of energy efficiency in the manufacturing industries notably: conversion of fuel wood or gas oil boilers in electric ones; recuperation of the sensitive heat of smokes; replacement of thermal insulation and vapour leak system;
- Decentralised electrification of public infrastructures;
- Extension of biogas digesters in institutions and the use of high performance peat kilns;
- Maintenance of hydropower predominance in energy supply.

Strategies and actions to be envisaged are described in table 22 below.

Table 22: Strategies and actions to reduce GHG in energy sector

Strategies	Actions
Use of alternative sources of energy	- To promote an extend use of biogas; - To promote the use of solar power; - To construct micro-hydropower stations; - To intensify regional collaboration in electricity generation and integration of supply network as well as promotion of commerce of energy at regional level; - To promote the use of some types of wastes as combustibles.
Promotion of effective energy programmes	- To promote the low consumption lamps
Improvement of wood combustion efficiency	- To extend use of improved cooking stoves at household level; - To introduce efficient wood-charcoal making technologies.
Efficiency in the sector of transports	- To impose installation of fuel ionisation system on motor vehicles; - To promote importation of new vehicle with low fuel consumption/regime through access to loan and decrease of taxes on vehicles aged less than 5 years; - To discourage importation and operation of old vehicles through high taxes levied on import and use; - To impose norms of regular control of technical maintenance; - To encourage public transport through incentive tariffs.

Urutare rwa Ndaba falls: one of identified potential sites of micro hydroelectric power

3.2. INDUSTRY SECTOR

Options to reduce greenhouse gas in the industry sector in Rwanda only concern carbon dioxide given off while producing cement, lime and tin.

3.2.1. CEMENT PRODUCTION

In order to avoid production of CO_2 related to industrial processes, we can choose artificial or natural binders without $CaCO_3$ (slag, natural lime, truss, pouzzolanes, and volatile ashes).

In order to reduce the quantity and intensity of CO_2 emissions from industrial processes of cement factory in Rwanda, it is recommended to CIMERWA to support programmes involved in the conservation of biodiversity, Nyungwe natural forest and in forestation programmes for Bugarama region in general.

3.2.2. LIME AND TIN INDUSTRY

Reduction methods for CO_2 emissions in the lime industry are the recuperation and storage of CO_2, recycling, transformation by algae and tree plantations.
As for the lime industry, it would be necessary to sequestrate CO_2 by Kabuye sugar works, ELECTROGAZ, construction and public works enterprises. Trees should also be planted near factories producing lime and use algae for small lime production units.
For the tin industry, appropriate industrial sites should be chosen and algae should be used to convert CO_2 since the produced quantities are small.

3.2.3. STRATEGIES TO REDUCE GREENHOUSE GASES FROM INDUSTRIAL PROCESSES

Strategies to reduce greenhouse gas in Rwanda are:

- **For the cement manufacture,**
  - Negotiate a protocol of understanding with CIMERWA so that the latter can voluntarily engage itself to reduce its emissions by 5 % between 2006-2008 and 8 % between 2010 and 2012;
  - Partially replace the clinker with alternative binders free of $CaCO_3$ (slag and volatile ashes);
  - Plant trees in the farmlands and support biodiversity and forests conservation.

- **For the lime industry,**
  - A protocol of understanding with the lime producers is necessary in a view to reduce emissions by 5 % / produced ton of lime during 5 years and support forestation programmes so as to increase carbon shafts.

- **For the tin industry,**
  - The strategy is similar to that of lime except that reduction of CO_2 emissions is by 5 % during 10 years.

Methods to be used to achieve the expected results are training, education, sensitisation, tax exemptions, low rate interest loans and other financial advantages.

3.3. AGRICULTURAL SECTOR

3.3.1. MEASURES TO REDUCE N_2O EMISSIONS

Options to reduce and management practices for reduction of N_2O in agricultural sector are:

- **Efficiency increase in the use of artificial fertilizers' nitrogen,**
  - Assess the fertilizer's contribution according to the plants' needs,
  - Moderated manure spreading,
  - Optimal synchronisation of spreading,
  - Improvement of the soil aeration,
  - Use of improved manure,
  - Use of nitrification inhibitors.

- **Make sure that N is given off under N_2 form instead of N_2O by liming acid soils.**

3.3.2. MEASURES TO REDUCE CH_4 EMISSIONS

- **Intestinal fermentation,**
  Potential measures for reduction are:
  - Reduction of the cattle herds according to respect of the carrying capacity per unit area of pasturelands;
  - Productivity improvement;
  - Improvement of food composition.

- **Management of manure,**
  Potential measures to be adopted for reduction of methane emissions from anaerobic fermentation in manure pits are the use of biogas digesters and reduction of fermentation materials.

- **Controlled burning of savannah and on- spot burning of farm residues,**

  Efforts to reduce emissions of GHG from controlled savannah burning and on -spot burning of farm residues will concern supervision, training and information of farmers as well as research – development on innovations for agriculture modernisation.

3.3.3. STRATEGIES TO REDUCE GHG IN AGRICULTURE

Strategies and actions envisaged for reduction of GHG in agriculture are shown in table below:

Table 23: Strategies and actions set up to reduce GHG in agriculture are shown in the table below :

Strategies	Actions
Reduction of deforestation rate	-To extend the use of selected seeds and improved livestock breeds; -To extend soil conservation techniques and use of farm manure; -To sensitise the population in the use of micro-technologies to maximise profit from farm manure; -To promote the use of farm inputs; -To promote livestock stalling system.

3.4. LAND USE CHANGE AND FORESTRY SECTOR

Measures to reduce GHG can be classified into different categories if we consider the technical framework of conservation and management of forestry ecosystems, agro-ecosystems; others are related to institutional and sector policies; and finally to legislation in force.

3.4.1. TECHNICAL OPTIONS

The proposed technical and technological options for maintenance and increase of the existing forest cover are conservation of natural forests, rehabilitation of degraded forests and promotion of new tree plantations together with extension of agro forestry and use of alternative sources of energy.

- **PRESERVATION OF NATIONAL FORESTS**

  - Promotion of eco-tourism;
  - Habitat and specie protection;
  - Restoration of degraded areas;
  - Research and monitoring;
  - To involve the local communities

- **PRESERVATION AND PROTECTION OF RELICTUAL, GALLERY FORESTS AND FORESTATION**

  Rehabilitate and ensure protection according to the biodiversity that some sites have.

- **AGROFORESTRY**

  Extension of agro-forestry trees which contribute in GHG reduction by permanent sequestration of an important proportion of CO_2.

- **MANAGEMENT OF FOREST ENERGY CONSUMPTION**

  Pressure reduction on forestations and therefore on GHG sink sequestration will be done through utilisation of sustainable sources of energy. However, this requires a technological level from the users that can allow the use of other materials, production of accessible construction materials in local products that do not demand source of fuel wood (ex: adobe bricks, blocs), use improved cooking stoves and biogas digesters.

3.4.2. POLICY OPTIONS

- **REGIONAL DEVELOPMENT**

  In the framework of regional development general policy, a rational land use and proper wetlands management are necessary if we consider their role in hydrological regulation.

- **NATIONAL WATER POLICY**

  A policy aiming at saving and management of water will have an impact on erosion's effects following rational rainwater management, maintenance of vegetation cover in all seasons notably through irrigation and increased plant and animal productions.

- **NATIONAL FORESTRY POLICY**

  The national forestry policy aims to preserve enough forest areas for protection of biological diversity, conservation of fragile ecosystems and maintenance of functions that forests and trees fulfil in the environment especially in water catchments areas.

- **MODERNALISATION OF AGRICULTURE AND ANIMAL HUSBANDRY**

  The agricultural policy targets promoting animal husbandry through stalling for up to approximately 500,000 heads and animal productivity. It also intends to increase carbon sequestration on farmlands through better management of residues and rehabilitation of degraded hillside soils.

3.4.3. INSTITUTIONAL FRAMEWORK

The central Government has a major role to elaborate laws and policies, and to provide guidelines. Inter-ministerial coordination committees have been put in place according to three key domains notably economy, social affairs and infrastructures.

The Ministry of Local Administration, Community Development and Social Affairs (MINALOC) is, through Community Development Committees (CDC) responsible for the daily management on field in all domains of rural development, social affairs and administration.

The Ministry of Agriculture and Animal Resources (MINAGRI) is in charge of the technical, institutional and even juridical direction of the land use in agriculture and animal husbandry (food productions, fishing and husbandry products).

The Ministry of Lands, Environment, Forestry, Water and Mines (MINITERE) elaborates, ensures coordination and follow up execution of laws and policies in management of forests, water, natural resources, conservation and protection of environment and reinforces institutional capacities for decentralised entities.

The Rwanda Office of Tourism and National Parks (ORTPN) has the mission of making tourism more profitable to all Rwandans by developing a unique Rwandan tourist product with cultural and natural attractions, in facilitating creation, for targeted customers and ensuring sustainable development by preserving environment.

Rwanda Environment Management Authority (REMA) has the mission to execute environmental policy, to advise the Government on the policy, strategies, legislation and other measures related to management of environment or implementation of conventions, relevant international treaties and agreements pertaining to the environment domain whenever needed; make an inventory and carry out inspections, exhaustive environmental audits; prepare and publish a biannual report on the natural resources state in Rwanda.

3.4.4. STRATEGIC OPTIONS

The strategy for management of manure aims at reduction of GHG emissions through effective manure spreading on farmlands and improvement of liquid manure storage methods. This may increase revenues to farmers, reduce pressure on forestlands (CO2 sinks) and lead to a decrease in number of farmers and favour of skills involving less use of land and thus forests.

Envisaged strategies and actions for reduction of GHG in the land and forest affectation sector are shown in the table below:

Table 24: Strategies and actions to reduce GHG in land allocation and forestry sectors

Strategies	Actions
Reduction of deforestation rate	- To sensitise the public opinion on importance of conservation; - To build required capacities to intervene in the field of education for conservation; - To ensure respect of the legislation in conservation sector of the protected areas; - To initiate income generating projects in the vicinity of protected areas (apiculture, basketry, medicinal plants); - To develop community based forestry management; - To promote the use of alternatives to direct or indirect use of wood in construction works;
Increase of afforestation area	- To reforest still bared or nearly bared lands on hillsides. - To find and introduce afforestation species adapted to dry areas; - To develop and popularise agro forestry techniques; - To create green spaces in the urban areas and extend afforestation along the road axes.

3.5. SECTORS OF WASTES AND WASTEWATERS DISPOSAL

3.5.1. WASTES DISPOSAL

Options to reduce greenhouse gas in the sector of wastes disposal are related to biological treatments (biogas production, composting, manure spreading and landfill) and thermal treatment (incineration, thermal plasma, cracking and vitrification), recycling, reuse, physico–chemical treatments and deep landfill.

3.5.2. WASTEWATERS DISPOSAL

Options for reduction of greenhouse gas in the wastewaters sector are:

- Banning wastewater flows on public roads;
- Banning use of cesspools for disposal of residuary urban waters;
- Imposition of water treatment taxes;
- Extension of purification technology by lagoon treatment.

3.5.3 STRATEGIES TO REDUCE GHG IN WASTES AND WASTEWATERS SECTORS

3.5.3.1 STRATEGIES TO REDUCE GHG IN WASTES SECTOR

Table 25: Strategies to reduce GHG in waste and wastewater sectors

Policy/ measure	Type of instrument	Objective and/or emissions reduction method
National communication programme on climate change	- Sensitisation - Information - Education	Campaign to inform the public on climate change and other problems of the atmosphere, coordination by MINITERE
Workshops, symposia, public consultations on possibilities of wastes management in towns and free-will measures	Idem	To assist the urban population, industries, enterprises and communities to take measures in order to reduce wastes and greenhouse gases they generate by encouraging prevention rather than rectification
Programme of studies of greenhouse gases	Idem	Greenhouse gases and global warming are subjects to be considered in curricula of primary and secondary schools
Toll free telephone line about wastes disposal	Idem	A toll-free telephone line allow residents in towns to obtain information and brochures on elimination of wastes
Reduction and/or prevention from sources	Idem and free-will measures	To promote individual management of wastes (zero generation of wastes, discharge of purified effluent, individual composting, reuse of containers, recycling of various objects, creation of products generating less wastes, to put a deposit on drink containers, transformation of wastes in animal feeds, etc.)
Sorting and selective collection of wastes	Laws and regulations	To create an industrial cleaner production centre .It is a simple and flexible system of solid wastes management on small scale including the following integrated components: sorting, storage, collection, transfer and transportation.
Capturing and recovering of methane from landfills and its use for energy	Laws and regulations	To regulate in order to authorise capturing and use of methane released from landfills (generation of energy for cooking, lighting, electricity, etc.) in order to reduce CH4 emissions and impose fines.
Criteria for future landfills	Laws	To authorize only landfill of ultimate wastes to reduce CH4 emissions
Burning of wastes in countryside and towns ; incineration of wastes in towns	Laws and regulations	Wastes management plan must limit quantities of wastes to burn or incinerate by prevention, reuse and recycling
Loans for greenhouse gases reduction programme	Financial incentive programme	To provide low interest rate loans to industries, communities, associations or cooperatives and even families to help them build units for greenhouse gases reduction (bio-digesters, composting mechanisms, etc).
Joint implementation	Free-will measures	Industrialists (or others) generating same kind of wastes can work together to treat their wastes or to share costs of treatment by a special subcontractor

3.5.3.2 STRATEGIES TO REDUCE GHG IN WASTER WATER SECTOR

Table 26: Strategies to reduce GHG in the wastewater sector

Policy/ measure	Type of instrument	Objective and/ or method to reduce emissions
Promotion of lagoon	Legislation	To acknowledge lagoon as sanitation system for individuals or community not larger than 2,000 people
Criterion for septic tanks	Legislation	To encourage Rwandans to equip their houses with septic tanks connected to a lagoon system or other wastewater treatment systems
Criterion for industrial wastewaters	- Legislation - Norms on industrial effluents	To treat on pre-treatment sites all industrial wastewaters before the discharge in ordinary wastewater collection canals or sewage system
Wastewaters Recycling	- Information - Sensitisation - Education	As there is sometimes water shortage in towns and water price is a bit high, wastewaters can be reused and sold at low price either for cleaning of city, windows, houses or use in toilets, in construction works, etc.
To improve efficiency of wastewater disinfections	Legislation	To reinforce « polluter pays » and « cleaner is assisted » principles
Programme of loans to public and private enterprises and districts, sectors and cells	Financial incentives	To set up a programme that offers low interest rate loans to help industry (or other private or public enterprises, districts, etc.) to install their purification treatment units or to associate themselves in order to buy treatment units so as to reduce investment and operational costs.
Wastewaters management plan for each town	- Planning - Legislation	- Formulation of action plans - Drafting of a law on urban management taking into account wastewaters management
Environmental management in each private or public institution	- Sensitisation - Information - Education	To encourage public and private enterprises to create an environmental management position whose incumbent will have a mandate of wastewater management on enterprise's compound

CHAPTER 4: VULNERABILITY AND ADAPTATION TO CLIMATE CHANGES

In Rwanda, we have climate changes related to general circulation of airstreams and variation of temperature in the Central African region where our country is located. In the last 30 years, Rwanda has undergone climate changes with regard to frequency, intensity and persistence of extremes like heavy rainfalls, waves of heat, drought and climatologic variables such as El Nino and Nina. Occurrences of rainfall deficits have reached 16 %.

Frequencies of rainfall deficits and excesses have significantly increased during these last years. Evolution of the climate during the same period has had impact on the environment, economy and human lives.

4.1. VULNERABILITY

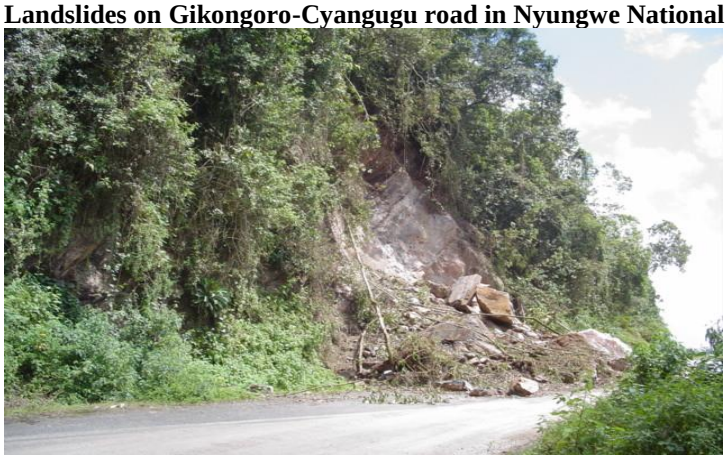
4.1.1. HUMAN SETTLEMENTS, ENERGY AND INDUSRY SECTORS

For the human settlements, energy, and industry sectors, Rwanda has no services capable of quantifying losses due to climate changes. Most of the time figures on human casualties are given but it is very difficult to precise economic losses imputable to catastrophic events relating to these climate changes.

4.1.1.1. EFFECTS OF CLIMATE CHANGES ON HUMAN SETTLEMENTS AND VULNERABILITY

The most frequent direct risks due to evolution of climate on human settlements in Rwanda are related to prolonged drought periods, flooding and landslides following long rainfalls.

Landslides on Gikongoro-Cyangugu road in Nyungwe National Park



- **FLOODS, LANDSLIDES AND COLLAPSES**

Rwanda has a very mountainous relief giving landscape with sloppy hillsides where rainfalls cause erosion on soils that often lack anti-erosion systems. These heavy rainfalls sometimes bring about deadly landslides that damage road infrastructures or sweep away the population's houses in rural areas. Erosion also contributes in agricultural production decrease, causing therefore food insecurity problems.

In urban areas, flood risks are bigger for human settlements located in the valley-bottom areas on riverbanks / lakeshores or marshlands. The overpopulated districts in these zones are threatened by epidemics like malaria and diarrhoeic diseases.

Urban infrastructures are also threatened due to runoff that sweep away land, gravel and other materials that obstruct gutters that collect rain water, hence the overflowing of waters and destruction of roadways and houses built with fragile materials.

- **DROUGHT**

In Rwanda, drought often affects the Eastern and South Eastern parts of the country and sometimes some zones of the central plateau. Effects of drought on food security and livestock constitute major risk elements and create favourable conditions to famines that cause displacements of the populations and transhumance of the livestock.

4.1.1.2. EFFECTS OF CLIMATE CHANGES ON HYDROPOWER INFRASTRUCTURES

Capacity for generation of energy by hydropower stations is affected by climate changes. Decrease of water level in lakes Bulera and Ruhondo has already had significant impacts on electricity production in the year 2003 and 2004, hence serious consequences on socio-economic activities.

4.1.1.3. EFFECTS OF CLIMATE CHANGES ON INDUSTRY

Most of the country's industries operate in Kigali city and the big majority of them are located in the Valley of Ruganwa River as well as in the Valley of Nyabugogo River. These valleys are characterised by very high vulnerability to flooding which causes considerable damages during rainy season as this was the case in September - December 2001 and May 2002.

4.1.2. VULNERABILITY IN FOOD SECURITY SECTOR

In Rwanda, the most frequent direct risks to which agriculture is exposed are related to flooding and landslides. In fact, intensification of rainfalls during the rainy seasons and prolonged droughts periods provoke a considerable decrease of plant and animal production leading to famine and acute hunger.

Erosion phenomenon in cultivated lands

The most recent case of widespread famine occurred in the years 2000 and 2004 in Bugesera and in some other regions of the country. Recurrence of famines and cyclic droughts has contributed to occurrence of increased crisis periods and losses in human lives and economic resources.

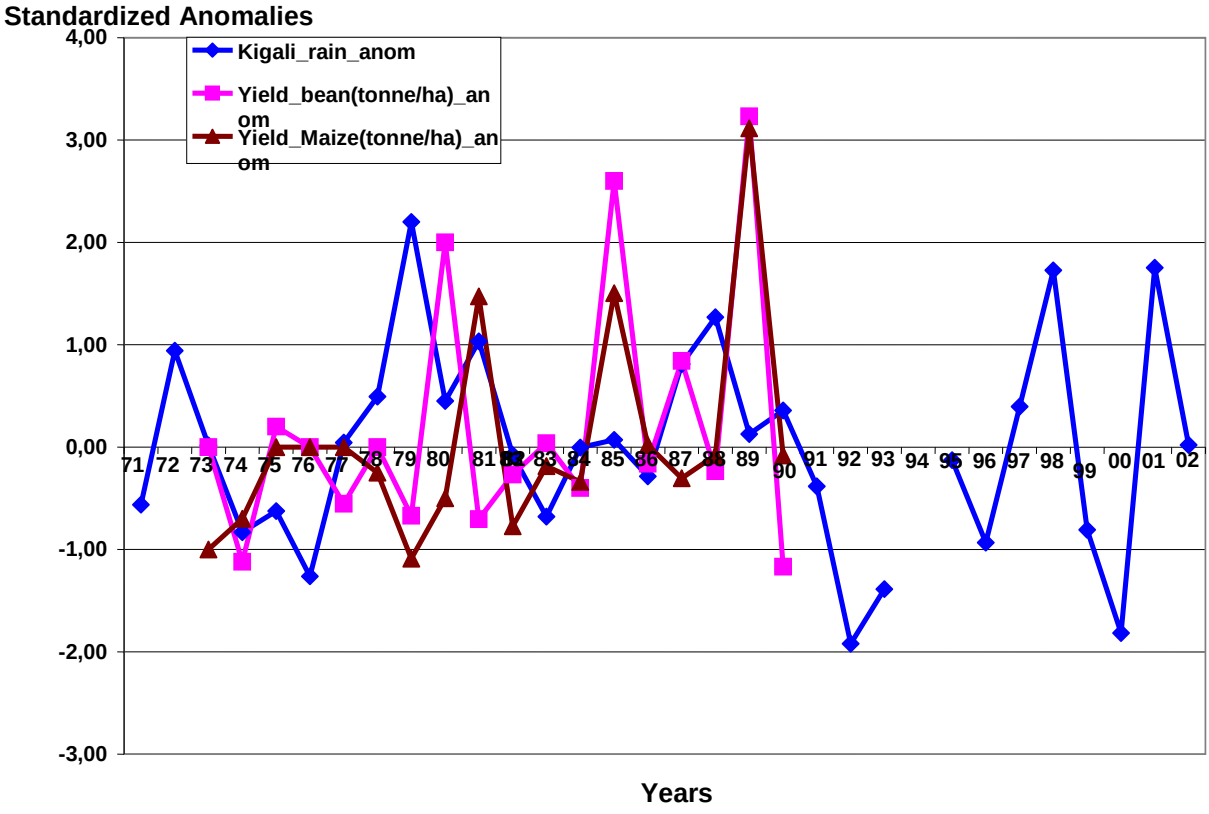
4.1.2.1. FLOODS, LANDSLIDES AND COLLAPSES

Erosion contributes to decrease of agricultural productivity, causing therefore food insecurity problem. It is acute in regions with high altitude in West, Southwest and North of the country and in the Central regions of the country.

Ravin caused by floods

Landslides damage crops and pasturelands and sometimes sweep away the population's houses in rural areas. This was the case of damages caused by Gishwati deforestation in the years 2001-2002 in the Northwest of the country in Kanama District.
During the two rainy seasons, from March until May and from September until December 2001-2002, losses in human lives were estimated at 99 people, affected families by famine at 30,000 and land at 1,645 hectares. The environmental degradation phenomena were the causes for displacements of the population and a slight decrease of agricultural production. The diagram 42 shows standardised irregularities in beans and maize production and rainfalls of the period between 1971 and 2001.

Diag 42: Irregularities in beans, maize and rainfalls between 1971 – 2001



Crops in the valley-bottom districts often undergo decreased production if not total destructions by flooding in marshlands. Each year, there is a loss in the production of beans and maize ranging from 20 to 30 % in the marshlands of Nyabugogo and Akanyaru watershed due to flooding.

4.1.2.2. DROUGHTS

In Rwanda, drought results from drop in rainfalls and very high evapotranspiration. It mostly affects the agro-bioclimate regions of the East and Southeast of the country and sometimes some zones of the Central plateau.

For example, Bugesera used to receive rainfalls between 700 and 800 mm/year before the 90's, but today it only receives 300 mm/year, that is more than 70 % of water deficit. Production of cereals and leguminous plants such as maize and beans has become almost impossible in this region. These conditions of drought have also favoured proliferation of parasites like caterpillars on sweet potatoes and predators of beans.

4.1.3. VULNARABILITY OF FRESHWATER AND LAND ECOSYSTEMS

Freshwater and land ecosystems are exposed to numerous pressures among which land allocation, deposit of nutrients and pollutants, intakes, pastureland, introduction of exotic species and natural variation of the climate.

Negative impacts on physical environment observed following climate changes result from natural hazards like erosion, landslides, flooding, drought, proliferation of competing species, diseases and destructive pests.

4.1.3.1. NATURAL THREATS

- **EROSION, LANDSLIDES AND FLOODS**
  The running of water on sloppy hillsides coupled with the soil's natural fragility sweeps away an important quantity of land towards the valleys.

Slops caused by floods

These land degradations are capable to be accentuated affecting notably a big portion of the country, especially fragile ecosystems of mountainous regions of the North and West. The erosion process in the valley-bottom areas accentuates the silting up of water plans thus making disappear some ecosystems as in the marshland complex of lakes Mugesera – Rweru.

Unforeseen flooding due to considerable irregular rainfalls can have destructive effects in some hours and destruct human lives, houses, livestock, infrastructures and communications. There is also disappearance of species by asphyxiation or simply loss of species swept away by waters.

- **THE WIND**

The violent wind is at the origin of uprooting and breaking up trees that fall down and destruct crops, kill or wound animals and damage houses. Biodiversity losses in some forests are evaluated at 10 % of plants in place, especially in Nyungwe natural forest.

- **DROUGHT**

Drought causes drop of water level from lakes, streams and drying up of sources . Prolonged drought periods affect the biodiversity housing and entails drastic decrease of varieties and species. Drought is often observed in the marshland complex of Akagera river where wetlands remain very sensitive to climate disturbances. During the Nino 1999-2000, 22 hippopotamuses were killed following the drying up of Gabiro / Akagera valley. Drought was also observed in Rugezi marshland where agricultural activities had impacts on maintenance of the water level.

4.1.3.2. ANTHROPOGENIC THREATS

Human pressure on freshwater and land ecosystems is presented under different forms: reduction of protected areas, overexploitation of biological resources, non- regulated introduction of exotic species and bush fires.

- **DEMOGRAPHIC PRESSURE**

High demographic increase of the Rwandan population exercises pressure on natural ecosystems. This pressure is expressed by the big demand in natural resources (land, water, energy, food products), clearing of the ground for agricultural and pastoral purposes, construction of houses and species sampling for craft and medicinal purposes. It particularly affects wetlands with modification and destruction of natural ecosystems causing loss of the flora and fauna of these areas. Today, it is the case of Rugezi marshland which is disturbed by agricultural and pastureland activities on 56 % of its area.

- **BUSH FIRES**

Periodically, both protected and unprotected areas are ravaged by arson. The PNA was the subject of such catastrophe in the year 2002. Negative effects of bush fires are notably:

- Disappearance of both micro-fauna and micro-flora;
- Disturbances and damages to micro-fauna and micro-flora;
- Disturbance of the water regime which can go till the drying up of water sources;
- Acceleration of erosion and modification of the soil's physico – chemical composition;
- Air pollution with greenhouse gas emissions.

Not only bush fires destruct fresh water and land ecosystems but they also propose the ground for continual degradations that make regeneration of genetic resources difficult.

- **IMPACTS IN THE SOCIO-ECONOMIC DOMAIN**

Impacts in the socio-economic domain are presented in different ways. Natural catastrophes like flooding cause deterioration of hygienic conditions for waterside residents following pollution of water that leads to vulnerability due to proliferation of water diseases. Increased rainfalls and high temperatures provoke proliferation of mosquitoes which are carriers of diseases and their survival in higher altitudes.

According to the United Nations' report 2001 on Environment, cases of malaria have been increased to 337 % in high altitude regions since some years ago and 80 % of this increase is imputable to changes both in temperatures and rainfalls.
The livestock contagious diseases like cattle plague and foot-and-mouth disease lead to animals' death. Vegetation is regularly attacked by diseases, pests and different plagues.

4.2. ADAPTATION

4.2.1. SECTOR OF HUMAN SETTLEMENTS, ENERGY AND INDUSTRY

With the little resources available, some adaptation measures can be envisaged to face bad effects of the climate changes.

For ***human settlements and industrial plants***, proposed measures are :

- Plan human settlements, industrial plants and their infrastructures by the use of master plans;
- Plan and implement allocation plans of clustered villages- imidugudu in rural areas;
- Provide the population and local authorities with necessary means to set up anti-erosion works and plant trees where forest plantations have been eradicated;
- Identify first the most fragile zones and build breast walls to protect roads;
- Fight against erosion notably by creating radical terraces on sloppy hillsides;
- Stabilise streams running across urban centres and build protecting walls on both riverbanks where required;
- Develop laws prohibiting the population to build in fragile districts and zones.

For ***energy sector***, the following adaptation measures are considered:

- Invest more in energy generation infrastructures sector by building other hydropower stations. Potentials exist on Nyabarongo river (Bulinga, 28 Mw), Rusizi, Akagera and on smaller streams where there are potentials for micro-hydropower stations;
- Promote new and renewable energies;
- Control erosion on hillsides around Lakes Bulera and Ruhondo to prevent sedimentation that in the long run, would lead to their drying up whereas they stand for compensating reservoirs for Ntaruka and Mukungwa hydropower stations.

Concerning ***industry***, the envisaged adaptation measure consist of moving to appropriate sites most of industrial plants which are presently built in valleys of streams running across Kigali city and which are under constant threat of flooding on occasions of heavy rainfalls.

4.2.2. SECTORS OF AGRICULTURE AND FOOD SECURITY, FRESHWATER AND LAND ECOSYSTEMS

Adaptation measures proposed to the climate changes in these sectors are described below:

Table 27: Adaptation measures proposed in sectors of agriculture and food security, land and freshwater ecosystems

Sector	Vulnerability impacts	Adaptation measures	Policy options	Political implementation framework	Answer strategies
Agriculture	Heavy rainfalls causing soil erosion, landslides, flooding in marshlands and pasturelands, plant diseases, loss of livestock, loss of fertility due to excessive rainfalls	Improvement of soil conservation techniques particularly in highlands (Northwest of Rwanda and zones of Congo-Nile Ridge) and introduction of agro forestry practices. Introduction of new improved crop varieties particularly early-fruiting, resistant and adapted to climate (for example climbing beans in highlands, sweet potato, rice, Irish potato, sorghum and maize)	Set up and use of environment information system Institutional strengthening	Partnership (synergy) among institutions in charge of agricultural production, watershed management, conservation and processing of farm produces as well as catastrophes management	Creation of rainwater dams on purpose of farming and livestock activities Preparation of varieties of drought resistant seeds (gemoplasm)
Food security and land and freshwater ecosystems	Migration of populations	Extension between researcher (ISAR) and farmer, use of fertilisers; Use of improved agricultural and animal husbandry technologies (for example irrigated crops and livestock stalling); Construction of valley-dams; Assistance to poor people; Construction of food stocks; Transformation & conservation of agricultural products; Preparation of land use master plan.	Institutional strengthening	Speeding up adoption of land legislation; set up of hydrological and meteorological observation network	Creation of storage system of phyto sanitary products; creation of anti-erosion structures/works

Radical terrace cultivation on the slopes of the Congo-Nile watershed in Budaha District

CHAPTER 5: PROGRAMMES RELATED TO SUSTAINABLE DEVELOPMENT, EDUCATION, RESEARCH AND SENSATISATION OF THE PUBLIC

Key elements of national programmes for sustainable development are written in major policy sector documents regarding sustainable development like Vision 2020, Poverty Reduction Strategy, the National Environment Policy, Land Policy, National Forestry Policy, National Policy on Management of Risks and Catastrophes, National Agricultural Policy as well as National Strategy and Plan of Actions for Biodiversity Conservation in Rwanda. A chapter "**National Circumstances**" gives a glimpse of their contents.

5.1. SUSTAINABLE DEVELOPMENT IN THE CONTEXT OF CLIMATE CHANGE AND SYNERGY AMONG RIO CONVENTIONS

5.1.1 VISION 2020

Vision 2020 document is a reference for a long term sector planning. It gives major orientations for social and economic development and management of natural resources in 2020 horizon.

Vision 2020 covers 4 transverse domains including protection of environment and aspects regarding climate changes. Among the major aspirations of the country in the year 2020, there is modernisation of agriculture and its integration in economic activities, a rational and sustainable management of the national space, the environment and natural resources such as land, water, energy and biodiversity.

According to the new approach on sector planning which recommends the process of sector groups (clusters) to benefit from contribution of all development actors, most of the concerned sectors tried to respect this approach and produced strategies that integrate adaptation or measures for facing climate changes.

In Vision 2020 document, efforts are made to establish mechanisms for rational management of natural resources and the environment. On the other hand, this document does not propose clear solutions concerning management of natural resources and the environment with regard to climate changes.

5.1.2. POVERTY ALLEVIATION STRATEGY PAPER

According to Participatory Evaluation of Poverty Report written in October 2001, climate hazards are classified in the 3rd position among 10 most important causes of poverty in Rwanda.
Report of the Comprehensive Survey on Household Living Conditions in Rwanda (2000-2001) published in March 2002 shows the major characteristics of poverty in relation with access of the population to services that directly depend on climate phenomena. This includes little access to clean water (52%) at an average distance of collection of 703 m per family, a high level of wood consumption as combustible (90. 2%), degradation of lands in particular and environment in general, mismanagement of water resources and deforestation.
This report has omitted some damages that appear with the phenomena of climate changes and which have a big influence on poverty as they frequently occur. This includes human lives and material losses due to flooding, diseases like malaria, cholera and meningitis and proliferation of bacteria, viruses and crops parasites. Activities for mitigation or adaptation to climate changes in PRSP can be found in many sectors.

According to this document, environment is a cross-disciplinary aspect of which perspectives deserve to be taken into account in every sector Sectors which are considered to be most concerned by control actions or adaptation to climate changes are: agricultural transformation and rural development, economic infrastructures (energy, water, sanitation, roads and transport, terrace cultivation, management of marshlands) and health.

Poverty Reduction Strategy Document also states revision of regulation on the environment and adoption of National Environment Policy. The global objective of this policy has been defined as follows: to improve the human well being, judiciously use natural resources; rationally manage and protect ecosystems for sustainable and equal development.

However, this document should have mentioned the industrial sector among sources of carbonic gas, which is listed among greenhouse gases.

- Agricultural transformation and rural development under this rubric are treated aspects regarding maximisation of agricultural profit by intensification actions, regionalisation of crops, promotion of most competing products, development of land policy and law to ensure security on land holding, support to the increase of investments of poor families by micro-credits and agriculture guarantee fund for promotion of public works on Man Power High Intensity to create employments in rural areas.

However, forestation programmes included in these public works do not clearly mention the role of forests in the reduction of harmful effects of the climate changes.

The PRSP does not mention palliative actions to water deficit like irrigation of dry zones, management of marshlands, techniques for transformation and storage of products for survival in shortage periods, either.

- Economic infrastructures
  This sector foresees actions like agricultural infrastructures, energy infrastructures of which we distinguish from energy of informal sector and that of poor families and rural enterprises, water and sanitation infrastructures, transport and communication infrastructures.

- Environmental health and social protection
  The health sub-sector only counts adaptation actions to the impact of climate changes. Therefore strategies of PRSP that take into consideration climate changes in health sector for prevention or fight against the identified diseases (malaria, meningitis, cholera) are:

- Extension of solidarity health system based on dissemination of most successful practices;
- Provision of health services by community health workers;
- Support to the vaccination programme with the objective of attaining a universal coverage;
- Grant programme for treated mosquito nets in rural areas at affordable prices for the poor;
- Information, Education and Communication “IEC” promotion for diseases that can be prevented;
- Encouragement of communities to take environment measures for fight against mosquitoes.

The social protection sub-sector has been described in PRSP under the name of disadvantaged and vulnerable Groups (MINALOC). Under this form of expression, the PRSP does not clearly show the real causes of vulnerability by dissociating those regarding natural catastrophes such as climate, volcano eruptions, earthquakes, landslide and those related to bad governance or insecurity.

5.1.3. NATIONAL ENVIRONMENT POLICY

The document on National Environment Policy proposes measures to be taken, strategic actions which have direct impact on climate changes in the framework of water resources, forestry and protected areas, biodiversity, agriculture, animal husbandry and fishing, transport and communication, commerce, industry and tourism, energy and mines, and finally atmospheric and natural catastrophes.

5.1.4. NATIONAL FORESTRY POLICY

Some dispositions contained in the National Forestry Policy like promotion of agro-forestry, conservation and rehabilitation of forests and reforestation of lands unsuited to agriculture are good to support adaptation to climate changes.

5.1.5. NATIONAL STRATEGY AND PLAN OF ACTIONS FOR BIODIVERSITY CONSERVATION

The National Strategy and Plan of Actions for Biodiversity Conservation aims at improvement of protection, management and knowledge of protected areas and wetlands, conservation of genetic diversity of indigenous species of plants and animals; durably use biological resources of agro and natural ecosystems and improvement of both the juridical and political frameworks for sustainable biodiversity conservation.

Recommended major actions that take into consideration aspects of the climate change are those regarding rehabilitation and environment of the damaged protected areas, conservation and sustainable utilisation measures of biodiversity.

Other actions concern promotion of modern animal husbandry and agriculture techniques and promotion of the use of new and renewable energies as well as technologies of energy saving.

This strategy also encourages the use of non – degrading mineral exploitation technologies of clearing the wood, fishing, agriculture, etc. Furthermore, it indicates sustainable and efficient traditional production systems and proposes development of policies and laws that favour promotion of conservation and sustainable use of biodiversity together with equitable sharing of benefits from the use of biological resources.

5.1.6. AGRICULTURE POLICY

Agriculture Policy suggests a strategic plan for transformation of agriculture and indirect deals with climate changes. Most of the proposed actions aim at protection and conservation of the soils against erosion and restoration of their fertility.

5.1.7. ENERGY POLICY

Planned activities in the framework of rational management of energy resources will certainly have a positive impact on the climate.
The table below shows strategies, programmes and planned activities for management of energy resources.

Table 28: Strategies, programmes and planned activities for management of energy resources

Strategies	Programmes	Activities
Reduction of fuel wood and charcoal consumption rate	Research for alternative energies	Assessment of potentials in renewable resources, need and demand; Promotion of alternative energy projects (biogas, peat, etc); Extension of improved cooking stoves; Use of methane gas.
	Diffusion of energy conservation technologies	Extension of energy saving cooking techniques; Sensitisation to rational management of energy; Extension of improved charcoal making techniques.
Extension of electricity grid	Rural electrification by extension of existing grid	Study of rural electrification master plan; Project identification; feasibility study; project implementation.
Isolated electricity grid supplied by micro-hydropower stations	Rural electrification by micro-hydropower stations	Project identification; feasibility study; project implementation
Isolated electricity grid supplies by solar power	Rural electrification by solar power stations	Electrification of remote public institutions : health centres, schools, district headquarters, telecentres and water pumping stations in rural areas
Environmental section integrated in all energy generation projects	Environmental impact assessment prior to projects implementation	Review of current standards; conformity studies; studies of lake Kivu monitoring system during methane gas extraction; environmental impact assessment for all energy related project

5.1.8. RISKS AND CATASTROPHES MANAGEMENT POLICY

Risks and Catastrophes Management Policy suggests an institutional framework to be set up for a better management of catastrophes and risks including those related to climate changes. Proposed structures are placed at national and local government levels and are made of economic or emergency structures.

5.1.9. CORRECTIVES MEASURES

Assessed documents on sustainable development contain many orientations that can positively influence adaptation to climate changes. Implementation measures of sustainable development policies are, among others, management of wetlands, reforestation of all free lands and likely to be freed Programmes of erosion control, all initiatives of sustainable management of water resources, desertification under all its forms and other actions favourable to maintenance of quality of environment should be encouraged.

5.1.10. RELATIONSHIP BETWEEN SECTOR STRATEGIES AND RIO CONVENTIONS

By comparing strategic actions of Rwanda to those incumbent on parties to Rio conventions (Biodiversity, Desertification and Climate changes), one can see that there is a strong correlation between measures required from parties to these conventions and the adopted national sector strategies for poverty reduction.

In order to induce more synergy between the Rio Conventions and integrate environment in all socio-economic sectors, it is necessary to act rather according to multi-sector programme approach than project approach. This requires provision for programmes of adaptation to the climate changes or mitigation of their devastating effects in provincial strategic plans including highly vulnerable regions.

In order to make PRS and sector strategies more relevant to address climate changes related vulnerability, in the way of mitigation or adaptation, while observing clauses of Rio conventions, some additional elements to suggest are :

FOR PRSP:

- Among the causes of poverty, to mention those which are related to natural catastrophes including those due to climate changes;
- Improve the chapter on environment taking into account land and environment policies which are in relation with the climate changes;
- Show existing cause -effect relationship in each sector when proposing strategies to be included in the PRSP for mitigation or adaptation to climate changes;
- Add research activities; those of technological transformation; use of organic fertilisers, promotion of commercial exchanges in the agricultural domain;
- Insert industrial sector in the PRSP not only for promotion of private sector but also for promotion of food processing units and conservation of farm produces.

FOR SECTOR STRATEGIES

- When analysing sector problems, to indicate problems of gas emission originating from sanitation sectors (solid wastes, industrial and domestic wastewaters), industry and transport sectors;
- Use the SWAP approach to harmonise complementary sector strategies. This particularly concerns agriculture where duplications exist with the Ministry in charge of environment, lands and forestry, the Ministry in charge of infrastructures, the Ministry in charge of commerce and industry and the Ministry in charge of community development.

This is valid for water resources that require consultation with the Ministry in charge of water, the Ministry in charge of agriculture and the Ministry in charge of infrastructures.

- **IN THE WATER SECTOR**

- Separate strategies related to water management as a natural resource to be managed especially in the context of regional integration from those related to infrastructures so as to increase industrial and domestic water services ;

- Add the development of new technologies to raise water service rate like collection and storage of rain waters, collection of underground waters, the use of photovoltaic and manual pumps, etc;
- Add construction of held water for different socio-economic use (domestic, industries, hydropower, irrigation, livestock, etc.);
- Add protection of rivers and streams against pollution and sedimentation (against water hyacinth, flooding);
- Add the revival of hydrologic service at the district level so as to facilitate regular publication of hydrologic annuals and make provisions on rising and flooding.

- **IN THE FORESTRY SECTOR**

- In conformity with the convention on fight against desertification, implement results of research institutions like ISAR on introduction of species that resist to drought;
- Design income generating projects around forest areas so as to prevent deforestation or poaching practiced by poor populations for different uses (agricultural, combustible, hunting).

- **IN THE AGRICULTURAL PRODUCTION SECTOR**

- Add food security to the sector's title both in the PRSP and sector strategy;
- Take into consideration results from research institutions and propose introduction of precocious varieties and those which resist to drought;
- Add creation of food security strategic stores in all districts.

- **IN THE INDUSTRIAL SECTOR**

Propose, in consultation with the Ministry of Agriculture and Livestock, development of processing industries for agriculture produces to allow farmers to join the two agricultural seasons in food crops and increase the added value of produces for which the prices fall by the time of harvest.

- **IN THE METEOROLOGY SECTOR**

Reinforce the national meteorological service by rendering it autonomous at the service of all sectors with a view to give it the possibility of disseminating information on weather forecast and prevention of natural catastrophes on time.

5.2. EDUCATION AND RESEARCH

5.2.1. FORMAL EDUCATION

Education plays a very important role in the development process particularly in dissemination and assimilation of information including information on climate changes.

- **PRIMARY EDUCATION**

In primary school, curricula of geography and environment and sciences and elementary technologies are elaborated in a view to bring pupils to know the existence of some elements of human and environment. The latter is limited on a simple enumeration and brief description and puts aside the cause -effect relationship.

At the first level, this programme does not allow pupils to notice interactions or interdependence that exist between the same elements due to the little capacity of understanding. At the second level, the programme consists in initiation to exploration of earth using observation, manuals, plans, maps and photographs, etc.

The content of this programme seems to be complete but the teacher should rather insist on consequences of the climate changes basing the course on elements planned in the programme. For example: consequences of deforestation, bush fires, land overexploitation, importance of protected areas on the climate (national parks, natural forests, and gallery forests).

In primary school, curricula of geography and environment should include concepts of environment balance, causes, effects and manifestations of climate change in environment as well as adaptation measures.

- **SECONDARY EDUCATION**

At the first level, the programme is limited on initiation to knowledge of the structure and internal movements of the globe that explain formation of the relief. It also deals with different external phenomena that shape the relief (erosion). This programme introduces aspects of the nature conservation, environment degradation (deforestation, destruction, poach, erosion, land degradation, overgrazing, industrial waste, etc.) and solutions to be considered. It concerns simple enumeration and description of importance of environment elements without referring to their implication in climate changes which are considered as the cause for degradation of that same environment.

At the second level, the programme is concentrated on points relating to the population, agriculture and animal husbandry, forest exploitation, fishing, mines and mineral exploitation, industrialisation, transport and communications, commerce and international exchanges and pollution of the environment. By the end of secondary education, the programme insists on physical, human and economic aspects of Rwanda in a view to promote a better knowledge of the country, its problems and solution approaches especially through regional integration and open international cooperation.

In general, curriculum of secondary education is characterised by lack of cause -effect relationship. This leads us to recommend that it should emphasize erosion factors and the causes of environmental degradation could be among factors of climate changes and therefore introduce climate changes phenomena.

- **HIGHER EDUCATION**

Organisational structure of higher education does not refer in any way to climate changes. In fact, beside courses and/or environment related branches (ex: regional development, environmental sciences, ecology and environment, etc.), more or less deeper concepts are found in branches dealing with natural sciences and technology, commerce and environment, agronomy, medicine, research and development, industry, hygiene and sanitation, pollution and wastes management.

5.2.2. STRATEGIES TO INTEGRATE ASPECTS OF CLIMATE CHANGES IN FORMAL EDUCATION

With the purpose of facilitating efficient integration of climate changes phenomenon in formal education, some actions and strategies will have to be implemented with a participatory approach of all actors including development of both human and material capacities.

Taking into account the already existing programmes in primary, secondary and higher education, the following priority actions have to be considered:

- Integrate environmental education in all education programmes and at all levels of learning;
- Show evils of forest destruction and of bush fires;
- Organise visits in national parks and reserves or in other protected areas in a view to arouse conscience of the youth on respect for environment;
- Multiply systematic monitoring networks so as to allow a better understanding of the climate at local and regional level and avail weather forecasts;
- Support different youth associations on conservation and protection of environment;
- Diversify education means: material, audio-video; newspapers, prize competitions such as poetry, theatres, radio and television reports in order to sensitise the public and the youth in particular on devastating effects of climate change.

5.2.3. NATIONAL ACTIVITIES OF SCIENTIFIC RESEARCH

Research activities are conducted in public and private research institutions and centres of higher learning. The most important research or higher learning institutions at the national level are the Institute for Scientific Research and Technology (IRST), Rwanda Institute of Agronomic Sciences (ISAR) and Rwanda National University. Recently, research units and/or of higher learning have been increased including the private sector (ULK, UAAC, UNILAK, KIE, INADES, etc.).

According to the inventory of Scientific and Technology Potential carried out in December 1999, 92.4% of scientific and technology institutions are located in five Ministries: MINEDUC, MINICOM, MINISANTE, MINAGRI and MININFRA.

In 1999, 86.9% of research units were operational. Among active units, industries and STA units (Scientific and Technology Activity Units) have an important place if compared to research or higher learning. Institutions.

Industrial and STA units are involved in activities which are directly oriented in accordance with their specialisations. These activities do not take into consideration aspects of the climate changes. Only some research or higher learning institutions conducting fundamental research have initiated projects that do not directly or indirectly take into account aspects of the climate changes. Those are UNR, IRST, ISAR, KIST and KIE especially in the framework of the students' dissertations.

Research activities directly or indirectly related to aspects of climate changes are hereafter:

- Production and dissemination of improved cooking stoves;
- Energy valorisation of biomass by using a biogas digester;
- Photovoltaic electrification in rural areas including water pumping by using solar energy;
- Solar drying of food products;

- Estimation of global solar radiation over Rwanda;
- Evaluation of sedimentation effects, shelter degradation pollution and poisoning of Rwandan lakes on bio- aquatic resources;
- Evaluation of human activities' impact on ecosystems;
- Research on water pollutants in Rwanda and their impact on sub – regional environment;
- Identification of natural products and atmosphere pollutants by using spectroscopy acoustic photo method;
- Use of forestry products and its impact on conservation of Nyungwe national park;
- Assessment on erosion processes and mechanisms and its effects on soil productivity;
- Assessment on management of liquid and solid wastes in Kigali city;
- Production of vinegar from pineapple peeling wastes in the juice production plants;
- Quantitative rainfalls forecasting for Rwanda using NCEP – ETA Model;
- Characterisation of wind sources in Rwanda.

Major problems encountered in research institutions are related to lack of funds, insufficiency or non- qualified staff, poor documentation and equipment, etc. Therefore, at the national level, the evaluation planning of research- development is quasi negative.

To overcome these obstacles, it has been envisaged to look for funds, recruit adequate staff, seek external expertise and train the available staff.

5.3. INFORMAL EDUCATION, INFORMATION AND SENSITISATION OF THE PUBLIC

Education, training and sensitisation of the public constitute the main pillars of policies and strategic orientations set up by the Government of Rwanda in order to face environment degradation problems and promote sustainable development. Those are environment, land, forestry and water policies of which the principles are centred on Vision 2020 and the National Poverty Reduction Strategy.

Education, training and sensitisation of the public on environment problems especially on climate changes remain a challenge. In fact, climate changes are among major environmental problems that Rwanda is facing today.

Education and sensitisation programmes to the benefit of the public do exist at national level. However, these programmes remain insufficient or inappropriate. The result from this situation is that the majority of Rwandans have no access to information on climate changes, especially on the phenomenon of greenhouse gas emissions as well as their socio-economic impacts on the populations' life.

The existing informal education programmes are implemented by different institutions such as ministerial departments, public institutions, the private sector, NGOs and the civil society. On the other hand, exceptional activities are conducted by different actors to educate and sensitise the public on fight against poverty, protection of environment and fight against climate changes and their effects.

Poor people rely more directly on natural resources for their subsistence and are therefore much affected by environmental degradation due to climate changes.
Education and sensitisation of the public and poor populations in particular are therefore very important for adaptation to climate changes vulnerability.

5.3.1. INFORMAL EDUCATION

The current permanent informal education programmes in the country that can significantly contribute to education and sensitisation of the public have to be extended to its training on climate change and its effects. These programmes include functional basic literacy teaching and appropriate technologies together with Vocational Training by MINEDUC.

In Rwanda, there is no national permanent training programme for the public in the context of climate. Trainings are only organised for authorities, field technicians, and grassroots leaders.

Through functional basic literacy teaching, the used education entertainments approach that deals with community preoccupations is a good method for education, information and sensitisation about climate changes and their effects. The tackled topics are particularly related to agriculture and animal husbandry, nutrition, reproductive health, epidemic diseases and HIV/AIDS, hygiene and sanitation, land conservation, erosion control, environment, management of water resources and agro-forestry. Unfortunately, topics conforming to climate changes are treated without much referring to their impacts and vulnerability.

5.3.2. TRAINING, INFORMATION AND SENSITISATION OF THE PUBLIC

Sensitisation of the public constitutes a key factor in the implementation of the United Nations' Convention on climate changes. The public's level of understanding of problems related to climate changes will allow it to play its full role when putting in place policies and making decisions for the very purpose.

Information and sensitisation programmes for the public in the context of climate changes are available and include information and sensitisation activities concerning:

- Production and diffusion of tools for information and sensitisation of the public;
- National and international weeks and days of environment, water, meteorology, tree planting and biodiversity, etc;
- Radio and/or televised magazines;
- Sensitisation campaigns or tours organised in vulnerable zones.

In this context, activities are oriented towards production and dissemination of extension material (posters, booklets, documentary films, magazines, leaflets), and tools made of publications and printed matters, sketches, political speeches, media and advertising banners related to environment. These tools are very important to education and sensitisation of the public on effects of climate changes, mitigation and adaptation measures in order to induce attitudes and behaviours favourable to natural resources and environment protection.

Vocational training at the level of Youth Training Centres (CFJ) targets primary school pupils who can't have access to secondary education. It deals mainly with carpentry, agriculture, animal husbandry, masonry, forge, cooking, sewing and plumbing.

5.3.3. DEVELOPMENT OF TOOLS FOR SENSITISATION OF THE PUBLIC THROUGH MASS MEDIA

In order to be able to educate, train and sensitise the public on devastating effects of climate changes and adaptation measures, involvement of private and official media constitutes one of the best strategies. In fact, these media (television, radio and others, notably advertising agencies), have all communication methods and techniques to reach effectively and quickly a large public.

It is in this context that the project "Enabling activities for preparation of the National Initial Communication on UNFCCC" has made translate into Kinyarwanda texts and other documents of international conventions and their protocols on environment, having synergy. These are related to climate changes, biodiversity, control of desertification and protection of the ozone layer, in order to use them as main tools for sensitisation of the public on environmental aspects in general and on climate changes in particular.

5.3.4. TRAINING OF MEMBERS OF THE NATIONAL COMMITTEE ON CLIMATE CHANGE

From October 15 to November 15, 2002, during a mission of UNISTAR expert, M. Monti MASSIMO in Rwanda, training sessions on methods of inventory of emissions and removals of greenhouse gases were organised to the benefit of the National Committee on Climate (NCC) and the team in change of multi-sector studies.

Moreover, M Ravi SHARMA and Miss Liza LECLERC, both representatives of UNEP/GEF, lectured on occasion of national workshops for evaluation of reports on technical studies written in the framework of the "National Initial Communication" project. These lectures were concerned with guidelines of the Intergovernmental Panel of Experts on climate changes for elaboration of national communications and vulnerability/impact assessments and measures of adaptation to climate changes.

CHAPTER 6: OTHER RELEVANT INFORMATION TO ACHIEVE OBJECTIVES OF THE CONVENTION

6.1. RESEARCH AND SYSTEMATIC OBSERVATION

6.1.1. DATA COLLECTION SYSTEMS AND METEOROLOGICAL DATABANKS IN RWANDA

Today, the meteorological service doesn't work properly due to inadequate staffing and lack of data collection, capture and processing equipment. Since it resumed its activities after the war and genocide of 1994, the service has no update climate yearbook and no agro-meteorological bulletin has ever been published so far. As a consequence, recent data needed by various users in their daily activities are missing.

The meteorological service manages a big historical databank dated way back in 1906 and collected from all stations operating before 1994 and those whose activities were resumed from 1998 to 2000 for civil aviation needs, and which are still operating today. This databank is managed with climate software (CLICOM) and includes many weather factors such as rainfalls, temperatures, humidity, sunshine, cloud covering, wind, atmospheric pressure etc. Nevertheless, an important part of data has not yet been computerised and is still referred to in technical documents. The big problem with the national meteorological service is the lack of comprehensive weather observation network as it was before 1994.

6.1.2. DATA COLLECTION SYSTEMS AND HYDROLOGICAL DATABANKS

The year 1972 has marked a particular important step that was characterised by reinforcement of the hydrological service by expatriate French and Belgian technicians. Special efforts to reorganise the service, to rehabilitate the network, to train the staff and to use data have enabled to realise this collection.

Today, the hydrological service is a Division of the Ministry of Lands, Environment, Forestry, Water and Mines. Before the tragic events of 1994, this service managed 47 hydrological stations. Since 1994, the number of stations has decreased following the war consequences and little importance given to evaluation of water resources.

Thanks to FAO assistance, the hydrological service has received modern equipment to automatically measure height and flow rate at some stations on Nyabarongo at Kanzenze, on Akanyaru and on Akagera at Rusumo.

Beside height and river flow rate, the service also has data on water quality in some regions where pilot projects are implemented by NGOs. ELECTROGAZ also manages a databank on water quality, especially drinking water.

Major problems that hinder observations, data collection and processing are little importance given to hydrology, lack of qualified staff, scattering of data and budget limits.

6.2. FINANCIAL AND TECHNOLOCIGAL NEEDS RELATED TO STUDIES OF VULNERABILITY TO CLIMATE CHANGES AT NATIONAL, REGIONAL AND/OR SUB – REGIONAL LEVELS

Appropriate technologies of adaptation to climate changes proposed hereafter can be adapted to Rwanda socio-economic and environment contexts.

These technologies concern industry, energy, human settlements, transport, agriculture and food security, forestry, management of the wastes and wastewaters, hydrology and water resources, freshwater and land ecosystems and health sectors.

Others technologies are related to the behaviour change for consumption of imported products such as importation of lead free fuel and limitation of plastic bags importation and products impoverishing the ozone layer. These technologies are either operating in the country or proposed for an initial implementation. For most of these technologies, available information presents cost estimates, the target group and eventually necessary means for production of some tools meant for adaptation or mitigation of the climate changes effects.

For any technology, socio-economic and environment impact assessments should be carried out before it is disseminated.

6.2.1 ENERGY SECTOR

In the sector of energy, identified technologies are: stove with improved fireplace (cost: 800-1000 RWF), Kenya ceramic stove (cost: 2,000 RWF), Nada Chula stove (cost: 50,000 to75,000 RWF), Nofie stove(cost: 2,000 RWF) and wood-charcoal making.

The various technologies can profit rural, urban and semi-urban populations, clustered settlements and communal establishments (schools, prisons, etc.).

Other options of these adapted technologies, always in the energy sector, are for industrial use, for example MANGIEN and NAVARE ovens as well as brick making by densification, whose target group is rural and urban populations, for a cost estimated at 7 millions RWF.

6.2.2 HUMAN SETTLEMENTS SECTOR

In human settlements sector, identified technologies are appropriate for the field of making construction materials and are divided up into dry pressing (cost: 5 millions RWF); extrusion (cost: 6 millions RWF); “four de campagne à murs verticaux” (cost: 1.5 millions RWF); “four de campagne amélioré continu” (cost: 75,000 RWF); “four à triage par le haut” (cost: 15,000 RWF); “four tranché” (cost: 5 millions RWF); Hoffman oven (cost: 2 millions RWF) and Tunnel oven (cost: 40 millions RWF).

These technologies can be applied for urban and semi-urban populations, and rural populations in clustered villages (imidugudu).

6.2.3. AGRICULTURE AND FOOD SECURITY SECTOR

In agriculture and food security sector, selected technologies are related to making of fodder silos for the livestock (cost: 700,000 RWF) as well as traction farming (cost: 300, 000 RWF) for rural areas.

In the framework of food security, technologies that seem to be most adapted to our country are peanuts or palm oil press (cost: 750, 000 RWF) and indirect solar drier (cost: 250, 000 RWF) used in urban areas or rural areas in clustered villages. As for transport, only animal traction in clustered villages of rural areas seems to be viable at a cost of approximately 300, 000 RWF.

6.2.4. WASTES AND WASTEWATERS MANAGEMENT

In wastes and wastewaters management sector, the proposed technologies are bacterial bed (cost: 150, 000 x 10^3 RWF/1000 EH); biological disk (cost: 125,000 x 10^3 RWF/1000 EH); activated sludge (cost: 160, 000 x 10^3 RWF/1000 EH); trickling filtration on sand (cost: 130 x 10^3 RWF/1000 EH); up-flow plants filters (cost: 130, 000 x 10^3 RWF/1000 EH); advection-flow reeds filters (cost: 130, 000 x 10^3 RWF/1000 EH); natural lagoon treatment (cost: 130, 000 x 10^3 RWF/1000 EH); aerated lagoon treatment (cost: 80, 000 x 10^3 RWF/1000 EH) but also improved latrines with ventilated pit (cost: 90, 000 x 10^3 RWF and 200, 000 RWF/ < 8 EH, 50, 000 RWF); composting by Indore method and biogas production (cost: 1,000 x 10^3 RWF per medium-size system).These technologies can be used by urban and rural populations in clustered villages.

6.2.5. HYDROLOGY AND WATER RESOURCES

In the domain of hydrology and water resources, proposed technologies are irrigation pump with pedal (cost: 700 x 10^3 RWF), animal traction pump (cost: 700 x 10^3 RWF), solar-geared pump (cost: 3, 650 x 10^3 RWF) as well as basket-shaped water reservoir (cost: 150, 000 RWF/m^3) for roof rainwater harvesting. These technologies can be adapted for the rural populations in clustered villages.

6.2.6. INDUSTRIAL SECTOR

In the case of industry related technologies, for better adaptation to climate changes caused by greenhouse gas emissions in lime and cement factories, recommended adaptation measures for developed countries consist of production of slag- based cement, which is actually beyond Rwanda's economic reach. As for a corrective measure, intensive reforestation around these factories is highly recommended.

6.2.7. SECTORS OF LAND AND FRESHWATER ECOSYSTEMS, FORESTRY AND HEALTH

Technologies related to the sectors of land and freshwater ecosystems, forestry and health are respectively: greenbelts around lake zones, grafting and treated mosquito super nets against malaria.

The target group is specifically the population living in lake zones, the rural population and eventually the whole population when considering treated mosquito net.

BIBLIOGRAPHY

1. ApproTEC *:* Super- MoneyMaker, pompe à irrigation, Guide d'utilisation.

2. B. KAGIRANEZA et ISAR, le Greffage dans l'Horticulture : Application à l'avocatier et aux Citrus au Rwanda ; 2002.

3. Banque Nationale du Rwanda, Statistiques économiques et financiers, mars 2003.

4. Barker T & Srivastava L. , 2001.Sector costs and ancillary benefits of mitigation.

5. C. PUECH, série Hydrologie , 1983: Persistance de la sécheresse au Sahel- conséquences sur les normes hydrologiques et pluviométriques.

6. Cabinet SAM/KP: Etude d'un projet d'assainissement dans les secteurs de Kimisagara et Nyakabanda, district de Nyamirambo, ville de Kigali, dans le cadre du programme des modules de développement urbains : collecte sélective et valorisation des déchets solides, appui à la construction et amélioration des latrines, appui à la collecte et stockage d'eau de pluie, Kigali, novembre 2001.

7. Calet, C., Dronne,Y., L'approvisionnement protéique des hommes et des animaux. Aspects nutritionnels, économiques et réglementaires, collection sciences et techniques agroalimentaires, Lavoisier TEC DOC.

8. Centre de la Tribune Internationale de la Femme /Service International d'Appui à la Formation et aux Technologies en Afrique de l'Ouest et au Sahel/ I.T. publications, Guide Mondial des Techniques et Outils, Catalogues des Techniques Utilisées par les Femmes dans le Monde Entier, Dakar-Sénégal, 1990.

9. Centre de Recherches pour le Développement International du Canada (CRDI), La santé et l'environnement, pour une collectivité active en recherche, Ottawa, Canada, 1992.

10. CERATEC : Production de matériaux de construction en technologie adaptée, Rue du Touquet, 228, Belgium, 1988.

11. CGIS-UNR : Environnement et Pauvreté, Etude Pilote pour une cartographie des Relations entre Environnement et Pauvreté, UNDP- Kigali, avril 2003.

12. Commission Européenne, Guide de Procédés Extensifs d'Epuration des Eaux Usées Adaptées aux Petites et Moyennes Collectivités (500-5000 E.H), 2001.

13. Coosmans, (M) & Hakizimana, (E), 2003. - Protocole pour la prévention des épidémies de paludisme au Rwanda. *Kigali*. 34 pp.

14. D. Chabi – Gonni, 1984, CIEH , série Hydrologie 1984 : Courbes hauteur de pluie durée-fréquence en Afrique de l'Ouest et Centrale pour des pluies de durée de 5 minutes à 24 heures.

15. DHS 2000 ; Rwanda : Stratégie de réduction de la pauvreté, 2002, p.31.

16. DSA, MINAGRI 2001: Statistiques Agricoles : Superficie des marais, Rapport non publié.

17. EICV/MINICOFIN

18. Encyclopédie Scientifique et Technique, Edition lidis, 1974 ; Page 73-75 et Page 90-92.

19. ESMAP, Rwanda : Problèmes et Choix Energétique, Rapport N°.8017-RW, juillet 1991.

20. Etude du Plan Directeur d'Aménagement et de Mise en Valeur des Vallées de la Nyabarongo et de l'Akanyaru : Phase 1 : Etude de base, Rapport Définitif MINAGRI – SOGREAH, Septembre 1988.

21. Evaluation Hydrologique en Afrique Subsaharienne : Pays de la C.E.P.G.L. Rapport de Pays : RWANDA, SOGREAH, Juin 1993.

22. Experco,1999. Enquête agricole nationale. Version définitive. Experco internationale et SCET Tunisie, Juin,1999, n° 6886/2.

23. FAO, Etude sur les Ressources Forestières Naturelles et les Plantations Forestières du Rwanda, Septembre 1999.

24. FEWS NET, 2002. Rapport mensuel sur la sécurité alimentaire au Rwanda. Rapport USAID. page 8.

25. FSRP/DSA, 2000. Statistiques agricoles : Production agricole, élevage, superficies et utilisation des terres. Année agricole 2000. MINAGRI. Kigali.

26. FSRP/DSA, 2001. Statistiques agricoles : Production agricole, élevage, superficies et utilisation des terres. Année agricole 2001. MINAGRI. Kigali

27. Gamrasni M.A., 1984. Utilisation énergétique des boues et des déchets 21, rue de Madrid, 75008, Paris, pp123 – 140.

28. GAPUSI, R.J. (1999). Identification et analyse des options stratégiques pour la conservation de la biodiversité dans le Parc National de Nyungwe.

29. Gervais J.B.,1999. Agriculture : Un secteur clé en crise da*ns* Marchés tropicaux et Méditerranéens. Paris, ISSN, N° hors série, octobre, 1999, pp 24-31.

30. GIEC 2001 : Bilan 2001 des changements climatiques. Mesures d'atténuation, rapport du groupe de travail III du GIEC.

31. GIEC : Lignes directrices du GIEC pour les inventaires nationaux de gaz à effet de serre-Version révisée 1996 : Manuel simplifié.

32. GIEC, 1996: Techniques, Politiques et Mesures d'atténuation des Changements Climatiques. Document techniques I du GIEC [Robert T. Watson, Marufu C. Zinyowera, Richard H. Moss].

33. GIEC, 2001. Summary for policymakers. Climate change 2001: Mitigation. A report of working group III of the intergovernmental panel on climate change.

34. GIEC, 2001: Bilan 2001 des Changements Climatiques: Conséquences, adaptation et vulnérabilités. Contribution du Groupe II au troisième rapport d'évaluation du GIEC.

35. GIEC, 2001: Technical summary, Climate change 2001: Mitigation, a report of working group III of the intergovernmental panel on climate change.

36. GIEC,1996 : Lignes Directrices révisées pour les inventaires nationaux de gaz à effet de serre.

37. GIEC: Troisième rapport d'évaluation du GIEC, Changements climatiques 2001 : Rapport de synthèse, Résumé à l'intention des décideurs.

38. Groupe d'experts intergouvernementaux sur l'évolution du climat, Aspect scientifique du changement climatique, Rapport rédigé pour le GIEC par le Groupe de Travail I, juin 1990.

39. GTZ : La Traction Animale en Afrique, Eschborn 1982 ; C.E.D.R. et GTZ, Guide de Construction et d'Utilisation des Installations BIOGAZ, Maroc, septembre 1996 .

40. Hammerich (A), 2000. - epidemiology of malaria in three Rwanda hospitals and their respective health regions with special view to pregnancy. *University of London*. 51 pp.

41. Hydrologie Tropicale et Appliquée en Afrique subsaharienne : Bernard Chieville OUAGADOUGOU, 1990.

42. IPCC (1996). Economics of Greenhouse Gas limitation. Main report "Methodological guidelines".

43. IPCC, 2001. - Climate Change 2001 : Impacts, adaptation and vulnerability. Cambridge University. 1005 pp.

44. ISAR, CIAT, USAID, dépliant « Icunga rya kijyambere muri ISAR » ; Centre pour notre Avenir à Tous, Un programme d'action, sommet de la Terre 1992.

45. J. A Rodier, cahier ORSTOM, série Hydrologie, vol. XIII, 1976 : Evaluation de l'écoulement annuel dans les régions tropicales sèches d'Afrique Occidentale :

46. J.F. GOTANEGRE, C. PRIOUL & P. SIRVEN, Géographie du Rwanda, éd. A. BOECK-BRUXELLES, EDITIONS RWANDAISES, 1974.

47. Jean Damascène NDUWAYEZU : Les Fondements Physiques, Humains et Economiques du Développement du Rwanda, Editions Universitaires du Rwanda, Ruhengeri, 1990.

48. Jean F. Feenstra, Ian Burton, Joel B. Smith and Richard S.J.Tol, Handbook on Methods for Climate change Impact Assessment and Adaptation Strategies, UNEP, October 1998.

49. John M. Callaway, Jorgen Fenhan, Roger Gorham, Willy Makundi, Jayant Sathaye; 1999: Economic of Greenhouse Gas Limitation. Published by by UNEP collaborating Centre on Energy and Environment. Riso National Laboratory, danmark, 1999.

50. Lester R.Broun, L'Etat de la Planète, Nouveaux Horizons, Economica, Paris, 1990

51. Markandya A. & Halsnaes K., 2001. Costing methodologies.

52. Michael Keating : Un programme d'Action, version pour le grand public de l'agenda 21 et des autres accords de Rio, Sommet de la Terre *1992*, 52, rue des Pâquis, 1201 Genève, 1993 ;

53. MINAGRI 2003 : Agenda agricole.

54. MINAGRI : Plan stratégique du MINAGRI pour l'année 2000-2010.

55. MINAGRI : Stratégie alimentaire et Plan d'action pour la sécurité alimentaire, octobre 1998.

56. MINAGRI, 2000. Les grandes lignes de la politique agricole. MINAGRI, Kigali.

57. MINAGRI, 2001a. Plan stratégique du MINAGRI : 2000-2010. MINAGRI, Kigali.

58. MINAGRI, 2001b. Rapport annuel. MINAGRI, Kigali.

59. MINAGRI, 2002. Rapport annuel. MINAGRI, Kigali.

60. MINALOC, 2002. – Evaluation de la capacité d'intervention face à tous les risques.

61. MINALOC, 2003. – Projet de politique nationale de gestion des risques et des catastrophes au Rwanda. Kigali, 24 pp.

62. MINALOC, Politique Nationale de Gestion des Risques et des Catastrophes au Rwanda, avril, 2003.

63. MINALOC, Stratégies du secteur de la Protection Sociale, juillet 2004.

64. MINANI Faustin/PNRP : La Revue de littérature sur les causes des disettes et Famines au Rwanda ainsi que les mesures prises pour pallier à ces fléaux, Kigali, août 2001.

65. MINECOFIN (2000). Indicateurs de Développement du Rwanda, n°3.

66. MINECOFIN (2001). Stratégie de la réduction de la pauvreté ; 186 pp

67. MINECOFIN: Un Profil de la Pauvreté au Rwanda, Un rapport basé sur les résultats de l'Enquête Intégrale sur les Conditions de Vie des Ménages 1999-2001, Kigali, février 2002.

68. MINEDUC DRST : Répertoire des projets de recherche, année 2002, Kigali, 2003.

69. MINEDUC : La Politique Sectorielle de l'Education, septembre 2002

70. MINEDUC, Inventaire du Potentiel Scientifique et Technologique, décembre 1999

71. MINEDUC, Plan Stratégique du secteur de l'Education 2003-2008, avril 2003.

72. MINICOFIN, 1999. Background to the Budget 2000. Rwanda's challenges on the eve of the millennium: economic recovery, poverty reduction and sustainable development.

73. MINICOFIN, 2001. Mission d'étude de la planification forestière de la province de l'Umutara. Rapport. Projet de Développement des Ressources Communautaires et des Infrastructures de l'Umutara. 35 p.

74. MINICOM : Stratégies Sectorielles du Ministère du Commerce, de l'Industrie, de la Promotion des Investissements, du Tourisme et des Coopératives, Partie IV : Industrie, Kigali, avril 2004.

75. MININFRA/ Rwanda Meteorological Service, Workshop on Application of Climate and Weather Information for Sustainable Development, Kigali, December 2003.

76. MINISANTE, 2002. –Rapport annuel des activités. *Kigali*. 74 pp.

77. Ministère de l'Administration Locale, du Développement Communautaire et des Affaires Sociales : Politique Nationale de Gestion des Risques et des catastrophes au Rwanda, Avril 2003.

78. Ministère de l'Enegie, de l'Eau et des Ressources Naturelles, Inventaire National de l'Alimentation en Eau potable au Rwanda, Edition 2001.

79. Ministère de l'Enseignement Supérieur, de la Recherche Scientifique et de la Culture : Les Actes du Séminaire Atelier sur la Recherche Scientifique et Technologique *;* Kigali, septembre 1996.

80. Ministère des Finances et de la Planification Economique : Programme National de Réduction de la Pauvreté, Rwanda : Stratégie de Réduction de la Pauvreté, juin 2002.

81. Ministère des finances et de la planification économique, Commission nationale de recensement, Service national de recensement, Recensement national de la population et de l'habitat Rwanda 16-30 Août 2002, Rapport sur les résultats préliminaires, Kigali, février 2003.

82. Ministère des Finances et de la Planification Economique, Edition n°5, Août 2002 ; Indicateurs de Développement du Rwanda 2002.

83. Ministère des finances et de la planification économique, Enquête intégrale sur les conditions de vie des ménages au Rwanda (2000-2001), Kigali, mars 2002.

84. Ministère des finances et de la planification économique, Indicateurs de développement du Rwanda 1999, Kigali, Juillet 1999.

85. Ministère des finances et de la planification économique : Indicateurs de développement du Rwanda 2000, Kigali, Juillet 2000.

86. Ministère des finances et de la planification économique n°4, Juillet 2001 : Indicateurs de développement du Rwanda 2001, Kigali, juillet 2001.

87. Ministère des finances et de la planification économique : Indicateurs de développement du Rwanda 2002, Kigali, Août 2002.

88. Ministère des Finances et de la Planification Economique, Novembre 2002 ; Vision 2020.

89. Ministère des Finances et de la Planification Economique, Programme National de Réduction de la Pauvreté : Rapport d'Evaluation Participative de la Pauvreté au Rwanda, octobre 2001.

90. Ministère des Finances et de la Planification Economique, Service National de Recensement, Recensement Général de la population et de l'habitat, Rwanda : 16-30 Août 2002, Rapport sur les résultats préliminaires, Kigali, Févier 2003, 43p.

91. Ministère des Infrastructures : Document des Stratégies Sectorielles du Ministère des Infrastructures 2005-2010 , juin 2004.

92. Ministère des Infrastructures : Stratégies sectorielles des Sous-Secteurs Energie et Gaz Méthane, Rapport Provisoire, janvier 2004.

93. Ministère des Terres, de la Réinstallation et de la Protection de l'environnement : Politique Nationale de l'environnement au Rwanda, Novembre 2001.

94. Ministère des Terres, de l'Environnement, des Forêts, de l'eau et des Ressources naturelles, Politique nationale de l'Habitat, Février 2004.

95. Ministère des Terres, de la Réinstallation et de la Protection de l'Environnement, Rapport National sur les Etablissements Humains Istanbul+5, Octobre 2000, 54p.

96. Ministère des Terres, de la Réinstallation et de la protection de l'Environnement: Stratégie Nationale et Plan d'action pour la conservation de la biodiversité au Rwanda, avril, 2003.

97. Ministère des Terres, de la Réinstallation et de la protection de l'Environnement, Rapport National sur la mise en oeuvre de la convention sur la lutte contre la désertification au Rwanda, Kigali, 2000.

98. Ministère des Terres, de la Réinstallation et de la protection de l'Environnement, Etudes relatives à la protection intégrée et conservation des ressources naturelles des zones humides critiques du Rwanda. Evaluation de la diversité biologique des zones humides, avril 2003.

99. Ministère des Travaux Publics et de l'Energie, Examen et évaluation des questions concernant les établissements humains et le logement par une série d'indicateurs, Rapport définitif, octobre 1995 (ARAMET).

100. Ministère des Travaux Publics et de l'Energie, Rapport national sur les Etablissement humains, Mars 1997, 68p.

101. Ministère du Commerce, de l'Industrie et du Tourisme, Août 2002 ; Politique Industrielle du Rwanda.

102. Ministry of Finance and Economic Planning, Directorate of Strategic Planning and Poverty Reduction Monitoring, Poverty Reduction Strategy Annual Progress Report, September 2004.

103. MINITERE (2003). Projet de loi environnementale ; 26 pp

104. MINITERE (2003). Stratégie Nationale et Plan d'action pour la conservation de la biodiversité au Rwanda ; 82 pp

105. MINITERE et MINAGRI, Direction des Forêts, 2002. Etude pour l'élaboration d'une action stratégique pour la conservation et la gestion de la biodiversité des écosystèmes – cas du Rwanda, 1999.

106. MINITERE : Document des Stratégies Sectorielles du MINITERE (2005-2010), Gestion des Ressources Naturelles et Protection de l'Environnement, Version finale, juillet 2004.

107. MINITERE, Consultation Thématique sur la Réinstallation des ménages vulnérables, Kigali, 2002.

108. MINITERE, National Strategy and Action Plan For The Conservation of Biodiversity In Rwanda, Kigali, March 2004.

109. Moomaw W.& Moreira JR., 2001, Technological and economic potential of greenhouse gas emissions reduction.

110. Nations Unies, Commissions des Etablissements Humains : Des établissements humaines viables dans un monde urbanisé y compris les questions relatives aux politiques foncières et à l'atténuation des effets des catastrophes naturelles, Rapport du Directeur Exécutif, Nairobi 25 Avril- 1er Mai 1995.

111. Ndoba S., 2000. Etude de l'influence du niveau d'alimentation sur la croissance et le développement corporel des génisses de race Ankolé. Mémoire. Inédit, Faculté d'Agronomie, UNR, Butare, 74 p.

112. Nshimiyimana E ., 1985 : L'assainissement et mise en valeur des petits marais au Rwanda. Mémoire. Inédit, Faculté d'Agronomie, UNR, Butare, 138 p.

113. OMM et PNUE (2001). Bilan 2001 des changements climatiques : Mesures d'atténuation. Rapport du groupe de travail III du GIEC.

114. OMM, 2000: L'épisode El -Nino 1997 –1998: Rétrospective scientifique et technique

115. Organisation des Nations Unies pour le Développement Industriel/ Ministère du Commerce, de l'Industrie et du Tourisme (ONUDI/MINICOM), Octobre 2001 : Recensement sur la production des entreprises industrielles, 2000.

116. Organisation des Nations Unies pour le Développement Industriel/ Ministère du Commerce, de l'Industrie et du Tourisme (ONUDI/MINICOM), Octobre 2001 ; Recensement sur la production des entreprises industrielles, 2000.

117. Organisation Suisse pour le Développement et la Coopération (OSDC), Biomasse-Energie, Rapport sur la valorisation énergétique de la biomasse, juin 1990 ;

118. PEAMR, ARAMET : Inventaire des Technologies d'Assainissement Applicables au Rwanda, décembre 2002 ;

119. Plan Directeur et Système de Gestion des Ressources en Eau : Rapport Final, Version Provisoire, MINITRAPE, 1991.

120. PNILP, 2002. – Rapport de l'investigation d'épidémie du paludisme dans le camp des déplacés de Bweyeye, Cyangugu. *Kigali.* 8 pp.

121. PNUE, Bilan 2001 des changements climatiques : conséquences, adaptations et vulnérabilités, rapport du Groupe de Travail II du GIEC, contribution du Groupe d'experts intergouvernemental sur l'évolution du climat.

122. PNUE, De la politique à la mise en oeuvre : Décisions de la cinquième réunion de la Conférence des Parties à la Convention sur la diversité biologique, Nairobi, Kenya, 15-16 mai 2000.

123. PNUE, L'avenir de l'environnement en Afrique ; le passé, le présent et les perspectives d'avenir, Royaume-Uni en 2002.

124. PNUE, OMM, Groupe d'Experts Intergouvernemental sur l'Evolution du Climat, Bilan 2001 des Changements Climatiques : conséquences, adaptation et vulnérabilité, Rapport du Groupe de travail II du GIEC.

125. PNUE, une guide simplifié du rapport GIEC : « Changement climatique 2001 » : Atténuation, Juin 2003.

126. Politique Nationale de Gestion des Ressources en Eau : MINAGRI, Juillet 1998.

127. Pré-Etude de la Qualité des Eaux du Rwanda : MINITRAPE – UNICEF, Décembre 1995.

128. Préfecture de la Ville de Kigali, Rapport de présentation du Schéma Directeur d'Aménagement et d'Urbanisme, Février 2001, p.109.

129. République française, 1991.Ministère de la coopération et du développement. Mémento de l'Agronome. Quatrième édition. Collection « Techniques rurales en Afrique », Paris, 1635 p.

130. Rwanda society-environment project, working paper, October 1993.

131. SAR II, IPCC, 1996: Climate Change 1995: Impacts, adaptation, and mitigation of Climate Change: Scientific-Technical analyses. Contribution of Working Group II to the second assessment report of IPCC [Watson R.T., M.C. Zinyowera et R. H. Moss].

132. Sathaye J & Bouille D., 2001. Barriers, opportunities , and market potential of technologies and practices.

133. SEPA, 2001: Sweden's third national communication on Climate Change. Swedish Ministry of the Environment,Vasteras,Sweden.

134. SGI Ingénieurs-Conseils, Lahmeyer International : L'assainissement des eaux usées de la Ville de Kigali, tranche II, rapport définitif, Kigali, avril 1996.

135. Tsuneyuki M. & Robinson J., 2001. Greenhouse gas emission mitigation scenarios and implications.

136. UICN,BRAO,GWP-WAWP,CILSS, Eau, Changement Climatique et Désertification en Afrique de l'Ouest : Stratégie régionale de préparation et d'adaptation, Ouagadougou, 3 octobre 2003.

137. UMUNEZERO O., 2002. Principales activités réalisées la au sein de station zootechnique de l'ISAR SONGA pour l'augmentation des performances zootechniques de la race Ankolé par l'amélioration de son génotype et de son phénotype. Rapport de stage. Inédit, Faculté d'agronomie, UNR, Butare, 50 p.

138. UNEP, Handbook on Methods for climate Impact Assessment and adaptation strategies, Version 2.0.

139. UNF CCC, Comprendre les changements climatiques : visite guidée à l'intérieur de la Convention – cadre des Nations Unies et de son Protocole de Kyoto, Genève, 1999.

140. UNFCCC, Guidelines for Impact and Adaptation Assessment: Design versus Implementation Issues, June 2001.

141. UWIZEYIMANA Laurien : Périodicité des Crises alimentaires au Rwanda, Essai d'Interprétation, Presses Universitaires de Ruhengeri, avril 1990.

ANNEX 1. CO_2 emissions tendency from petroleum products (in Gg CO_2)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Combustible													
Petrol Super	101.86836	78.63805	96.65561	90.88644	33.18865	60.38377	92.32443	112.65338	99.39714	106.82104	128.22649	126.11269	121.4345
Gas oil	74.97878	57.89821	50.10438	56.96108	25.79609	70.27053	74.31222	93.64535	126.32308	93.19446	93.19446	91.3928	83.07174
Kerosene	37.64581	25.66234	26.76373	30.41577	11.99059	13.0955	14.5405	21.99399	24.27073	22.25865	22.25865	38.40712	28.6392
GPL	0.59939	0.51946	0.62623	0.46952	0.19166	0.01188	0.45767	0.25722	0.48136	0.1005	0	0.16232	0.00293
Fuel-oil	40.54373	42.33834	46.21698	42.8806	14.28291	25.87618	11.2119	37.46241	26.61531	26.61531	24.16432	3.31892	26.53182
Lubrificant	3.16573	2.72686	3.39915	4.42644	1.61063	2.12428	1.59903	5.72187	4.54263	4.54263	3.31892	271.17	1.60593
Total	**258.80**	**207.78**	**223.77**	**226.04**	**87.06**	**171.76**	**194.45**	**271.73**	**281.63**	**253.53**	**271.16**	**530.56**	**261.29**

ANNEX 2 Petroleum emissions tendencies other than CO_2 (in Gg CO_2)

Year		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Combustible	**Other gases different CO2**													
Petrol super	**CH4**	0,029696	0,022924	0,028177	0,026495	0,009675	0,017603	0,026914	0,03284	0,028976	0,03114	0,03738	0,036764	0,0354
Gas oil		0,00511	0,00395	0,00342	0,00388	0,00176	0,00479	0,00507	0,00639	0,00861	0,00579	0,00635	0,00623	0,00566
Fuel OIL		0,001057	0,001155	0,001207	0,001114	0,000373	0,000676	0,000294	0,000978	0,000988	0,000696	0,000631	0,001177	0,000693
	Total	**0,035863**	**0,028029**	**0,032804**	**0,031489**	**0,011808**	**0,023069**	**0,032278**	**0,040208**	**0,038574**	**0,037626**	**0,044361**	**0,044171**	**0,041753**
Essence super	**N20**	0,000891	0,000688	0,008452	0,000795	0,00029	0,000528	0,000807	0,000985	0,000869	0,000934	0,001121	0,001102	0,001062
Gas oil		0,000614	0,000474	0,00041	0,000466	0,000211	0,000575	0,000608	0,000766	0,001033	0,000695	0,000763	0,000748	0,00068
Fuel OIL		0,000318	0,001106	0,001206	0,00112	0,000373	0,000676	0,000294	0,000978	0,000988	0,000696	0,000631	0,001177	0,000208
	Total	**0,001823**	**0,002268**	**0,010068**	**0,002381**	**0,000874**	**0,001779**	**0,001709**	**0,002729**	**0,00289**	**0,002325**	**0,002515**	**0,003027**	**0,00195**
Essence super	**NOx**	0,890886	0,687726	0,845298	0,794844	0,29025	0,528084	0,80742	0,985206	0,869274	0,9342	1,1214	1,102914	1,062
Gas oil		0,8188	0,63168	0,54665	0,62146	0,28144	0,7667	0,81076	1,02169	1,37821	0,92629	1,01677	0,99711	0,90633
Fuel OIL		0,10587	0,11055	0,12068	0,11197	0,0373	0,06757	0,0294	0,09782	0,09883	0,06956	0,064	0,11775	0,06928
	Total	**1,815556**	**1,429956**	**1,512628**	**1,528274**	**0,60899**	**1,362354**	**1,64758**	**2,104716**	**2,346314**	**1,93005**	**2,20217**	**2,217774**	**2,03761**
Essence super	**CO**	11,87848	9,17448	11, 27064	10,59792	3,87	7,04112	10,7656	13,13608	11,59032	12,456	14,952	14,70552	14,16
Gas oil		1,02254	0,7896	0,68331	0,77682	0,3518	0,95838	1,01345	1,27711	1,72228	1,15786	1,27096	1,24639	1,13291
Fuel OIL		0,005293	0,005527	0,006034	0,005599	0,001865	0,003378	0,00147	0,004891	0,004941	0,003478	0,003155	0,005887	0,003464
	Total	**12,90631**	**9,969607**	**0,689344**	**11,38034**	**4,223665**	**8,002878**	**11,78052**	**14,418081**	**13,317541**	**13,617338**	**16,22612**	**15,957797**	**15,29637**
Petrol super	**NMVOC**	2,22726	1,71932	2,11325	1,98711	0,72563	1,32021	2,01855	2,46302	2,173119	2,23355	2,8035	2,75729	2,655
Gas oil		0,20451	0,15792	0,13666	0,15536	0,7036	0,19168	0,20269	0,25542	0,34455	0,23157	0,25419	0,24928	0,22658
Fuel OIL		0,002647	0,002764	0,003017	0,002799	0,000932	0,001689	0,000735	0,002446	0,002471	0,001739	0,001577	0,002944	0,001732
	Total	**2,434417**	**1,880004**	**2,252927**	**2,145269**	**1,430162**	**1,513579**	**2,221975**	**2,720886**	**2,52014**	**2,466859**	**3,059267**	**3,009514**	**2,883312**

ANNEX 3. LIST OF RESOURCE PERSONS AND EXPERTS

RESPONSIBLE/UNEP/GEF IN CHARGE OF NATIONAL COMMUNICATION PROGRAMMES:

Ravi SHARMA, Liza LECLERC and Mahendra KUMAR, UNEP, Nairobi/Kenya
Victor OGBUNEKE, UNEP/GEF, Nairobi/Kenya

CLIMATE NATIONAL COMMITTEE

1	MUNYANEZA	SYLVERE	PRIMATURE
2	BISHANGARA	CYPRIEN	MINITERE, CCD Focal Point
3	NYIRIMANZI	VITAL	MINITERE, OZONE Focal Point
4	UWIMANA	SUZANNE	MINITERE, BDC Focal Point
5	DUSABEYEZU	SEBASTIEN	MINITERE, UNFCCC Focal Point
6	RUZIGANA	SILAS	MININFRA
7	URAMUTSE	CHARLES	MINITERE, National Project Coordinator
8	KAYIRU NDEKA	EMMANUEL	MININFRA
9	UWIZEYIMANA	J.BAPTISTE	MINAGRI
10	MUSABE	JULES SIMON	MINEDUC
11	USENGUMUREMYI	MAXIMILIEN	MINECOFIN
12	KALISA	NYIRIMBIBI	UNR
13	MURENZI	CHANTAL	KIST
14	HAKIZIMANA	CYPRIEN	IRST
15	KAGABO M.	DESIRE	ISAR
16	RUTAGENGWA	ANTOINE	ELECTROGAZ
17	BITWAYIKI	CATHERINE	FEDERATION RWANDAISE DU SECTEUR PRIVE (FRSP)
18	KALIWABO B.	DESIRE	RWANDA RURAL REHABILITATION INITIATIVE (RWARRI)
19	KAREMERA G.	PROTAIS	CARE INTERNATIONAL AU RWANDA
20	NTEZIYAREMYE	FIDELE	ARAMET
21	KAYITARE	ANECTO	PROG. INTERN. DE CONSERVATION DES GORILLES (PICG)
22	MUKAKAMARI	DANCILLA	ASSOCIATION RWANDAISE DES ECOLOGISTES (ARECO)
23	RUTEMBESA	G.EMILE	OFFICE RWANDAIS DE NORMALISATION (ORN)
24	KARAMBI	DAVID	ACAPE
25	RUTAGENGWA	SHEMA	ARPET

NATIONAL EXPERTS:

Working Group I: GHG Inventory

1. RULINDA J.Baptiste, UNR, Waste and Wastewater Management Sector
2. NTAGANZWA Innocent, MINICOM, Industry Sector
3. MURERE REHE Sabin, MINAGRI, Land Use Change and Forestry;
4. NYAGATARE Guillaume, UNR, Agriculture Sector
5. RUZIGANA Silas, MININFRA, Energy Sector

Working Group II: GHG MITIGATION

1. Dr. SAFARI Bonfils, UNR, Energy Sector
2. Dr. NTAGANDA Charles, UNR, Land Use Change and Forestry;
3. HAKIZIMANA Cyprien, IRST, Industry, Waste and Wastewater Management Sectors
4. KAGABO Désiré, ISAR, Agriculture Sector
5. MUTABAZI Alphonse, MININFRA, Transport Sector

Working Group III: Vulnerability and Adaptation

1. MUNYANEZA Sylvère, PRUMATURE, Human Settlements, Energy and Industry
2. UWIZEYIMANA J.B., MINAGRI, Agriculture and Food Security
3. NIYONZIMA Théophile, UNR, Land and Freshwater Ecosystems
4. MUGENZI Augustin, MININFRA, Hydrology and Water Resources
5. HAKIZIMANA EMMANUEL, MINISANTE, Human Health and Finance Services

Working Group IV: Programmes related to Sustainable Development, Education, Research and Sensitisation of the Public

1. BIZIMANA Innocent, MINITERE, Sustainable Development
2. MUSABE Jules Simon, MINEDUC, Scientific Research
3. MUKAMANA Laurence, MINEDUC, Formal Education
4. MUKAKAMARI Dancilla, ARECO, Informal Education, Training and Public Awareness
5. USENGUMUREMYI Maximilien, MINECOFIN, Poverty Reduction
6. NTEZIYAREMYE Fidèle, ARAMET, Information related to Technological Needs

COORDINATION UNIT

URAMUTSE Charles, National Project Coordinator
NGILINSHUTI Straton, Project Administrative Secretary.