WATERSHED MANAGEMENT CASE STUDY: BURUNDI

Comprehensive, integrated watershed and swamp management

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Preface

On the occasion of the International Year of Mountains, and in response to the clear consensus reached by the international community regarding the need to ensure harmonious and sustainable development of mountainous areas and watersheds, FAO and its partners in the subject, undertook a large-scale assessment and global review of the current status and future trends of knowledge about and techniques for integrated watershed management.

The objective was to promote the exchange and dissemination of experiences on integrated watershed management techniques, identify constraints to the implementation and development of those techniques during the decade 1990 to 2000 and capture relevant new paradigms and approaches. The lessons learned from diverse experiences are being used to define a new generation of integrated watershed management projects.

Experts from four continents contributed to the assessment, which yielded four main outputs: i) a review of experiences in watershed management, based on questionnaires sent to active partners in the field; ii) substantive reports of four regional workshops in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France); iii) four case studies from the Mediterranean basin, Nepal, Bolivia and Burundi; and iv) an international conference in Sassari, Italy.

Watershed management concepts and approaches were reviewed and different experiences assessed. The results of this exercise are presented in several documents, which include the proceedings of workshops and reports on the four case studies.

The conservation, use and sustainable management of watershed resources in order to meet the demands of growing populations have been a high priority for many countries over the past decades. In this respect, integrated people's participation in watershed management has become widely accepted as the approach that ensures sound sustainable natural resources management and an improved economy for upland inhabitants, as well as for people living in downstream areas.

Burundi is a small, mountainous and densely populated African country that is one of the poorest countries in the world. A long period of excessive pressure on the limited natural resources resulted in a serious ecological, social and economic situation in the late 1980s.

Appeals for international support led to the development of comprehensive, integrated watershed and swamp management techniques that were refined throughout the 1990 to 2001 period, under UNDP–FAO projects. The country's current strategy for sustainable rural development is based on combating erosion and restoring soil fertility.

Implementation of the simple techniques that were developed by these various initiatives is based on the close involvement of local people and rural development partners. The use of such techniques on a wider scale will be indispensable in efforts to eradicate poverty and achieve food security for Burundi's rural communities, who rely on the land as their unique resource.

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Acronyms

ACF	Aid and Cooperation Fund
ACORD	Association for Cooperation Operations, Research and Development
ADB	African Development Bank
ADSSE	Association for Social Development and Environment Protection
CIE	Environmental Information Centre
DGATE	Department of Land Planning and the Environment
DGVA	Department of Agricultural Extension
DPAE	Provincial Department of Agriculture and Animal Husbandry
EDF	European Development Fund
EU	European Union
FACAGRO	Faculty of Agricultural Sciences
FAO	United Nations Food and Agriculture Organization
GDP	gross domestic product
GEF	Global Environment Facility
GIS	Geographic Information System
IFAD	International Fund for Agricultural Development
IGEBU	Geographic Institute of Burundi
ILO	International Labour Organization
INECN	National Institute for the Environment and Nature Conservation
ISA	Agricultural Institute
ISABU	Burundi Agricultural Sciences Institute
ITAB	Burundi Agricultural Technical Institute
MINATE	Ministry of Land Planning and the Environment
NGO	non-governmental organization
PAE	Environmental Action Plan
PREBU	Burundi Rehabilitation Programme
RAMSAR	Convention on Wetlands of International Importance, Especially as Waterfowl Habitat
SNE	National Strategy for the Environment of Burundi
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	Office of the United Nations High Commissioner for Refugees
WFP	World Food Programme

Introduction

Lying between the Congo and Nile basins, Burundi covers an area of 27 834 km² and has a population of about 6 500 000 inhabitants, i.e. about 230 inhabitants/km². It is very mountainous, with a humid tropical climate and settlements that are very dispersed.

Wood accounts for 97 percent of the fuel used, hence the strong pressure on Burundi's limited and fragile forests, which cover about 239 634 ha altogether – 130 634 ha of which is natural forest, while 109 000 ha is made by humans.

The country's economy is largely dominated by the agriculture sector, which employs more than 90 percent of the economically active population and accounts for more than 53 percent of gross domestic product (GDP). Farming is the occupation of about 1 million households. Farms are very small (about 0.7 ha per household) and input use is low. Coffee and tea are the two export crops.

This key sector is experiencing a decline in productivity owing, on the one hand, to soil degradation caused by severe erosion, excessive land use and unusual weather conditions and, on the other hand, to the many effects of the political crisis that has blighted Burundi since 1993, as well as to low coffee and tea prices on the world market.

Overpopulation exerts strong pressure on natural resources, i.e. land and forests, and has created a need to control erosion, restore soil fertility and control runoff and swamp water. In response to this need, comprehensive, integrated watershed and swamp management aimed at ensuring sustainable use of resources has been Burundi's sustainable rural development strategy since the 1990s.

Photograph 1: Natural resource degradation caused by intense population pressure

PHOTOGRAPH JEAN PROSPER KOYO

The watershed management (WM) techniques developed by FAO with UNDP funding have now been disseminated throughout the country. They require a significant level of involvement from rural people and other rural development players.

This is the context in which comprehensive, integrated WM has become a priority in the national government's programmes for poverty alleviation and food security. In conjunction with its development partners, including UNDP, FAO, the International Fund for Agricultural Development (IFAD) and the World Bank, Burundi has undertaken a number of schemes aimed at the large-scale implementation of this type of management as a means of achieving sustainable agricultural development.

This case study reviews Burundi's experience in WM over the past 15 years. In addition to this chapter, the document consists of six main parts:

- main natural regions, mountains and climate;
- socio-economic context and review of crop production systems;
- description of the forestry and land planning subsectors;
- WM experiments in Burundi;
- major lessons learned;
- conclusion.

1. Main natural regions, mountains and climate

CLIMATE

Burundi's humid, tropical climate comprises two wet seasons extending from September to December and from February to May. The mean annual rainfall is 1 100 mm. For the past five years, Burundi and the other countries of the subregion (Rwanda, the United Republic of Tanzania, Uganda and Kenya) have experienced unusual weather patterns and a gradual decline in rainfall. This state of affairs is often aggravated by population pressure, uncontrolled deforestation and wildfires. The areas most affected are those below 1 200 m altitude, especially north of Bugesera, Moso, east of Buyogoma and west of Imbo. In the areas most affected, there is a very significant correlation between the drop in rainfall levels and the decline in production.

NATURAL REGIONS – MOUNTAINS

Lying between the Nile and Congo basins, the country covers the following five main ecoclimatic zones at varying altitudes.

The Imbo plains in the west: Altitude here varies between 750 and 1 000 m. The Imbo plains cover about 13 percent of the national territory and have a population density of about 200 inhabitants/km^2. They are endowed with very rich alluvial soils. The main crops are irrigated rice, oil-palm and subsistence crops. The original forest formations are of *Acacia* spp. trees, savannah type. A few relics of dense semi-deciduous forests survive along the banks of Lake Tanganyika (altitude 800 m).

The Mumirwa escarpments: These are the foothills of the Congo–Nile ridge. They are made up of narrow valleys and deep gorges. Their altitude varies from 1 000 to 2 500 m, and they cover 9 percent of the national territory. Relics of caducifoliate forests are found here and there. Population density is 190 inhabitants/km^2. Strong pressure from crop and livestock farming is exposing Mumirwa to intense rain erosion owing to its very steep topography.

The Congo–Nile ridge: Rising to 2 700 m, the Congo–Nile ridge forms the Mugamba natural region. It covers about 9 percent of the national territory. Annual rainfall often exceeds 1 400 mm, and the mean annual temperature is 15° C. Population density is about 150 inhabitants/km^2. The main subsistence crops are cereals and tea, and there are also extensive pastures. The original forest formations are dense humid forests in the highlands and xerophilous forests on the summits.

The central plateaux: With altitude ranging from 1 500 to 2 000 m, and mean annual rainfall between 1 000 and 1 400 mm, the central plateaux cover about 23 percent of the national territory. The mean annual temperature is about 20° C. The plateaux include:

- the highly populated natural regions of Kirimiro and Buyensi, with average population densities of 300 and 450 inhabitants/km^2, respectively, and activities that include livestock and subsistence farming, as well as export crop production, including arabica coffee;
- the natural region of Bututsi, which extends southwards and is colder and less densely populated than the remainder of the central plateaux. The soils here are unfit for agriculture owing to their very high aluminium acidity, and the main activity is livestock raising, associated with traditional crops. The natural forest formations are very poor.

The eastern plains: These consist of various natural landscapes including: i) the depressions of the natural regions of Mosso and Buragane to the east and southeast, respectively; ii) the eastern edges of

the natural regions of Bweru and Buyogoma; and iii) the lakes and swamps to the northeast of the natural region of Bugesera. Altitude varies from 1 200 to 1 600 m, and mean annual rainfall from 800 to 1 200 mm. Cereals are the main crops grown in these relatively sparsely populated (60 to 150 inhabitants/km^2) areas.

Apart from the Imbo plains and Mosso, the remainder of the country (87 percent of the national territory) comprises numerous watersheds with the following essential characteristics:

- bare and generally rocky ridges that are unfit for agriculture;
- slopes that cover about 1 million ha and are cultivated by about 1 million households, accounting for the bulk of the country's agricultural activity;
- swamps covering about 120 000 ha, 69 percent of which are used indiscriminately during the dry season.

Table 1 shows the areas covered by each type of land use.

Table 1: Land use in Burundi in 1998

Land use	Area (ha)	% of territory
- Natural vegetation[1]	240 716[2]	8.6
- Forests	128 375	4.6
- Pasture etc.	775 506	27.8
- Food crops (swamps excluded)	1 210 000	43.4
- Cash crops	104 000	3.7
- Cultivated swamps	81 103	2.9
- Lakes	263 400	9.9
- Towns	25 000	0.9
Total	**2 783 400**	**100**

[1] Including forests, swamps and uncultivated savannahs.
[2] 50 000 ha for Kibira.

Figure 1: Map of Burundi

2. Socio-economic context and crop production systems

SOCIO-ECONOMIC CONTEXT

Burundi's economy is largely dominated by the primary sector. The rural population, by far the largest group, depends on agriculture for its livelihood. About 1 million households farm very small plots (about 0.7 hectares per household) with little use of inputs. The two main export crops are coffee and tea. In 2002, agriculture accounted for 53 percent of GDP, and 93 percent of the economically active population were involved in crop farming, livestock raising, forestry and fisheries. Export earnings from agriculture totalled 26.8 billion FBU, i.e. 92.8 percent of all foreign currency earnings that year.

This pre-eminence of the primary sector, particularly agriculture, is in keeping with the difficult economic context. Insecurity and population displacement, which are due to the political crisis that has affected the country since 1993, have led to a significant rise in poverty levels. At the same time, programmes designed to improve the population's quality of life by increasing agricultural production and improving incomes and food security have shown disappointing results.

In addition, weather conditions, especially drought, structural constraints, such as the fragmentation of arable land caused by population pressure, land degradation and inappropriate management, and the lack of farmers' organizations and funding have put paid to any real socio-economic progress.

The very high proportion of rural dwellers[1] and the decline in agricultural production over the past ten years have increased poverty in the country. This situation has been further aggravated by exceptional weather conditions, including drought and flooding. The proportion of poor people is about 68 percent higher in the rural areas than in the towns.

REVIEW OF BURUNDI'S CROP AND FOREST PRODUCTION SYSTEMS

Small-scale agriculture in Burundi has remained basically traditional and is geared mainly to self-sufficiency. It involves growing several food crops (Table 2) on a single plot. This mixed cropping is based on bananas, pulses (beans, soya and groundnuts), grain crops (maize, rice, sorghum and wheat on the Congo–Nile ridge) and tubers (cassava, sweet potato, taro and potato), and is necessary given the land scarcity. Bananas are grown mainly to produce local beer.

Cash crops (Table 3) are grown as monocultures by State-owned and private companies and by small-scale farmers. Cash crops include coffee, tea, oil-palm, cotton, tobacco, rice and sugar cane. The main agricultural exports are coffee and tea, while the other crops are used for national requirements.

Domestic animal stocks (i.e. cattle, goats, sheep, pigs, poultry and rabbits) have been adversely affected by the socio-political crisis, with the theft of animals reaching unprecedented levels. A 1997 survey showed losses of 32 and 46 percent, respectively, for large and small stock. Table 4 summarizes the situation.

[1] More than 90 percent of the country's population.

Table 2: Production trends for the main food crops (in tonnes)

Crops	Average 1988–1993	1993	1996	1997	1998	1999	2000	2001	2002	% growth 1993–2002
Cereals	298	300	273	292	314	266	254	274	278	- 7.3
Pulses	369	374	324	298	291	262	244	282	281	- 24.0
Tubers	1 433	1 449	1 364	1 296	1 501	1 497	1 482	1 613	1 713	+18.0
Bananas	1 563	1 580	1 544	1 297	1 573	1 526	1 516	1 549	1 598	+ 1.1
Total	**3 663**	**3 703**	**3 505**	**3 183**	**3 679**	**3 551**	**3 496**	**3 718**	**3 870**	**+ 4.5**
Δ comparison with 1993		100	89	91	93	89	89	104.4	104.5	

Table 3: Production trends for major cash crops (in tonnes)

Year	Coffee	Cotton	Tea	Sugar
1991/92	34 190.00	5 365	5 921	
1992/93	37 094.46	8 813	5 523	
1993/94	22 867.70	4 915	6 864	
1994/95	41 226.35	4 593	6 970	
1995/96	25 129.52	2 604	5 716	
1996/97	26 260.50	2 382	4 189	
1997/98	19 976.58	3 232	6 500	16 078
1998/99	17 035.14	2 580	7 000	20 923
1999/2000	28 716.00	2 585	7 118	19 084
2000/01	18 503.00	2 901	9 009	19 264
2001/02	16 000.00	2 735	6 765	17 245
2002/03	35 000 00			19 300

Table 4: Trends in livestock (thousand head)

Type of livestock	1992	1993	1996	1997	1998	1999	2000	2001	2002
Cattle	448	420	346	338	332	329	358	364	378
Goats	932	900	659	643	614	594	868	940	1 058
Sheep	370	390	163	142	137	130	224	308	528
Pigs	105	100	73	74	74	77	194	350	479
Poultry	380	400	457	404	382	343	698	765	837
Rabbits			79	70	69	67	218	319	420

MAIN CONSTRAINTS IN THE AGRICULTURE SECTOR

There are two types of constraints: structural and short-term.

Structural constraints can be summarized as follows:

- fragmentation of agricultural land, which is likely to increase over time because of population pressure[2] and the tradition whereby children inherit equal shares of their deceased father's property;
- land degradation due to erosion and excessive land use without the addition of fertilizers;

[2] There are already 225 inhabitants/km^2, while more than 500 000 Burundi refugees are due to return from the United Republic of Tanzania.

- the decline in livestock raising, which has drastically restricted the use of organic manure, the main fertilizer available to farmers;
- poverty and the fact that credit is not readily accessible mean that farmers are unable to purchase fertilizers and other necessary inputs;
- weak public support and advisory structures (e.g. agricultural research and extension services) restrict development of the agriculture sector. Seed shortages and plant diseases have a negative impact on crop and livestock production.

Short-term constraints, the major ones of which are:

- the civil war and the state of insecurity in which the country has been living since 1993, which have had a very negative effect on agricultural production and food security;
- climatic conditions, i.e. late rainfall, drought and flooding – factors that are unpredictable and detrimental to agriculture;
- the suspension of external aid under the embargo imposed on Burundi from 1996 to 2000, which halted agricultural programmes throughout the country. Aid was resumed in 2000, but the level remains low.

3. Forestry and land planning subsectors

The land planning, environment and forestry subsectors, formerly under the Ministry of Agriculture and Livestock, have been under the Ministry of Land Planning and the Environment (MINATE) since 1988. MINATE comprises several departments, including: i) the Geographic Institute of Burundi (IGEBU); ii) the National Institute for the Environment and Nature Conservation (INECN); and iii) the Department of Land Planning the Environment (DGATE).

FORESTRY SUBSECTOR

Policy framework

Burundi's current forestry policy is a component of MINATE's sectoral policy. It was approved by the government in July 1999 and aims to:

- improve the legislation governing natural resource and environment management by revising the forest code, adopting an environment code and preparing swamp legislation;
- develop forest resources through agroforestry and rural forestry in an effort to meet the country's requirements for all types of forest products; for this, the commitment of the entire population is necessary;
- strengthen forestry management and the structure of the timber subsector by: i) drawing up an inventory of forestry resources; ii) systematically applying basic silviculture rules in an effort to guarantee product quality; iii) providing training in forest management; iv) providing training and support for woodworkers; and v) rigorously applying the provisions laid down by law;
- protect and preserve natural ecosystems and combat pollution with a view to achieving harmonious and sustainable development by strengthening watershed and protected area management;
- strengthen information systems and databases on rational management and the monitoring of natural resource levels and environmental changes by establishing an environment information centre;
- develop the skills of the country's forestry personnel.

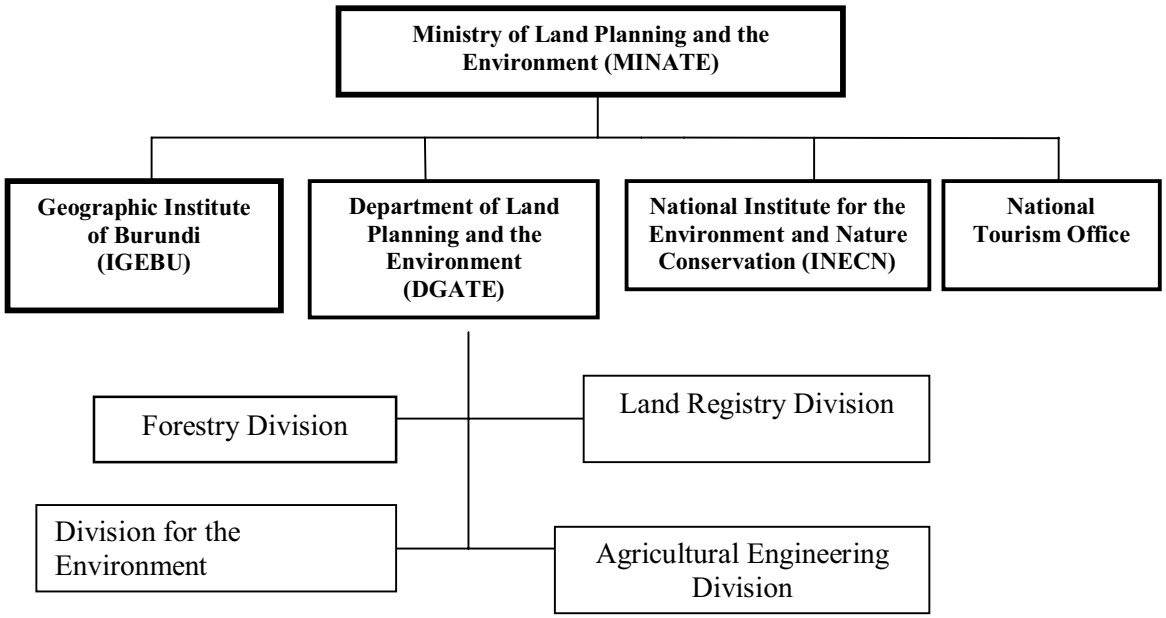
Institutional and legal frameworks

The Department of Land Planning and the Environment (DGATE) comprises four main divisions: i) the Rural Engineering and Land Protection Division; ii) the Land and Land Registry Division; iii) the Environment Division; and iv) the Forestry Division.

The Forestry Division is responsible for the design, implementation and monitoring of all forestry measures taken by the State, communities and private individuals. It includes the following services:

- the Human and Material Resources Service, comprising the accounts, personnel and training, marketing, and equipment units;
- the Forest Resources Development Service, comprising the extension, seed purchasing and research and planning units;
- the Forest Resources Management and Administration Service, comprising the forest inventory and statistics, management and promotion units;
- the Project Management Service.

Figure 2: Organizational chart: Ministry of Land Planning and the Environment



At the regional level, implementation of the Forestry Division's general mandate is entrusted to seven forestry inspectorates:

- Rural Bujumbura forest inspectorate, covering rural Bujumbura, Bubanza and Cibitoke provinces;
- Gitega forest inspectorate, covering Gitega, Muramvya and Karuzi provinces;
- Ngozi forest inspectorate, covering Ngozi and Kayanza provinces;
- Muyinga forest inspectorate, covering Muyinga and Kirundo provinces;
- Mwaro forest inspectorate;
- Ruyigi forest inspectorate, covering Ruyigi and Cankuzo provinces;
- Bururi forest inspectorate, covering Bururi, Makamba and Rutana provinces.

The provinces without a forest inspectorate are served by provincial forest services administered by forest technicians.

Since independence, several laws have been passed to strengthen environmental protection. The most important of these are:

- Act No. 1/02 of 25 March 1985 establishing the Forest Code;
- Decree Law No. 1/033 of 30 June 1993 on plant protection;
- Act No. 1/010 of 30 June 2000 instituting the Environment Code.

Further legislation has been introduced since 2000 to bolster the battery of laws already in place. National legislation has been complemented and strengthened by international conventions, including those emerging from the Rio Summit, i.e.: i) the Convention on Biodiversity Conservation; ii) the Desertification Control Convention; and iii) the Framework Convention on Climate Change.

Forest and aquatic resources:

Burundi has two types of forests: natural and human-made.

Table 5: Distribution of forest types – protected areas

Type of forest	Area* (ha) at various times	Area in 2000 (estimate)	Protected area	%
- Montane rain forest	104 000 (1960–1970)	50 000 ha	47 500	95
- Hyphaene forest (Urukoko)	2 800 (1951)	1 200	1 200	100
- Kigwena Mesophile forest	2 000 (1960)	500	500	100
- Open forest (southern and eastern parts of the country)	30 000 (1950)	± 20 000	8 716	43
- Gallery forests	-	-	1 018	-
Total	**138 800**	**71 700**	**58 934**	**82**

* Estimates from archive reports.

Natural forests: In 2000 these forests covered about 71 700 ha and comprised: i) Kibira dense, humid montane forest in the northwest of the country on the Congo–Nile ridge; ii) the isolated Kigwena forest on the edge of Lake Tanganyika at 800 m altitude; and iii) relics of the Bururi open forest of *Brachystegia* sp. in the southern part of the country.

There has been a marked regression of the natural forest cover – from 138 800 ha to 71 700 ha in 40 years. Burundi has lost some 67 100 ha of natural forest (48 percent) at a rate of 1 677 ha/year, which corresponds to an annual deforestation rate of about 2.5 percent. This deforestation rate has accelerated over the past 20 years, and averaged 3.2 percent between 1983 and 1998.[3]

Plantations: Nearly 109 000 ha of land are covered by plantations (all species taken together). Large-scale plantation projects since 1978 include:

- the Rugazi Timber Project, funded by the European Development Fund (EDF), under which 2 954 ha of mainly pines (*Pinus elliotii, P. patula, P. caribaea* and *P. oocarpa*) were planted between 1980 and 1986;
- the Mugamba–Bututsi Project, funded by Saudi Arabia and Belgium, which involved the planting of 10 080 ha of mainly *Callitris calcarata* and pines;
- the World Bank–Aid and Cooperation Fund (WB–ACF 1) Project, funded by the World Bank and ACF from 1980 to 1985, under which 9 857 ha were planted in rural Bujumbura, Bururi and Muramvya provinces;
- the – International Labour Organization (PSTP–ILO) Project, funded from 1980 to the present by IFAD (with an agroforestry plantation) and the German Cooperation Office**,** which has planted mainly *Callitris* sp. on an area of 9 000 ha;
- the WB–ACF 2 Project, funded from 1985 to 1990, which planted 3 105 ha of forests in Makamba, rural Bujumbura and Cibitoke provinces;
- the Bukirasazi Project, funded by the African Development Bank (AFB), which since 1988 has: i) planted 3 000 ha of State-owned forests; ii) rehabilitated 4 500 ha of old plantations; and iii) created 1 675 ha of microplantations and agroforestry plots;
- rehabilitation of the forest cover in the north of the country, funded by the Office of the United Nations High Commissioner for Refugees (UNHCR) from 1993 to 1997, which involved the planting of 2 300 ha of *Eucalyptus grandis*.

State-owned plantations are composed of stands of more than 10 ha planted under projects funded through external aid. The main species planted in Burundi are *Eucalyptus* sp., tropical pines, *Callitris calcarata* and *Grevillea robusta*. The management of these plantations leaves much to be desired given the weakness of the country's forestry institutions. The sharp decline of plantations is caused by poor forest management coupled with the population's massive demand for fuelwood and building poles and the destruction caused by refugees and displaced people.

[3] Outlook study of Africa's forestry sector to 2000, MINATE, Burundi.

Table 6: Comparison of plantation areas between 1993 and 1997

Type	Area (ha) before 1993	Area (ha) in 1997
- State-owned plantations	80 000	56 000
- Local authority plantations	11 000	7 000
- Agroforestry and private microplantations	60 000	46 000
Total	**151 000**	**109 000**

Communal plantations are made up of individual stands not exceeding 10 ha. These are microplantations that the government handed over to the local authorities so that rural households can obtain the fuelwood and building poles that they need. Management is extremely haphazard, which explains the gradual loss of these plantations, many of which have been turned into agricultural land or building sites.

Microplantations – agroforestry: These include agroforestry schemes and plantations in farming areas, as well as border planting, and cover about 46 000 ha altogether. Given Burundi's high population density and the scarcity of land for reforestation, forestry now depends on incorporating trees into other rural activities such as agriculture and livestock raising.

Protected areas: Protected areas cover approximately 109 000 ha, including 58 934 ha of natural forests, and have been managed since 1980 by INECN, which set about classifying most of them. The most important protected areas in Burundi are:

- Kibira National Park (40 000 ha), which contains relics of montane forests on the watershed between the Congo and Nile basins and has a relatively rich endemic flora and fauna;
- Bururi Nature Reserve (3 300 ha), which is situated at high altitudes in the south of the country and has a fauna similar to that of Kibira Park; some of the flora is also similar to that of Kibira, while some forest formations are reminiscent of Kenya and the United Republic of Tanzania;
- Kigwena Nature Reserve (600 ha), which is in the south of the country, close to Lake Tanganyika, at between 773 and 820 m altitude; its flora is similar to that of the central Congo basin and to species found in montane forests;
- Rumonge Nature Reserve (5 000 ha), which is the northernmost example of open Brachystegia forest and contains an abundance of mammals and birds;
- Vyanda Nature Reserve, which comprises medium-altitude open forests of Brachystegia, gallery forests and dense humid montane forests above 1 400 m altitude;
- Rubuvu National Park (50 800 ha), which is situated between 1 350 and 1 800 m altitude and comprises very diversified vegetation, including tree savannahs, open forests, gallery forests and swamps, which provide shelter for many animal species;
- Rusizi National Park (9 000 ha), which is situated on the Imbo plain, northwest of Bujumbura at between 773 and 850 m altitude; its vegetation includes principally Phragmites and the palm *Hyphaene benguellensis* var. *ventricosa,* while its fauna include large and small mammals, such as crocodiles, hippopotamus and several species of birds.

Burundi's rich and varied fauna is the result of its biological diversity and includes some relatively well-known vertebrates and some less well-known invertebrates.

Recent studies of mammals, birds and reptiles show that there are about 101 species threatened with extinction, 45 of which are endangered and 56 vulnerable.

Table 7: Inventory of Burundi's vertebrates

	Families	Genera	Species
Mammals	28	88	163
Birds	78	347	716
Reptiles	11	28	52
Amphibians	7	15	56
Fish	16	89	215
Total	**140**	**567**	**1 202**

Aquatic environments: Burundi has several natural lakes: Tanganyika, Cohoha, Rweru, Rwihinda and the smaller Gacamirinda, Kanzigiri and Gitemo. Lake Tanganyika is by far the largest, measuring 32 600 km², 2 634 km² of which lies within Burundi's national territory. The lake contains more than 1 300 species of vertebrates and invertebrates, 500 of which are endemic. It is very rich in fish and has an annual production potential of 21 000 tonnes of fresh fish.

The northern lakes contain biological resources that have not yet been fully inventoried. They are also known to contain several species of fish and have an annual production capacity of about 700 tonnes, as well as providing a home for thousands of birds, for which they are referred to as the "lakes of birds". Burundi also has many rivers, but these have not yet been the subject of any specific research.

LAND PLANNING SUBSECTOR

Policy, legal and institutional frameworks

Policy framework: Burundi's current land planning policy is a component of MINATE's sectoral policy. It was adopted by the government in July 1999 and has been updated fairly regularly since then. It aims to:

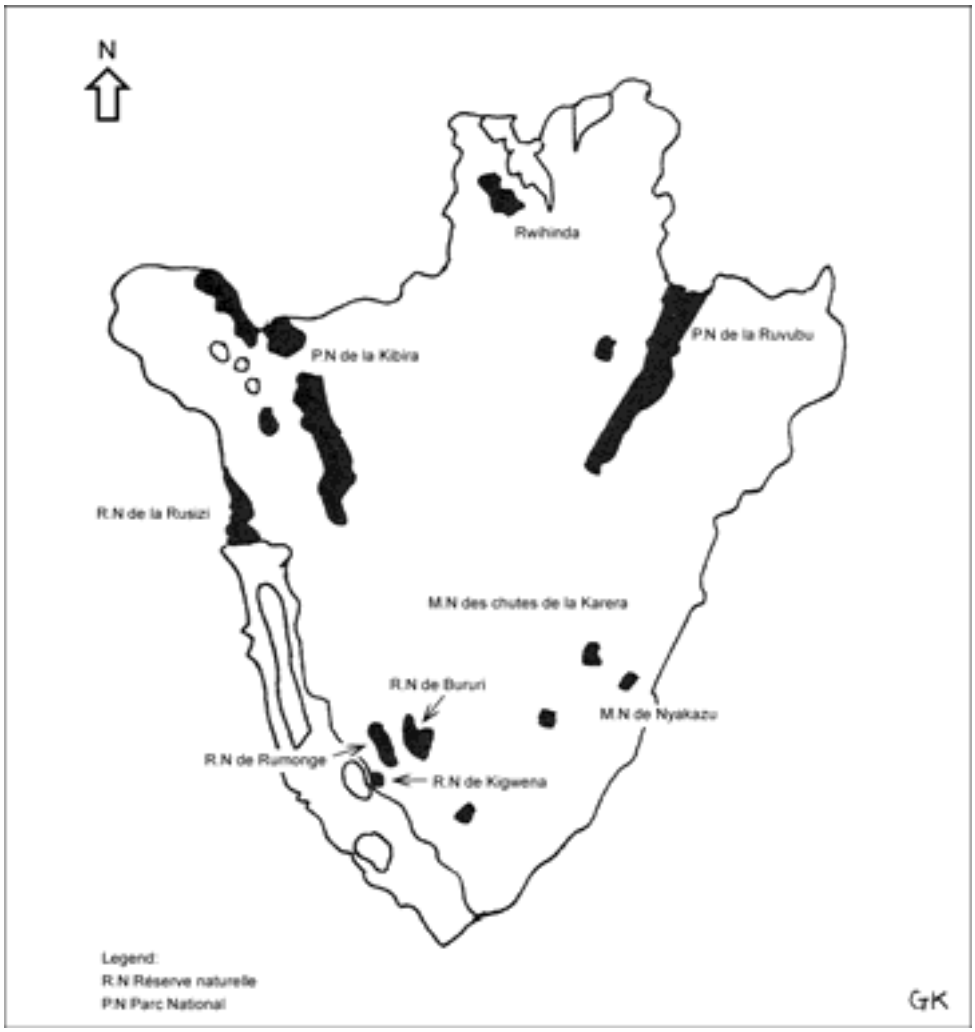
- develop comprehensive, integrated and participatory watershed and swamp management with a view, *inter alia,* to combating erosion, intensifying agricultural and grazing practices and managing runoff and swamp water efficiently;
- protect and preserve natural ecosystems, control pollution using a harmonious and sustainable development approach, and improve protected area management;
- develop the skills of the country's foresters and rural engineers;
- implement international resolutions and recommendations regarding the environment.

Legal framework: Burundi has a number of legal instruments at its disposal, including:

- the Environment Code;
- the National Environment Strategy;
- the Environment Action Plan;
- Land and Forest Codes;
- the National Environment Strategy;
- the Swamp Management Master Plan.

The Burundi Government has also signed and ratified several international conventions, including those on biodiversity, climate change, desertification, protection of the ozone layer, and the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (RAMSAR).

Figure 3: Burundi's national parks and nature reserves



Institutional framework: In keeping with Decree No. 100/010 of 16/01/1989 on the organization of MINATE, DGATE is responsible for drawing up and implementing the government's land planning and watershed management policy.

In addition to the Forestry Division, the Rural Engineering and Land Protection Department (DGR) is also involved in watershed and swamp management activities. It is responsible for carrying out inventories and surveys and developing new farmland, including swampland, using irrigation and drainage.

DGR comprises the following services: i) Soil and Water Conservation; ii) Swamp Development; and iii) Human and Material Resources. Support services for local people are provided by technicians seconded to the decentralized agricultural extension services.

At the provincial and local levels, MINATE's activities in support of family farms are passed on to the provincial agriculture and livestock departments, which are the extension and support structures of the Agriculture and Livestock Ministry's Agricultural Extension Department (DGVA).

DGVA acts as DGATE's representative, carrying out extension activities and providing support for local people in matters such as rural forestry, integrated WM, agroforestry and swamp development.

The Environmental Information Centre (CIE) is responsible for monitoring the environmental situation throughout the country, establishing environment data banks for the purpose. It has a Geographic Information System (GIS), a tool for collecting, processing and mapping environmental data.

Land resources (land and water)

Most of the land in Burundi is mountainous, and excessive use and the resulting loss of plant cover are subjecting it to intense water erosion. Experiments carried out by Burundi's Agricultural Sciences Institute (ISABU) in Mumirwa (Kanyosha, Isale) showed that very heavy precipitation (of 60 to 70 mm in less than one hour)[4] can lead to soil losses of more than 100 tonnes/ha. The loss of topsoil that is rich in organic elements reduces the fertility and production potential of these lands.

Potential agricultural land, including swamps, covers about 2 366 000 ha, with 1 210 000 ha under subsistence crops, 104 000 ha under cash crops, and 940 000 ha given over to pastures and savannah. More than 70 percent of the 117 000 ha of swampland is under cultivation.

In addition to being erosion-prone, Burundi's soils are also highly acidic. The productivity of almost 1 million ha of high-altitude land depends on reducing this acidity (which is often accompanied by aluminium toxicity).

Photograph 2: Extreme erosion in the Mumirwa natural region

PHOTOGRAPH JEAN PROSPER KOYO

Apart from on the Imbo and Moso plains, where there is little erosion, the greater part of the country is prone to erosion, which is a major constraint for agricultural production. The ecological areas most affected by erosion are Buyenzi, Kirimiro, Mugamba and – especially – Mumirwa, where annual soil losses from arable land amount to several tonnes per hectare.

Flooding, mudslides and landslides occur frequently throughout the country. Bujumbura regularly suffers flood and landslide damage because of its geographical position and topographical conditions, which make it an unsuitable location for urbanization. Such damage is also a serious threat to agricultural production and forestry, and to industrial installations, public infrastructure and housing, hence the need for more initiatives to minimize the effects of these disasters.

[4] Seminar on soil erosion in Burundi, October 1992.

Lakes and watercourses cover a total area of about 218 000 ha. These aquatic environments contain a variety of endangered biological resources, but the continual flow of silt-laden erosion water into Lake Tanganyika will, in the long term, destroy its aquatic ecosystem.

TRAINING AND RESEARCH INSTITUTIONS

Agriculture, livestock, forestry and agroforestry training institutions come under the Ministry of Education. Some of the most important of these are:

- the Faculty of Agricultural Sciences (FACAGRO), which is part of Burundi University and provides a five-year non-specialized agricultural engineering course for some 15 students a year;
- Ngozi University, which is a private institution established in 2001 and also trains non-specialized agricultural engineers;
- Gitega Agricultural Institute (ISA), which provides a number of four-year multipurpose courses geared to the rural economy, including animal husbandry, agriculture, rural engineering and water and forests;
- Burundi Agricultural Technical Institute (ITAB), which provides courses for senior technicians in agriculture, livestock, erosion control, forestry and agroforestry.

Agricultural, livestock and forestry research is covered mainly by the Burundi Agricultural Sciences Institute (ISABU) and FACAGRO. ISABU has several experimental stations scattered throughout the country.

4. Watershed management experiments

MANAGEMENT WITHOUT THE COMPREHENSIVE INTEGRATED APPROACH

Given that erosion is a major constraint to agricultural development, comprehensive, integrated WM has become an essential prerequisite for the sustainable management of Burundi's natural resources.[5]

The Burundi Government received support from FAO, UNDP and other donors to refine pilot watershed and swamp management techniques and apply them in a number of programmes and projects, including the following:

- UNDP–FAO Subsistence Crop Intensification in the Swamps (BDI/85/005-BDI/87/011) refined swamp management techniques on a pilot site and built small irrigation and drainage structures so that the swampland could be used in any season. The local people, who were the main beneficiaries of these techniques, were taught how to manage the structures effectively and to distribute water to all the farms.

Photograph 3: Small structure for use in all-season swamp irrigation and drainage

PHOTOGRAPH JEAN PROSPER KOYO

- UNDP–FAO Forestry and Agroforestry Training at Burundi's Agricultural Technical Training Institute (BDI/87/007) trained ITAB students in forestry and agroforestry, as well as developing experimental agroforestry management measures for farmers, based on the participatory approach. These measures included planting anti-erosion hedges of grasses, shrubs and agroforestry trees along the contour lines of slopes. They represented a major innovation in erosion control, enabling the production of grass forage (*Trypsacum* sp. and *Setaria* sp.) and tree fodder (*Calliandra calothyrsus*), as well as of construction poles in the short term and timber in the long term.
- UNDP–FAO Continuum I and II – Agriculture Component (BDI/93/007 and BDI/95/004) encouraged the use of livestock in agroforestry systems developed under project BDI/87/007. They distributed cattle or goats to pilot farmers in order to test their ability to manage whole systems, i.e. of anti-erosion hedges and livestock that are partly stall-fed on fodder obtained from the hedges.

[5] Forest and fodder formations, soil, water and agricultural crops.

- UNDP–FAO project Support for Food Security (BDI/97/006) was implemented from February 1998 to 2002, extending and expanding the activities begun under the Continuum I and II projects. The livestock and swamp management components were greatly developed and the solidarity chain concept, whereby animals are gradually incorporated into all farms, was used to great advantage.

UNDP–FAO PROJECT BDI/96/001: AN EXAMPLE OF COMPREHENSIVE, INTEGRATED WATERSHED AND SWAMP MANAGEMENT

Brief description of the project

Project BDI/96/001 Support for Environment Restoration and Management was initiated in response to the environmental deterioration that has occurred since 1993, when political upheaval and a vast influx of Rwandan refugees caused the destruction of about 30 000 ha of woodland and accelerated environmental degradation. In addition, a study carried out by the government in 1996, with financial support from UNDP, highlighted the lack of coherent legal, technical and institutional frameworks for the sustainable management of Burundi's environment.

The formulation of the project was based on an analysis that was made under the preparatory assistance programme, funded by UNDP and implemented by FAO from 1 June 1997 and 27 June 1998. It, too, was funded by UNDP (for an amount of US$4.8 million) and implemented by FAO. It got under way in February 1998 and ended in January 2002. Burundi's DGATE was responsible for project management. At the local level, non-governmental organizations (NGOs) and the Provincial Department of Agriculture and Animal Husbandry (DPAE) helped to disseminate project activities to the farms.

The project's long-term objective was to help ensure the country's sustainable development through promoting comprehensive, integrated WM with a view to the rational, participatory management of natural resources and the environment. Its four immediate objectives were to:

- bolster MINATE's capacity;
- promote WM techniques;
- promote rational swamp development;
- develop and manage forest resources.

Pilot watersheds and measures taken in the field

Comprehensive, integrated WM measures were introduced in five provinces at the following five pilot sites:

- Rubanza, in rural Bujumbura province;
- Kibuye, in Gitega province;
- Kigoma, in Karuzi province;
- Murama, Shore 1 and 2, in Kirundo province;
- Rugasari, in Cankuzo province.

The project was assisted by three NGOs: CARE Burundi, the Association for Social Development and Environment Protection (ADSSE) and the Association for Cooperation Operations, Research and Development (ACORD). The pilot watersheds were chosen through consultations between project management and the provincial authorities. Local residents took an active part in a participatory assessment to determine the existing levels of socio-economic development and natural resource management. An analysis of the assessment followed, and solutions to the constraints detected were

suggested. Some of the major problems identified on all the sites were water erosion, lack of fuelwood and building poles, loss of soil fertility and the small size of farm plots.

The project's field activities centred on the comprehensive, integrated management of five watersheds in an effort to overcome these constraints. The local population at the various sites were drafted in to help with the physical work. A labour-intensive, participatory approach was used.

In particular, the labour-intensive method was applied to forest management work carried out in the interest of the community and the public in general, i.e. the planting of public woodlands and the building of small irrigation and drainage structures in the swamps. The labour recruited among the local population received World Food Programme (WFP) food rations as payment for their work. The participatory approach was mainly used in the erosion control operations on farmers' individual plots, with local people taking an active part in the implementation of erosion control measures.

The three project NGOs, plus another one (COPED) helped to organize the labour force, thereby enabling the work to progress satisfactorily.

Main techniques and achievements in watershed and swamp management

The greater part of Burundi's landscape consists of hills of between 800 and 2 500 m altitude. Given the topographical configuration of Burundi's countryside, the management work involved the following components:

- *Reforestation of State or privately owned land* on bare, rocky ridges, with the aims of reducing the volume and intensity of runoff, limiting the impact of erosion and providing humus to the soil in an effort to reduce acidity. The most widely used forest species were *Eucalyptus* sp. and *Callitris calcarata***.** Labour-intensive methods were used to create 286 ha of community plantations on the bare ridges of the five pilot sites. Groups of charcoal producers and women fuelwood producers involved in supplying tobacco drying activities were particularly active in these reforestation operations.

Photograph 4: Burundi's high plateaux: typical topography

PHOTOGRAPH JEAN PROSPER KOYO

- *The systematic planting of slopes*, i.e. on agricultural fields, with anti-erosion hedges of grasses (*Trypsacum* sp., *Setaria* sp. and *Pennisetum* sp.), fodder shrubs (nitrogen-fixing pulses *Calliandra calothyrsus* or *Leucaena leucocephala,* depending on the altitude) and agroforestry or fruit trees (such as *Grevillea robusta*, avocado and banana). Local people introduced agricultural crops

between the anti-erosion hedges. At altitudes of 1 500 to 2 000 m, the species of pulse found to be best suited and most productive in terms of leaf biomass was *C. calothyrsus*. *G. robusta* is also considered a useful agroforestry species owing to the high-quality humus that it produces.

Using the participatory approach, the following operations were carried out by the local people, with technical and material support from the project and supervision from an agricultural extension agent:

- staking out of contour lines using a triangle level;
- bund formation or digging of anti-erosion trenches along the contour lines, depending on the steepness of the slope;
- planting of forage grasses for fodder, which are propagated from cuttings of *Trypsacum* sp., *Setaria* sp. or *Pennisetum* sp. root stock planted every 30 cm along staggered rows on the bunds; the number of rows varies from two to three, depending on the steepness of the slope and the number of livestock on the farm; on very steep slopes, cuttings of fodder grass root stock are planted in staggered rows on bunds above anti-erosion trenches;
- planting of fodder shrubs at 40-cm intervals uphill from anti-erosion grass hedges; the two most useful atmospheric nitrogen-fixing pulses are *Calliandra calothyrsus* and *Leucaena diversifolia* because of their ability to put out roots and produce large quantities of leaf biomass, even at high altitudes;
- planting of agroforestry or fruit trees; *Grevillea robusta*, avocado or banana are spaced at 10-m intervals along the same line as the shrubs; *G. robusta,* which originates in Australia and is highly valued by the people, is a very common species in Burundi's countryside; it has a relatively light cover and produces good timber, as well as providing high-quality humus.

Photograph 5: Preparation of erosion control bunds: planting of *Pennisetum* sp.

PHOTOGRAPH JEAN PROSPER KOYO

The farmers grow crops between the anti-erosion hedges, which are a source of both fodder and wood.

A year after planting, the grasses (*Trypsacum* sp. or *Setaria* sp.) and the stems of *Calliandra calothyrsus* are regularly lopped. The leaf biomass is used as fodder for goats and cattle that are partly stall-fed, while the wood obtained from the stems of *C. calothyrsus* is used as fuel and as supports for bean plants.

After two years of ploughing in the direction of the slope, the anti-erosion hedge can retain the sediment brought by water erosion, and terraces are gradually formed. Anti-erosion hedges have been planted along the contour lines of a total of 518 ha of cropland. Careful management of these hedges is

required in order to control erosion, reduce competition between the crops and the hedges and produce enough fodder for livestock.

After an inventory and socio-economic, hydrological and soil studies of Burundi's swamp areas had been carried out, a swamp management master plan was prepared. Small-scale water structures were built to provide an irrigation and drainage network in the swamps, and it is now possible to cultivate crops there in all seasons. Under the project, 219 ha of swamp have been developed at four sites, and crops can now be grown all year round, using either irrigation or drainage, depending on the weather conditions.

A number of seminars held on the project's four sites helped to develop the skills of the beneficiary farmer groups, with the result that they can now control the water, maintain the structures and make good use of the developed areas.

Thanks to the availability of grass and browsing fodder that can easily be cut or collected from the anti-erosion hedges, it has been possible to incorporate domestic animals (sheep, goats and cattle) into production systems. The animals are partly stall-fed in order to provide manure that can then be transformed into organic compost and used to fertilize the fields.

Figure 4: Burundi's comprehensive, integrated WM model

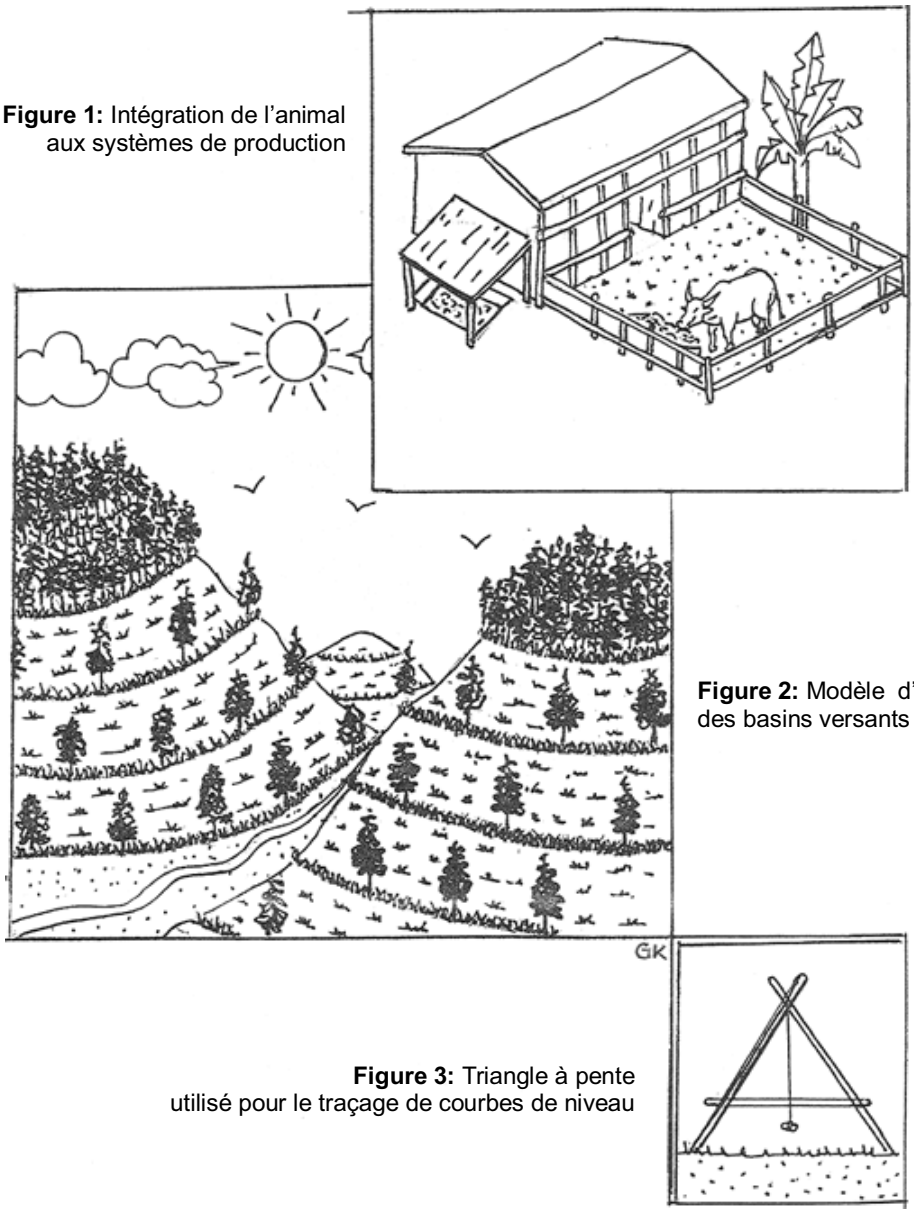


Figure 1: Intégration de l'animal aux systèmes de production

Figure 2: Modèle d'aménagement des basins versants et des marais

Figure 3: Triangle à pente utilisé pour le traçage de courbes de niveau

Local people's involvement in forest management in Burundi

Given the insufficient human, financial and material resources allocated to the Forestry Division, Burundi's forest resource base is poorly administered and poorly managed. This has prompted the State to disengage itself and involve local people more fully in the management and development of forests in an effort to enhance the value of the forest resource and ensure permanent forest cover, thereby reducing the damaging effects of erosion and wildfires.
Regular study tours have been organized within and outside the country to allow target populations to learn about ongoing experiments. A study tour to Burkina Faso in June 1999 allowed 15 men and women farmers to draw the following lessons:

- They were able to appreciate their Burkina Faso counterparts' efforts in land management, and are now committed to supporting people's involvement in forest management and other activities in their own provinces.
- They recognized the Burkina Faso farmers' good example and committed themselves to following it as soon as the technical and administrative conditions allowed.
- The whole delegation was very impressed with the Burkina Faso farmers' strong spirit of cooperation.

However, given the significant differences between the two countries, not least the constraints imposed by the imbalance between scarce forest resources and a large population, every care must be taken when transferring the Burkina Faso approach to the participatory management of natural forests in the Burundi context. It must also be borne in mind that Burundi has plantations rather than the natural forests that abound in Burkina Faso.

Table 8: Achievements of comprehensive, integrated WM at five sites

Province	Watershed	Plantation area (ha)	Area of hedges planted (ha)	Area of managed swamps (ha)
Rural Bujumbura	Rubanza	53	97	
Gitega	Kibuye	30	295	48
Cankuzo	Rugasari	15	71	61
Karuzi	Kigoma	6	15	60
Kirundo	Murama	182	40	50
Total		**286**	**518**	**219**

Dissemination of the new comprehensive, integrated WM techniques

The comprehensive, integrated and participatory WM techniques that FAO developed in Burundi are now part of the country's sustainable agricultural development strategy. They have been widely disseminated in rural areas by the extension services of the Ministry of Agriculture and Livestock. Several agricultural and rural development projects and programmes in the country now apply these techniques. The following are some examples of this:

- The programme to reactivate rural development in Burundi, funded by IFAD, is concerned mainly with the rehabilitation and rebuilding of agricultural production potential in the four provinces of Gitega, Karuzi, Kayanza and Cibitoke. Its strategy includes introducing rural support systems based on the participatory approach, and its main aim is to protect the land by encouraging farmers to adopt comprehensive, integrated WM techniques as a means of improving food security.
- A food security project funded by UNDP and implemented by FAO aims to improve food security in a country blighted by more than ten years of civil war. Comprehensive, integrated WM is the essential prerequisite for the agricultural activities promoted by the project. With World Bank support, the project lays particular emphasis on promoting the livestock component of agricultural production systems.

- A project entitled Credit for Economic Recovery, funded by the World Bank, covers the main comprehensive, integrated watershed and swamp management operations, i.e. hilltop reforestation, agroforestry development, farm erosion control measures and swamp management.
- An FAO-funded project supports the promotion of peri-urban and agroforestry plantations for the production of fuelwood and building poles. The project covers three areas: i) the rehabilitation of old and the creation of new forest plantations in peri-urban areas; ii) the promotion of microplantations in agroforestry systems; and iii) the refining of techniques to enhance the value of fuelwood through the use of improved stoves for charcoal production.
- The Burundi Rehabilitation Programme (PREBU) is directed at reforesting the country through the production of forest and agroforestry plants that are then planted by individual farmers or groups of farmers on the bare ridge tops or in agricultural fields, under the technical supervision of the forestry administration.

Table 9: Ongoing projects and programmes

Projects	Programmes	Funding
1. Nile Basin Water Resource Management	Preparation of draft projects on the Nile Basin	Italy
2. Africover East Africa	Land use map	Italy
3. Support for Food Security and Environment Management	Comprehensive, integrated watershed management	UNDP, FAO implementation
4. Countryside Reactivation and Development Programme	Reforestation and hydro-agricultural management	IFAD
5. CRE: Credit for Economic Recovery	Swamp reforestation and management	World Bank
6. UN Framework Convention on Climate Change (CCC)	2nd communication on climate change	IUCN
7. Park for Peace	Environmental education for the park's resident population	CEFDHAC
8. Developing Skills for the Implementation of SNPA-DB and Strengthening CHM.	Identification of requirements for the implementation of the SNPA.	UNDP
9. Support for the Promotion of Peri-urban and Agroforestry Plantations for the Production of Fuelwood and Building Poles	Preparation of wood development projects	FAO
10. PREBU: Burundi Rehabilitation Programme	Reforestation	EU
11. Lake Tanganyika Biodiversity Project	Studying the lake's biodiversity	GEF

Photograph 6: Dissemination of new WM techniques

PHOTOGRAPH JEAN PROSPER KOYO

5. Lessons learned

INSTITUTIONAL STRENGTHENING

Given the environmental and socio-economic need for WM in Burundi, MINATE has had to develop the skills needed to plan, monitor, manage and coordinate WM operations. Supervisory staff have been given on-the-job training by the project's international experts and have attended study tours abroad. These measures aimed to strengthen MINATE and ensure the sustainability of the project's results. Examples of measures aimed at developing the skills of national management staff and farmers include:

- promotion and dissemination of the participatory approach by DPAE technicians trained by the project;
- production of improved forest seed using seed orchards and seed stands, thanks to the training received by forestry officers;
- a study tour of community forest management in Burkina Faso for community members accompanied by the Provincial Governors of Kirundo and Ruyigi and technical officers from MINATE;
- training of forestry division supervisory staff in GIS techniques;
- training of charcoal producers in new improved stove carbonization techniques;
- local farmers' adoption of efficient watershed and swamp management measures introduced at pilot sites.

MINATE's technical departments were also revitalized, making them far more dynamic. The Ministry now has a national strategy for the environment and an updated environment action plan (SNE/PAE), as well as an environment code and a swamp development master plan. The first two are instruments for mobilizing funds for implementing the PAE, the third is a legal framework and the fourth is a series of technical guidelines.

The other codes, i.e. the forest, mining and land codes, are now out of date in some respects and need to be updated to bring them into line with the environment code.

PLANNING, COORDINATION AND MANAGEMENT OF ENVIRONMENTAL DATA AND INFORMATION

A GIS has been installed at MINATE. In addition to storing databases and producing maps, the GIS can analyse virtual situations using techniques that involve superimposing thematic maps. For example, maps of erosion sensitivity can be obtained from existing databases by superimposing maps of slopes on maps of population density; and maps predicting wood resource shortages can be obtained by superimposing forest maps on population density maps.

The GIS is a valuable tool as it helps the MINATE and The Ministry of Agriculture and Livestock to plan WM programmes with knowledge of the potential risks.

The dissemination of environmental data regarding specific socio-economic contexts could be another good way of providing data to the various user institutions.

The Environment Information Centre (CIE), which opened in May 2000, uses the GIS as a working tool and disseminates information in many areas, both physical and biological (biodiversity).

COMPREHENSIVE, INTEGRATED AND PARTICIPTORY MANAGEMENT OF WATERSHEDS AND SWAMPS

The participatory approach is based on the direct involvement of all development partners, especially local people, in all stages of the natural resource sustainable development process, i.e. identification of needs, formulation of plans, implementation, and monitoring and evaluation of results. This differs from past practices, where grassroots players had simply to accept decisions taken at the top. However, it should be noted that very few players are really prepared to apply this approach in full.

In its capacity as both player and beneficiary of development measures, the government continues to prepare national and sectoral development policies without sufficient involvement of local people and other development partners. Having been trained under the old system, government staff at all levels are reluctant to apply the participatory approach as it implies their having to give up some of their own authority.

UNDP and other donors, such as the World Bank, IFAD and ADB, favour operating and funding procedures that are not always compatible with the requirements of the participatory approach. Old project formulation practices are still used to determine project objectives, project duration and the rules for implementation and evaluation. This restricts the use of the participatory approach in the implementation of sustainable development programmes, e.g. in WM.

NGOs and national and international project implementation agencies rarely comply with the requirements of the participatory approach, and project teams are not always technically and psychologically prepared.

The main development players – the people – are not being given the importance in the participatory process that is due to them, nor do they receive the training and support that they require.

Reform of government institutions and aid agencies and training for the various players in natural resource sustainable development are essential prerequisites for the effective use of the participatory approach.

Photograph 7: Training for rural people

PHOTOGRAPH JEAN PROSPER KOYO

Despite these constraints, people's involvement in watershed and swamp management is the only way to ensure the sustainability of soil and water conservation operations, especially in Burundi. The growing interest in the participatory approach stems from the widely held view that projects are too highly technical and government departments are ineffective motivators and administrators of development.

The approach should be based on a redistribution of the roles of the institutional players, a new attitude to decision-making and new investment management procedures. It aims to ensure sustainability while attaching greater importance and giving new responsibilities to beneficiaries, who become partners in the development process – from the design stage right up to implementation and evaluation.

THE IMPORTANCE OF EROSION CONTROL AND SOIL FERTILITY

Because of water erosion, most of Burundi's soils are acidic and have low organic matter contents. Agroforestry anti-erosion hedges are an effective means of controlling erosion. Two consecutive wet seasons suffice to initiate the formation of anti-erosion terraces between the hedges, creating space for crops. The manure produced by partially stall-fed livestock is mixed with compost and incorporated into the soil's organic matter, thus correcting the pH level and improving the cohesion of soils under crops.

The areas adjacent to correctly managed watersheds are protected from the flooding that often destroy crops and housing in the vicinity of swamps and lowlands.

Photograph 8: Erosion control

PHOTOGRAPH JEAN PROSPER KOYO

The incorporation of livestock[6] (partly stall-fed) into WM operations has become a very popular practice. The livestock provided by various projects in the country[7] are more valuable for the manure that they provide than for their meat or milk.

[6] Sheep, goats and cattle.
[7] UNDP-FAO BDI/96/001 and BDI/87/006, IFAD and World Bank.

Photograph 9: Integration of livestock into farming systems as a means of improving soil fertility

PHOTOGRAPH JEAN PROSPER KOYO

The principle of distributing livestock for this purpose is described as "a solidarity chain". It consists of gradually giving livestock to all the farmers on a single hill, starting with one batch of animals being given to a certain number of farmers. The young born thereafter are then given to other farmers, until the needs of all the farmers on the hill have been met.

THE CHANCES OF COMPREHENSIVE, INTEGRATED TECHNIQUES BECOMING A STANDARD FEATURE OF WM IN BURUNDI

The Burundian model of comprehensive, integrated WM is relatively complex as it includes a number of operations that local farmers cannot master without correct, long-term support. In addition to the hard work that is traditionally part and parcel of crop farming and other household activities, the people will have to devote time to:

- creating nurseries of forest and agroforestry shrubs and cuttings of fodder grasses;
- moving plants from the nurseries to the fields;
- marking contour lines using a triangle level, for which farmers need to be trained to work in teams of at least two people; contour lines have to be marked by wooden pegs, but these are very scarce and must be collected several days before the marking operation begins;
- preparing the anti-erosion bunds along the contour lines and planting them with fodder grasses, shrubs and/or trees;
- managing the anti-erosion hedges by regularly lopping the grasses and agroforestry shrubs to obtain fresh fodder;
- looking after stall-fed livestock (i.e. veterinary care, hygiene and feeding) and regularly cleaning the stalls by removing the manure and placing it in compost trenches nearby, which are managed on a day-to-day basis by the farmers;
- burying organic fertilizer in pockets dug along lines, which requires a great deal of care and is very time-consuming;
- planting and maintaining plantations on bare hilltops, which requires a great deal of work.

Farmers whose agricultural plots are in the swamps must be involved in the community management of small commonly owned irrigation and drainage structures.

All these operations require extra work from local people. The gains in crop yields resulting from erosion control measures and the addition of organic matter to the soil will not be tangible for the first

few years,[8] and the people will need government and donor support until the direct effects of the management measures are felt. The use of all these techniques will therefore require very efficient and long-term technical support. Help will also have to be provided for the production of the plant material required, e.g. for the hedges.

Swamp management also requires the building of small irrigation and drainage structures, and the implementation and costs of these structures are well beyond the people's reach. Technical and financial support is therefore absolutely necessary for their establishment and management.

THE FORESTRY SECTOR

Burundi's forestry sector is based mainly on plantations that require large amounts of high-quality seed. BDI/96/001 started by setting up a network of seed stands selected from the best forest stands in the country and by introducing seed from provenances other than the main reforestation species. These are first tested and then used to establish seed orchards.

Burundi's total forest seed requirements (for all species) amount to 1 tonne per year. The national production of forest and agroforestry seed through the Forestry Department's Seed Agency is about 800 kg annually. Almost all of the seed used in Burundi continues to be of mixed quality. However, with the introduction of a network of 14 selected and managed seed stands, the country is beginning to have improved local seed.

The seed orchards of *Eucalyptus grandis, Acacia mangium, Calliandra calothyrsus* and *Grevillea robusta* established at Simba and Kamushiha will produce seed in the medium and long terms. The country will then be able to increase its seed production capacity and the quality of certain species of seed. It would be worth taking similar steps with other species currently used for reforestation in Burundi.

It is clear that the *in-situ* production of improved seed will allow Burundi to meet its requirements in terms of quality forest and agroforestry seed, thereby avoiding the need to import seed at great expense. The possibility of Burundi exporting quality seed in the medium term must not be ruled out. This would have a great positive impact on the country's economy and forestry activities.

Burundi no longer has enough space to establish large-scale reforestation programmes. The only available areas for such plantations are the bare hilltops. Another way of increasing tree cover in the country is to combine trees and agricultural crops through agroforestry and to create line plantations, which require the close involvement of local people.

THE INVOLVEMENT OF LOCAL PEOPLE AND NGOs IN FOREST MANAGEMENT AND ADMINISTRATION IN BURUNDI

The forestry division is not allocated sufficient human, financial and material resources, which means that Burundi's forest assets are poorly administered and managed. The involvement of local people in forestry administration and management would improve this situation, and the Burundi authorities are encouraging local communities, projects and NGOs to become involved in forest and agroforestry plant production, as well as in the planting, management and evaluation of resources.

A number of experiments involving local people in the management, administration and evaluation of wood resources have been carried out. These include:

[8] This can be regarded as a sort of investment period.

- the transfer of responsibility from MINATE to groups in the Magara plantations in Ngozi province and the Ntamba plantations in Muyinga province;
- the establishment of farmers' groups, supported by the forestry services, to implement management operations in two plantations;
- the implementation of the following operations: i) identification and marking out of plantation areas; ii) preparation of a management plan; iii) production of 80 000 plants for restocking; and iv) preparation and sale of fuelwood.

This type of operation needs to be closely supervised for relatively long periods as the Burundi people are not used to managing plantations.

Following the study tour to Burkina Faso in June 1999 the 15 Burundi farmers who took part:

- acknowledged the achievements of their Burkina Faso counterparts and promised to follow their example in Burundi when technical and administrative conditions allowed;
- were impressed by the spirit of cooperation that existed among the Burkina Faso farmers.

In 2000, the number of forest and agroforestry seedlings produced in the country totalled 30 million (all species included). These seedlings are distributed to farmers so that they can create their own individual or community plantations on the bare hilltops that have been handed over to them by the provincial or local authorities.

6. Conclusions

Burundi is a very mountainous, landlocked country, situated between Rwanda, the United Republic of Tanzania and the Democratic Republic of Congo. It is considered one of the world's poorest countries, and is also one of the most densely populated in Africa (230 inhabitants/km²). More than 90 percent of the population is rural, living mainly from traditional agriculture, which accounts for almost 60 percent of the country's GDP. The habitat is dispersed and wood provides 97 percent of the country's fuel requirements.

Burundi's highlands consist of many watersheds presenting the following three main characteristics:

- bare, rocky ridges that are unfit for agriculture;
- slopes covering about 1 million ha, on which all crop farming is done;
- swamps covering about 120 000 ha, more than 69 percent of which is used indiscriminately during the dry season.

In response to soil impoverishment, which is due to intense erosion, excessive land use and strong pressure on scarce and fragile natural resources, project UNDP–FAO BDI/96/001 (Support for Environment Restoration and Management) developed a comprehensive, integrated watershed and swamp management model to provide the country with a sustainable and sustained agricultural and forestry production system.

The measures introduced were based on the participatory approach with the close involvement of NGOs. They comprised:

- afforestation of bare hilltops using species such as *Eucalyptus grandis, E. maideni* and *Callitris calcarata;*
- the planting of slope contour lines with anti-erosion hedges of agroforestry trees (mainly *Grevillea robusta*), forage grasses (*Trypsacum* sp., *Setaria* sp. and *Pennisetum* sp.) and fodder shrubs, especially atmospheric nitrogen-fixing pulses (*Calliandra calothyrsus*);
- the construction of small water retention structures for irrigation and drainage in the swamps during the dry and wet seasons, which allows the swamps to be used throughout the year;
- the incorporation into the production system of partly stall-fed livestock, using grass and shrub fodder collected from the anti-erosion hedges as feed; the manure produced by the animals is used to make compost, which is spread on the fields to reduce soil acidity.

These types of measures have made it possible to control runoff and swamp water effectively, protect, restore and maintain soil fertility, produce fuelwood and building poles, and obtain milk and meat.

The large-scale use of these management measures, together with crop intensification and diversification, are essential prerequisites for achieving food security and poverty alleviation.

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