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Nile Trans boundary
Environmental
Action Project

WETLAND AND BIODIVERSITY COMPONENT

STUDY OF THE FLORA IN THE COHOHA SUB-BASIN

By

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ABREVIATION

IGEBU:	Geographical Institute of Burundi
UICN/IUCN:	International Union for Nature Conservation
UNDP:	United Nations for Development Program
FAO:	Organisation for Food and Agriculture
CRS:	Catholic Relief Service
INECN:	National Institute for Environment and Conservation of the Nature
MINATETAP:	Ministry of Environment, Land management and Public Works
DGFTE:	General Direction of Forestry, Tourism and the Environment
DPAE:	Provincial Direction of Agriculture and Livestock
ISABU:	Institute of Agronomic Sciences of Burundi
FACAGRO:	Faculty of Agronomy
IRAZ:	Institute of Agronomic and Zootechnical Research
CEPEGL:	Economic Community of the Great Lakes Countries
HIMO:	High Intensity Manpower
FIDA:	Fonds International de Développement Agricole
ISAR:	Institute of Agronomical Sciences in Rwanda
MINAGRI :	Ministère de l'Agriculture et des Ressources Animales
MINECOFIN :	Ministère des Finances et de la Planification Economique
MINITERRE :	Ministère des Terres, Environnement, Forêts, Eau et des Mines
PDL-HIMO :	Labour Intensive Local Development Programme
PSTA :	Plan Stratégique de Transformation Agricole
RADA :	Rwanda Agricultural Development Authority
REMA :	Rwanda Environment Management Authority
UNDP:	United Nations Development Program
PNUD :	Programme des Nations Unies pour le Développement

CONTENT

INTRODUCTION

The wetlands in the Cohoha sub-basin are consisted to lakes, rivers and marshes. The flora of the the Cohoha sub-basin is summarized in marshes which surround the lakes or are located throughout the rivers, the aquatic vegetation and the xerophilous vegetation and rare savannas dispersed on hills.

Currently, the wetlands vegetation in the Cohoha sub-basin is subjected to anarchistic exploitations in particular by irrational drainage with like consequence, the enormous and irreversible losses of the sol, of the flora and fauna, the lowering of the level of water and finally the prolonged dryness.

The Nile Transboundary Environmental Action Project (NTEAP), with the support of the United Nations Office for Project Services (UNOPS) wishes to carry out in-depth ecological and economic studies of the roles of wetlands and biodiversity in supporting sustainable development together with a detailed water quality assessment of the Lake Cyohoha sub-basin. The studies will provide a better understanding of wetlands and biodiversity and avail information for their effective management.

The studies will explore the ecological processes including the water quality and hydrologic role of wetlands in flood control and the impact of wetland modifications and loss, on biodiversity. They will also assess the economic potential and major threats together with the underlying social and economic functions, and provide information for effective management of trans boundary water resources, wetlands, and biodiversity in the wider Kagera basin.

It is accordingly that a study on the flora was entrusted to us with main objectives as follows:

1. Produce a comprehensive description of the flora in the Cyohoha sub-basin, its Wetlands and the catchment including the macrophytes that occupy the ecotons of these habitats.
2. Identify an explanation of the link between the ecology of the flora and livelihoods of the riparian communities should be given.
3. Establish the legal and institutional arrangements for the management of the flora should be elaborated.
4. Produce a list of the flora and their economic and scientific importance and their management

This study of Cohoha sub-basin flora was rarried out in 6 localities following:

- The Western termination of Cohoha lake (Rwanda):
  - The vegetation in the western edge of lake at Kiri;
  - The vegetation in the East edge of lake;
  - The vegetation of Cohoha tributary at Kagali-Ngenda.
- Kagenge locality with 2 sites (Rwanda) following :
  - The vegetation of Cohoha tributary at Gahigiri,
  - The vegetation of Rusamaza.
- The termination of Cohoha tributary of Yaranda, in Burundi
- The termination of Cohoha tributary at Marembo, in Burundi
- The vegetation of Mugombwe, in Akanyaru valley, in Burundi
- The xerophilous thickets of Gasenyi, in Burundi.

The analysis of the flora in Cohoha sub-basin has been done on the basis of transects. The observations, the sampling and the photography have been made throughout the transects. Diagrams of the profiles give the image of the flora of the sub-basin.

The analysis of link between the ecology of the flora and livelihoods of the riparian communities concerns the ecological influences of the vegetation on the socio-economic life of the population. It shows also the various uses of the living resources. A sampling of the floristic resources constantly used by the local communities has been done. The analysis visualizes also the utilization factors, the abundance of the resources and the impact of the threats. The lists of the flora and their economic and scientific importance have been given. A guideline for the vegetation conservation and endangered species safeguard has been done.

Concerning the legal and institutional arrangements, the legal framework governing the swamps and lakes has been analyzed. The current systems of natural resources management in the sub-basin have been analyzed. The institutions and other stakeholders involved in vegetation management of Cohoha sub-basin are explored. Based on proposal provided by various actors involved in the flora management, the legal and institutional arrangements have been elaborated.

I. COHOHA SUB-BASIN PHYSICAL CONDITIONS

I.1. Cohoha lake Geographical Situation

Cohoha lake is located between Burundi and Rwanda and lies between 2°20' and 2°35' Southern latitude, and 29°58' and 30°11' of Eastern longitude at 1,351 m of altitude. With a surface of 7,850 ha, the lake is presented in the form of a lengthened corridor of 27 km long and 0.4 – 1.8 km width. On the right and on the left are ramifications both numerous and long (0.4 km width and up to 8 km long) (Fig.1). Some of these distributaries are bifid or even ramified several times, especially in the Southern part. It is certainly this dendritic form that gave the name of Cohoha lake (Cohoha in Kirundi means wandering). It is in the Southern part that this lake reaches its greater width, i.e. 2.3 km. The average depth is 7 m and varies from 5 -7 m towards the North and 8 - 10 m in the Southern part. The bottom of the lake is sandy or gravely all along the littoral zone except at the bottom of bays where it is muddy (Ntakimazi, 1985).

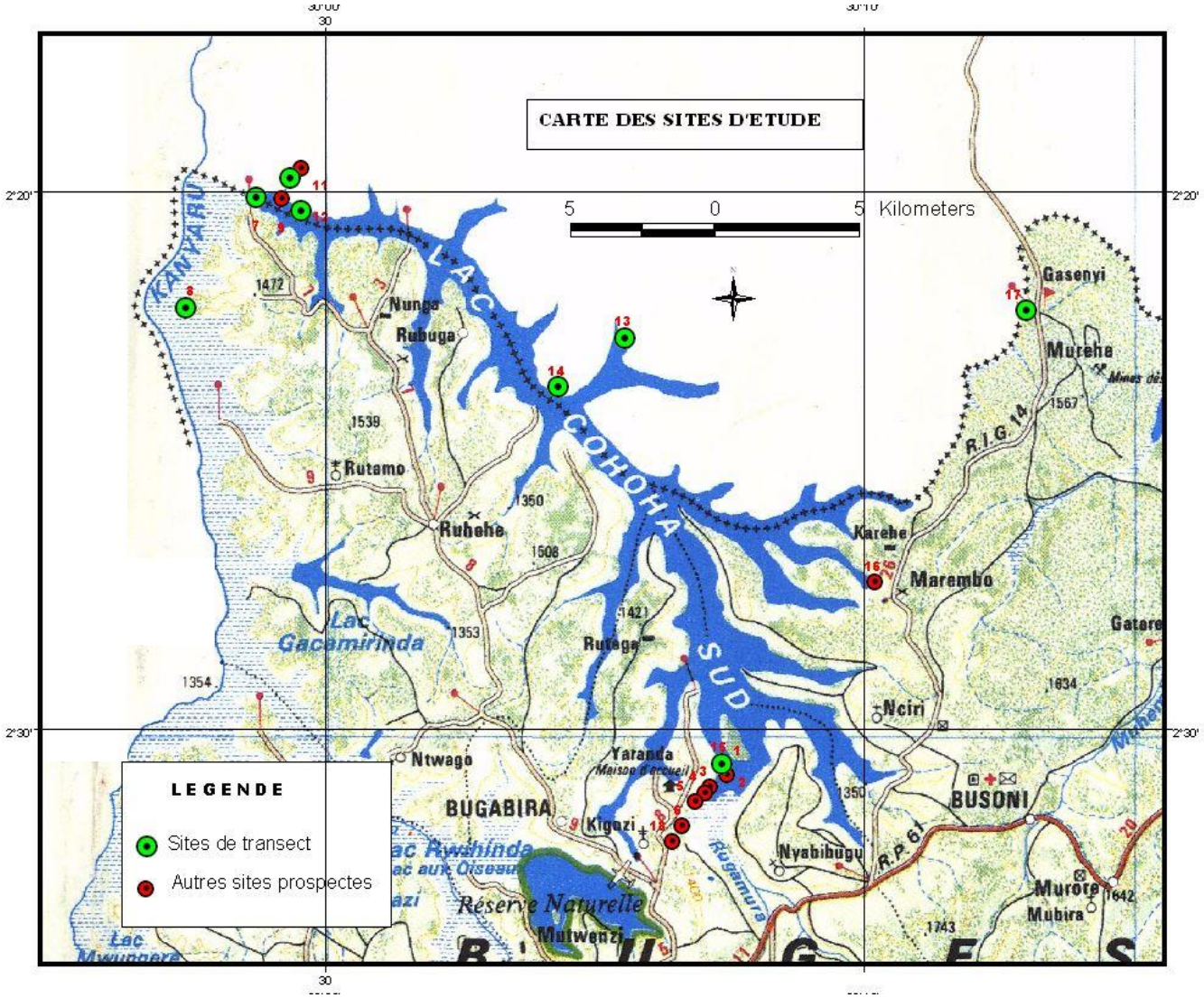


Fig. 1: Map of the sites of this study

I.2. Hydrology

The hydrological system of Bugesera belongs to the Nile Basin and the Akagera sub-basin. The whole of the area of Bugesera is characterized by the marshy and Lake Complex of Akanyaru, upstream, the marshy and lake system of Nyabarongo-Akagera, downstream (Fig. 2). The principal marshy extents of Bugesera are, on the one hand the Lower Akanyaru Complex and its Nyavyamo tributaries downstream from Lake Rwihinda and Cohoha Lake, and on the other hand, the Rweru-Kanzigiri Complex and Akagera right in its downstream.

Akanyaru River curves, by a very slow course, in a marsh of *Cyperus papyrus* where it traces several meanders. The tributaries of the river are all marshy. It is in these secondary valleys that the marshes are located, hosting the various lakes (Rwihinda, Cohoha, Gacamirindi, Nagitamo, Mwungere and Narungazi). Waters of these lakes are maintained in place only thanks to the existence of these marshes.

The hydrological study which was made by Ntakimazi (1985) on these systems highlighted the annual and inter-annual fluctuations of the level of water in Akanyaru and Nyabarongo rivers, entailing that of the lakes.

During the rainy period of April - May, one observes risings of Akanyaru and Nyabarongo rivers. Under these conditions, the surplus overflows over banks and floods the marshy valley and the lakes. Similarly, at the junction of Nyabarongo-Akanyaru, the flow of the principal river slows down and can even block that of the tributary, thus supporting the overflow of water in the lower part of the latter, in the side valleys and in the lakes. These marshy systems are used for storage of important quantities of water during the rainy season, which runs out then more slowly in the rivers during the dry season and at the beginning of the following rainy season, thus making water longer available to the natural and agricultural ecosystems. The hydrological surplus or deficit influences the flow of the following year.

The annual fluctuations from 1-1.5 m (extreme of 3.5 m) for the level of the lakes constitute an important modification depth and extent of the lakes, and thus indirectly influence most of the ecological parameters in the lake milieus.

At Rweru lake, the low-level mark is lower than the shallow water which delimits its discharge system; even if the level in Nyabarongo is lower than that of the lake, there is no straight flow between the two milieus. The lake runs towards Akagera as of the rise of water of the beginning of the rainy season. In March-April, the level of the river goes up more quickly and exceeds that of the lake; the flow is then reversed and it is the river which runs towards the lake, invading then the entire surrounding marshy zone. With the fall, from June to August, the lake runs again towards Nyabarongo, initially over the marsh, by a single channel then.

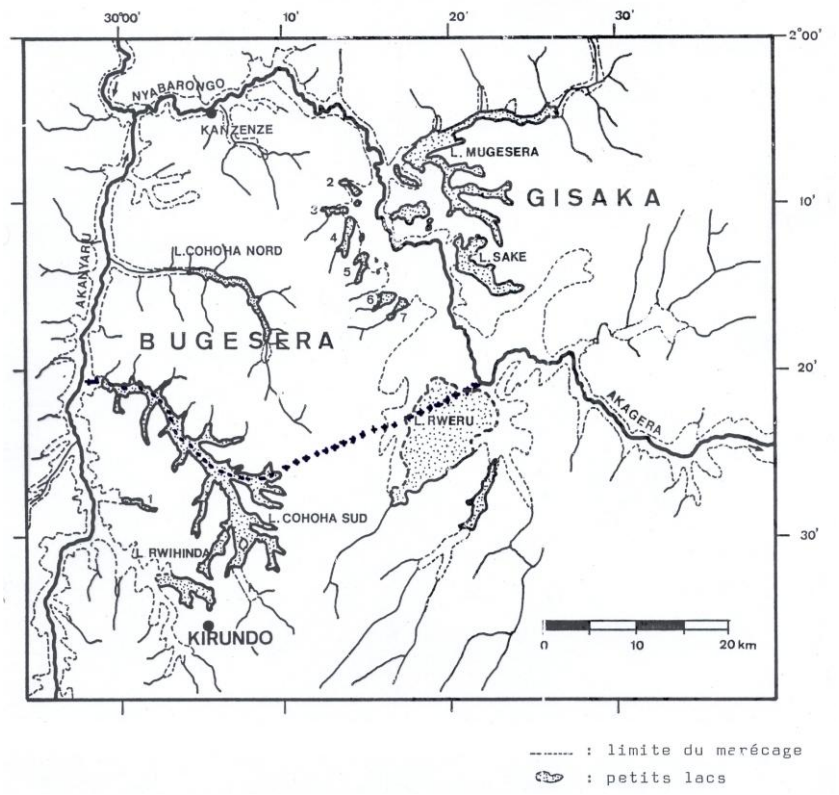
Cohoha lake, on the contrary, is separated from Akanyaru River by an 11-m depth vegetable stopper in a valley of 24 km-long and 500 m-width. The hydrological communication between the lake and the river is done by slow diffusion of water, in a direction and in another, through the marsh. Almost non-existent during low waters, it becomes significant at the time of the risings of the river where it contributes, with the secondary precipitations and tributaries, to rise the level of the lake by approximately one meter. Apart from exceptional risings, the average annual fluctuations of the level of Akanyaru do not make it possible to flood the marsh to the lake. It is thus very seldom that the lake and fluviatile system have a frank communication by a continuous water table.

Contrary to Rweru Lake, Cohoha Lake is maintained only thanks to the contributions of its own tributaries and precipitations, the marsh downstream being especially a dam which fixes the level. A succession of 2 - 3 years of hydrous deficit has as a consequence a very significant fall of the level of water in the lake.

Thus, the drainage of the marsh downstream from Cohoha lake would be fatal for the system. It would be a matter of opening an exit point for all water, like one empties a pond of stopping. This is what occurred for the Northern Cohoha Lake in Rwanda in the 1980's.

The marshy Akanyaru and Nyabarongo-Akagera Complexes thus have a regulating function, not only on the level of the rivers, but also on the level of the lakes. The shoals, consisted of vegetable stocks, make it possible for the lakes to be maintained on a level higher than that of the rivers, and thus to remain during the periods of low-level water.

The artificial draining of these marshes, ex. for agricultural needs, could thus have for effect the disappearance of these free water tables.



Lakes : 1 : Gacamirinda 4 : Rumira 7 : Gaharwa
2 : Gashanga 5 : Mirayi 8 : Birira
3 : Murago 6 : Kilimbi 9 : Kanzigiri

Fig. 2: The marshy and lake complex of Bugesera and Gisaka (Akagera basin) (Ntakimazi, 2006).

I.3. Climate

Analyses of precipitations and average monthly temperatures were made on the basis of data of Murehe and Kirundo stations provided by the IGEBU over 25 years (1980 - 2004) (Nzigidahera et al, 2005). The calculation of the variations of precipitations was carried out, which made it possible to affirm that during such or such other year, the rains were surplus, very surplus, normal, overdrawn or very overdrawn.

Over the 25 last years, one knew 12 years during which, precipitations lower than the normal were recorded (Table 1). From 1984 -1985, there were surplus rains whereas the years 1993, 1996 and 2000 were characterized by overdrawn rains. However from 2001 - 2004, normal rains were recorded. These changes of precipitations during years however do not translate a certain periodicity (Fig.3). By questioning the literature, we noted that at Murehe station (1564 m), annual average precipitations of 1973 - 1980 were 699 mm, with a minimum in 1975 (548 mm), whereas with similar altitudes in other parts of the basin, they exceed 1,000 mm (Ntakimazi, 1985). Annual average precipitations were thus overdrawn with a variation of – 34.7% at Murehe. In Kirundo (1,490m of altitude), just in the South of Cohoha Lake, the average annual rainfall (1973-1980) was 998 mm, with a minimum of 590 mm in 1980. In 1981, one recorded in Kirundo 1,183 mm of precipitation, a height which had not been reached during the preceding 8 years. There is also an irregular distribution of the rains on the area, according to numerous parameters such as the latitude, longitude, altitude, the orientation of the relief, the local topographic factors such as forests, marshes, lakes, etc. (Ntakimazi, 1985).

Regarding the temperatures, one does not notice a clear difference during years. The average temperatures vary between 20 - 25°. According to Ntakimazi, 1985, diurnal thermal amplitudes, i.e. the differences between daily average maximum and minimum are about 13°C at Kirundo and 15.3 °C at Murehe. The most important variations are recorded towards the end of the dry season (14.6°C at Kirundo and 16.8°C at Murehe), because during the rainy season, the screen of the clouds, precipitations and evaporation tend to attenuate the extremes. In the marshy valleys and plains, these daily variations of the temperature seem attenuated. It would be due to the influence of the mass of water existing in the area: they are heated less quickly than the air during the day and keep longer their heat during the night.

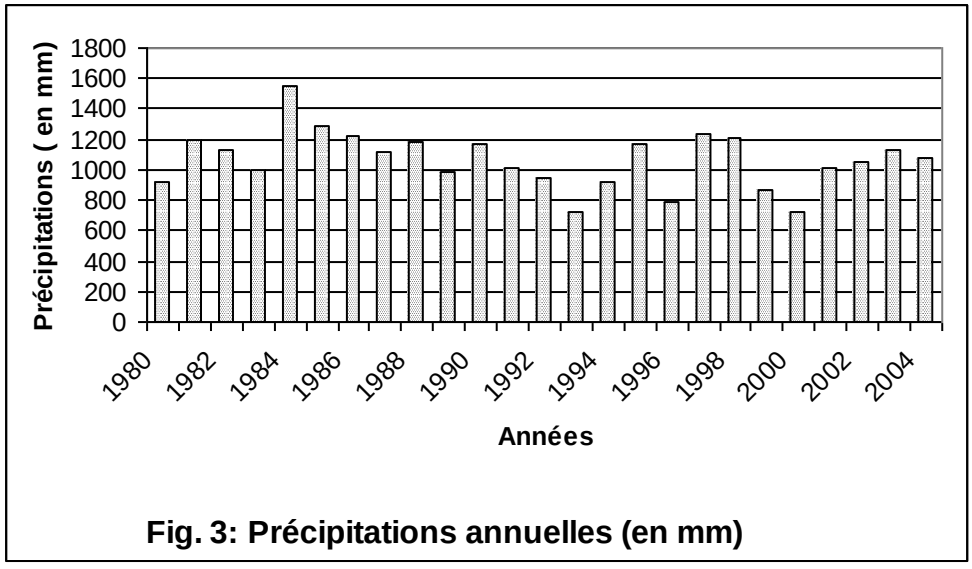


Fig. 3: Précipitations annuelles (en mm)

Table 1: Variations of annual precipitations over 25 last years in the area of Bugesera (data provided by the IGEBU, 2005)

Years	Variations	Annual precipitations (in mm)	Observations and conclusion
1980	-13,7%	923,3	Precipitations lower than the normal, normal Rain
1981	11,7%	1197,2	Precipitations lower than the normal, normal Rain
1982	5%	1130,5	Precipitations lower than the normal, normal Rain
1983	-6,5%	1001,1	Precipitations lower than the normal, normal Rain
1984	44,2%	1545	Precipitations higher tha the normal, surplus rains
1985	20,7%	1292,9	Precipitations higher tha the normal, surplus rains
1986	13,6%	1217,2	Precipitations lower than the normal, normal Rain
1987	4%	1114,5	Precipitations lower than the normal, normal Rain
1988	10%	1179,4	Precipitations lower than the normal, normal Rain
1989	-8,4%	981,1	Precipitations lower than the normal, normal Rain
1990	9,7%	1175,9	Precipitations lower than the normal, normal Rain
1991	-6%	1006,1	Precipitations lower than the normal, normal Rain
1992	-11,5%	947	Precipitations lower than the normal, normal Rain
1993	-32,9%	718,2	Precipitation lower than the normal, rain overdrawn
1994	-14,3%	917,4	Precipitations lower than the normal, normal Rain
1995	9,3%	1171,2	Precipitations lower than the normal, normal Rain
1996	-26,4%	788	Precipitation lower than the normal, rain overdrawn
1997	14,8%	1230,3	Precipitations lower than the normal, normal Rain
1998	12,8%	1209,2	Precipitations lower than the normal, normal Rain
1999	-19,5%	861,3	Precipitations lower than the normal, normal Rain
2000	-32,1%	726,9	Precipitation lower than the normal, rain overdrawn
2001	-5,1%	1015,5	Precipitations lower than the normal, normal Rain
2002	-1,8%	1051,8	Precipitations lower than the normal, normal Rain
2003	5,6%	1131,9	Precipitations lower than the normal, normal Rain
2004	0,02%	1073,9	Unimportant variation, normal rain.

1.4. Geology

The rocks of Bugesera are of Precambrian age and belong to lower Burundian. The geological nature of this area is dominated by the folded sediments of the Karagwe-Ankole system or Burundian, consisting of the successive layers of pelitic rocks, especially of phyllite and the argillaceous schist, arenaceous rocks like the quartzose and quartzite. The granites and the granitogneissic rocks appear in the peneplane zones or very dissected by erosion (Ntakimazi, 1985).

The Bugesera area is schematized by a central basin which is a granitic base surrounded by round hills with soft slopes and broad widened valleys. The most deeply dug valleys of the lower course of Akanyaru River pass through soils of sedimentary rocks of schistous predominance, while the remainder of the basin is of granitic and gneissic nature, with sedimentary enclaves. All the lakes are placed in the hollow granitic cells.

Around the central basin, the hilly zone is dominated in the West (left slope of Akanyaru) by a terrazzo-gneissic complex from where stem seams of quartzite. The South-east of the hilly zone is dominated by a quartzito-schistous unit, also associated to quartzitic ridges. These hard stone outcrops are even more abundant and are more strongly folded downstream from Rweru Lake.

1.5. Pedology

The Bugesera area consists of two types of soils: well drained soils and hills subjected to degradation during a very long period and recent soils of the lowlands and valleys flooded or not flooded (Ntakimazi, 1985).

At hills, the soils consist of ferralsoils, more particularly of the xeroferralsoils. They are very erodable substrates, particularly inert, with a very thin humus-bearing layer. In spite of the aridity of the area, the scrubbing of original material was thus very marked. One very rainy time would have preceded the current time (Ntakimazi, 1985).

In the lowlands, the soils are alluvia in the bottoms of valleys and colluviums on the edges and the organic soils in the flooded zones. The bottoms of the non-hydromorphic valleys are generally papered with vertisoils, of soils characterized by a fine texture, an important quantity of clay and little organic matter. In the flooded valleys, including the bottom of the lakes, the organic soils are associated to silt and sand.

Underwater, the decomposition of the vegetation wastes by micro-organisms is very slow, especially because of the acid pH and the anaerobic conditions. When accumulation is faster than the decomposition, the result is a deposit of peat, with contents of organic matter of 80% and even more than 90%.

II. COHOHA SUB-BASIN VEGETATION

II.1. Historical Background

From the phyto-geographical point of view, Bugesera is attached to the Eastern field of the sudano-zambezian region. The vegetable flora and groupings show particularly many affinities with those of the area of Kagera and the district of Ankole in Uganda (Liben, 1960).

Liben (1960) gave a global view of the vegetation of Bugesera basin which prevailed in the 1960's. His zone of study extended to the East up to the Eastern bank of Rweru Lake. To the South, the limit joined the ends of the lakes Rweru and Cohoha, while in the west and north, it was roughly parallel to Akanyaru and Nyabarongo rivers. The area thus exactly comprises our zone of study.

At banks of lakes, the author described the paludicole vegetation consisting of marshes with predominance of *Cyperus papyrus*. In the bottom of the dry valleys, Liben (1960) mentioned a grassy savannah of *Bothriochloa insculpta* and *Themeda triandra*. In the North-eastern part, the xeric stations comprised of ochre-yellow soils colonized by a savannah of *Loudetia simplex* and *Heteropogon contortus*.

The shrubby savannah of *Loudetia simplex* and *Pappea ugandensis*, the less xeric of Bugesera, was mentioned in the South-western part of the basin. In 1960, Liben (1960) shows already that shrubby savannah started to be invaded by thickets when balance with the milieu was broken. Following the action of the termites that become intense on certain localities, savannah of *Loudetia simplex* and *Heteropogon contortus* became a xeric lawn of *Brachiaria dictyoneura* and *Brachiaria eminii* maintained by the overgrazing. The lawn of *Ctenium concinnum* and *Elyonurus argenteus*, the most xeric of Bugesera was localized on lateritic lithosoils and the remains of the dismantled flagstones.

Regarding the filling of the heads of valleys and recent colluviums in general, there was a timbered savannah of *Acacia seyal* and *maximum Panicum*. This type of vegetation occupied rather important surfaces in the hilly zone bordering Bugesera basin in the East, where the relief supports an intense colluvial deposition. Timbered savannah of *Acacia nefasia* was localized on the humus-bearing alluvia in edges of the lakes. From the floristic point of view, the savannah was dominated either by *Acacia sieberiana*, *Acacia nefasia*, or by *Acacia caffra* var. *campylacantha*, or by a mixture of these two species with extremely similar ecological requirements.

In the 1960's, these savannahs, located on the best farming soils, had been strongly altered by man. The covering of the higher layer, formed by *Acacia*, was already variable by about 30 - 80%. Where the underwood had been completely cleared for the preparation of farming, there was no longer anything but only one herbaceous layer where *Panicum maximun* occupied a dominating place. Since the action of man had been less radical, the stratification was much more complex and the species of the clear forests were much more abundant, particularly *Bridelia micrantha* and *Cordia abyssinica*.

The xerophilous thickets are located on hills where they carry out a well individualized association distributed in mosaic with other types of vegetation.

Among the sclerophyllous forests of Bugesera, Liben (1960) mentioned the climacic forest of *Carissa oppositifolia* and the dry forest of *Apodytes dimidiata*. This author stresses that the climacic forest of *Carissa oppositifolia* was already in danger in 1960 and that it was represented more only by

some strongly altered scraps. The forest of *Apodytes dimidiata* still occupied the sides exposed to the West of some hills, on graverous lithosoils.

In the 1960's, crops occupied relatively restricted surfaces and were almost exclusively localized in edges of lakes. The farmer chose preferably the groupings of *Acacia nefasia* to establish his fields. A number of these trees are generally respected during the first clearing. The commensal vegetation of the crops was characterized by ruderal species. In the event of abandonment of the crops, a grassy grouping dominated by *maximum Panicum* settled, which could not continue its evolution, in most of cases, because of the setting in farming after few years (Liben, 1960).

Today, the human action has completely modified the various types of vegetation in Bugesera. This is related to the movement of immigrants which was accentuated since 1960 in Burundi as well as in Rwanda. For the case of Burundi, it is at the beginning of the years 1961-1962 that the area of Bugesera started to be invaded by populations primarily coming from the provinces of Kayanza and Ngozi (Nzigidahera et al, 2005). But the great movements of immigrants are those of the 1980's, a period when the area of Bugesera was regarded as the attic of Burundi.

According to investigations and studies carried out in the Rwandan part, the natural vegetation especially that of the hills was quickly eliminated. Indeed, on the one hand, large scale clearing activities in this area practised by a wave of immigrants from all the areas of the country in search of new farming grounds in years 1970-1990 ended up exposing a great part of this area. In addition, coal manufacturing activities which fed the town of Kigali almost entirely destroyed all the woody vegetation of this area. On the 50,000 ha (according to the estimate of 1983) of the Bugesera wooded, there remained, according to an investigation carried out by the MINAGRI in 1988, only less than 10,000 ha which were no longer in a natural state since they had been arranged in pastures and military reserve. These are the pastures belonging to Ririma prison, Karama ISAR station, and Gako barracks military reserve.

Currently, most of the vegetation of Liben (1960) is represented only by relics which will no longer be able to require ground. On the hills, various savannahs and thickets were eliminated in favour of farming and dwellings. In Burundi, certain intolerable scraps show the old vegetation of certain localities. The thickets intermingled with other vegetable formations are localized in the Murehe Natural Reserve and the military field of Rwanda, at the extreme East of our zone of study.

The wooded savannah which was localized on the humus-bearing alluvia in edges of the lakes is completely cleared. Some rare trees of *Acacia sieberiana* and *Acacia polyacantha* remain in the fields.

Concerning the paludicole vegetation, the most remarkable invasion of the marshes of Bugesera was observed since 1998. Following the hard and long dryness which struck the area of Bugesera, agriculture in the marshes was intensified. This resulted into the complete elimination of the vegetation from the edges of rivers and lakes.

II.2. Analysis of the Vegetation

II.2.1. Space layout of the vegetation of Cohoha sub-basin

In the Cohoha sub-basin, one distinguishes the vegetation of the terrestrial environment and the vegetation of the wetlands. The important terrestrial vegetation which deserves to be highlighted relates to the xerophilous thickets of Gasenyi forming continuous vegetation connecting the vegetation of the military field of Rwanda and the vegetation of the Murehe Natural Reserve in Burundi. The wetlands include primarily the marshes and some plants submerged on Cohoha Lake and Akanyaru River.

In the Cohoha sub-basin, the topographic variations offer various landscape aspects colonized by various vegetable formations. One distinguishes the following:

- A topography of slope falling abruptly in the waters of Cohoha Lake

The lack of projecting ledge in the edge of Cohoha Lake does not support the deposit of alluvia and colluviums. Thus, a very thin vegetation of edge is formed, not exceeding 10 m width. It is the field of *Phragmites mauritianus*, often dispersed in the form of tuft. The transition between the aquatic environment and the terrestrial environment is not marked. The crops occupy the immediate edge all the year long. This type of topography occupies most of the safe lake on the terminations. This is related to the fact that the bottom of the lake is sandy or gravely all along the littoral zone.

- Soft topography creating a small projecting ledge in the edge of the lake

This is the projecting ledge not reaching 50 m width in the edge of the lake. It is the field of *Typha domingensis*. In most cases, *Typha domingensis* is bordered by a band of *Phragmites mauritianus* or *Echinochloa pyramidalis.* In the period of exondation, the small spaces left by water are ploughed and the vegetation of edge is uprooted except some tufts of *Typha* protected by their constant position in water.

- Topography of the valley of Akanyaru

The marshy valley of Akanyaru extends over a width of 2 - 4 km and over a 70 km length with a surface estimated at 200 km ² (Ntakimazi, 1985). This is the marsh of *Cyperus papyrus* which dominates the valley and is constantly fed out of water by Akanyaru River and its tributaries. It is also this cover of *Cyperus papyrus* which connects the valley of Akanyaru and the various lakes (Rwihinda, Cohoha, Gacamirindi, Nagitamo, Mwungere and Narungazi in Burundi and Northern Cohoha in Rwanda). The organic soils in the flooded zones are drained for agriculture.

- Topography of the terminations

The great Western termination of Cohoha Lake is characterized by great water mass occupied primarily by *Cyperus papyrus*. At the head of the termination, the marsh which separated Akanyaru River and Cohoha Lake is ploughed on more than 2 km. The immediate edges are occupied by *Typha domingensis* often uprooted in favour of agriculture during the period of exondation.

The terminations of the distributaries offer projecting ledges able to extend on several kilometres. Thus various types of vegetation superimpose from deep water until semi-aquatic milieus. The open water table is bordered by a cover of *Nymphea lotus* in immediate contact with *Cyperus papyrus* which, in its turn is bordered by a band of *Typha domingensis*. In certain terminations of the distributaries where the depth is low, *Cyperus papyrus* gives place to *Typha domingensis* which dominates the ground. This case is frequent also throughout the distributaries. The space occupied by *Typha domingensis* on shallow water is coveted for agriculture. Then a vegetation of transition develops towards the terrestrial milieus influenced by alternation of flood and exondation.

- Topography of hills

As a whole, there is no longer terrestrial natural vegetation on hills in immediate contact with Cohoha Lake or the marsh of Akanyaru. The various vegetable formations which prevailed on the hills are represented by small relics of much dispersed shrubs which, following agricultural intensification, will never re-conquer the ground.

Even the least effort which could be provided to regenerate the vegetation will not be possible because of the very invading capacity of *Lantana camara* which already occupied incredible extents evaluated per thousands of km². However, certain relics observed, particularly the small vegetation of *Euphorbia dawei* on the hill of Nyakarama leads to believe that several single vegetable formations disappeared before their description.

In spite of this, one will note the quite clear importance of the xerophilous vegetation on the hills at the Rwando-Burundian border of Gasenyi and of degraded savannah of *Parinari curatellifolia* on the slopes bordering the valley of Akanyaru on the side of Burundi.

II.2.2. Influence of the spatial occupation of man on the vegetation

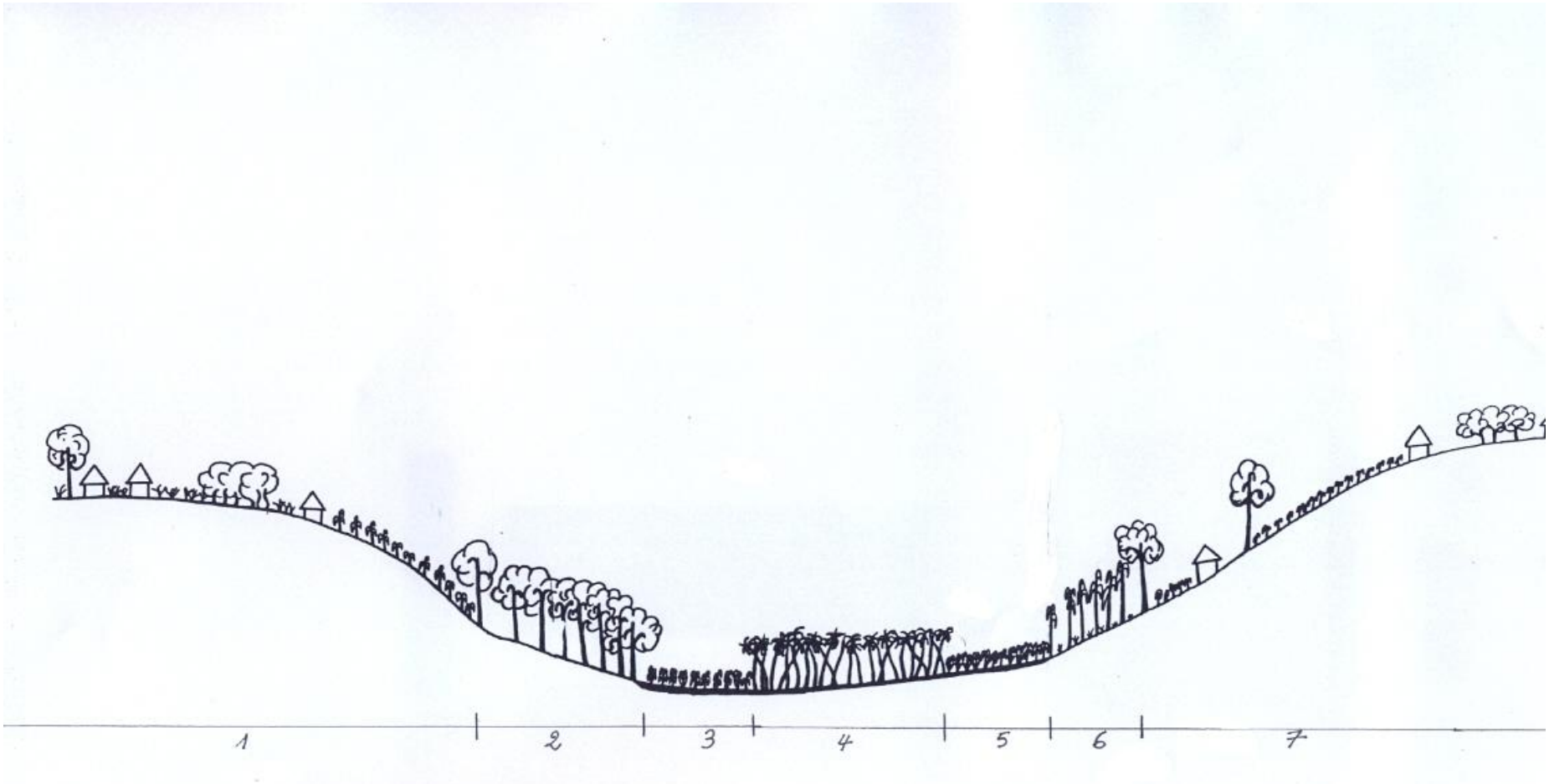
The presence of man in the Cohoha sub-basin is marked by installed crops on the immediate edges of Cohoha Lake and Akanyaru River by the elimination of the marshes, and on the hills by the deforestation of terrestrial vegetations. Man also occupied the ground by the installation of dwellings and other infrastructure on the tops and the sides of the hills often very far away from the marshes. This installation of man in the Cohoha sub-basin seems to be older in Rwanda than in Burundi. When crossing the Rwandan hills of the sub-basin, one realizes that the relics are limited to very disperse rare shrubs whereas in Burundi, some tufts of shrubs are still observable even in full crops. Although there are similarities in the occupation of the ground between Rwanda and Burundi, differences are noticed regarding protection measures.

On Cohoha Lake, the marshes bordering the lake are exploited everywhere for the culture of *Oryza sativa*, *Phaseolus vulgaris*, *Zea mays*, *Arachis hypogea* and *Colocasia esculenta*, etc. On the side of Rwanda, this agriculture is followed by a buffer zone which is a 50 m band of plantation bordering the whole lake with trees, particularly *Grevillea robusta*, *Cassia spectabilis*, *Markhamia lutea*, *Leucena* and *Cedrela*, etc. But it is not rare that one observes cultures under this protection plantation, thus conferring the agro-forestry role to the plantation. This will not be the case for Burundi where one observes cultures generally dominated by banana plantations (Fig. 4).

While progressing towards the hills, one notices some human dwellings, becoming numerous on the tops. Thus, the sides and the tops of the arid hills comprise cultures less varied than those of the marshes which are constantly wet.

In the valley of Akanyaru, the marshy vegetation of the sub-basin was eliminated in favour of agriculture. On the side of Burundi, a buffer zone of marsh with *Cyperus papyrus* exists there from Akanyaru River to the bottom of the slopes of the neighbouring hills with a width of 600 m. Since the high valley of Akanyaru up to the level of Cohoha Lake, there are 15 buffer zones. However, the very precarious protection of these buffer zones makes that the latter are nibbled for agriculture. While progressing towards the hills, the situation is similar to that of Cohoha Lake. There will be cultures primarily of banana tree on firm land followed by less prosperous cultures on the sides and tops of the hills, intersected by human dwellings.

In conclusion, it is worth noting that there are no strict zones of natural transition between the aquatic vegetation and those of the firm soils following the agricultural activities installed in the semi-aquatic zones. However, regarding fallow caused by the temporary abandonment of cultures in semi-aquatic milieu, one notices the appearance of the pioneer species with the presence of some ruderal species of the terrestrial environment which will end up disappearing with the maturity of the vegetation typical of marshes with abundance of water.



1 - 4 : Rwanda

1 : Agriculture and houses
2 : Band of protection plantation
3 : Rice culture

4-7 : Burundi

4 : *Cyperus papyrus* mash
5 : Rice culture
6 : Band of banana plantation
7: Agriculture and houses

Fig. 4: Profile visualizing the occupation of the ground on both sides of Cohoha lake (Burundi et Rwanda)

II.2.3. Description of the vegetation

II.2.3.1. Vegetation of Western termination of Cohoha Lake

- **Ruderal vegetation of the marshes at Kiri**

The figure 5 shows the Western limit of the marsh of *Cyperus papyrus* of Cohoha Lake. The marsh with Cyperus papyrus of the lake only extends over a 1.63 km length. This means that space between Akanyaru River is entirely occupied by crops like corn, rice, bean, groundnut, etc. There is thus no contact between waters of this river and those of this lake. The band of marshes with 2.39 km which separated Akanyaru River and Cohoha Lake was quickly eliminated in favour of agriculture. However, in the period of rains, about April, water of Akanyaru River floods the entire valley and flows in Cohoha Lake. During this period, agriculture is temporarily abandoned. Thus natural vegetation develops which, following repetitive agriculture, will never be able to reach the much more advanced stage of marsh with *Cyperus papyrus*.

In order to visualize the aspect of vegetation after the abandonment of agriculture, a study was done on a 19 month fallow. This is a zone which normally constitutes a zone of culture left in fallow since April 2006. The vegetation clearly shows an evolutionary stage towards the marsh of *Cyperus papyrus* (Table 2).

Polygonum pulchrum is the dominant species. In places, it intermingles with *Panicum* sp.. *Ipomea rubens* marks its presence by curving on the remainder of the vegetation. It is through this grassy mass that several tufts of *Typha domingensis* make irruption with approximately 2 m height. *Ludwigia leptocarpa* will colour the whole vegetation with its sharp yellow flowers. Tufts of *Cyperus papyrus* timidly emerge from the herbaceous layer. It already reaches 2 m. One still observes *Cyperus dives* tufts there.

This evolutionary stage still comprises of ruderalisation species with some individuals of *Ageratum conyzoides*, *Bidens pilosa*, *Galisonga parviflora*. In small fenestrations giving place to open waters of approximately 10 - 50 cm depth, *Hydrocotyle ranunculoides* and *Hyla nodiflora* cohabit without intermingling. In draining channels often traced during former cultures, calm waters hosts Lemnaceae, *Lemna rwandensis* and *Spirodela polyrhiza*, two species which seem to be inseparable. In places, these two species dispute the ground with *Azolla pinnata* which, by its fast multiplication, ends up conquering the ground.

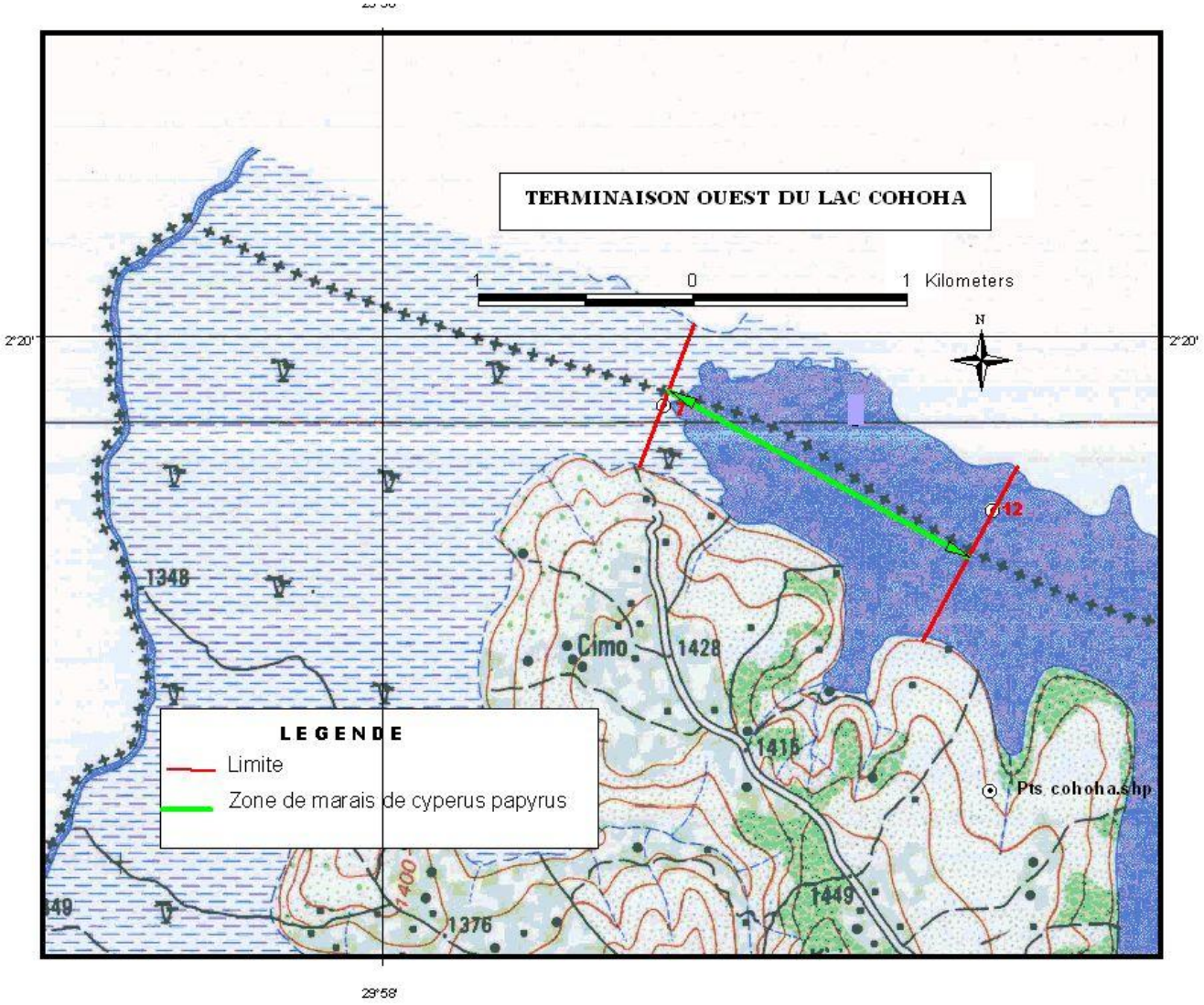


Fig. 5: Map showing the Western limit of the marsh of *Cyperus papyrus* of Lake Cohoha (Green line)

Table 2: Species of a 19 month fallow to the termination of the lake Cohoha at Kiri

Types of vegetation	**Species**	**Local names**
watery or semi-watery Vegetation	*Typha domingensis*	Umuberanya
	Cyperus papyrus	Urufunzo
	Spirodela polyrhiza	
	Hydrocotyle ranunculoides	
	Lemna rwandensis	
	Azolla pinnata	
	Cyperus dives	Ikigaga
	Phyla nodiflora	
	Polygonum pulchrum	Igorogonzi
	Panicum humidicola	
	Panicum sp.	Urwiri rwomurufunzo
	Ipomea rubens	
	Nymphea lotus	Irebe
	Aspilia africana	Icumwa
	Ludwigia leptocarpa	
	Pycreus capillifolius	
Ruderal vegetation	*Commelina benghalensis*	Inteza
	Bidens pilosa	Irebe
	Galinsoga parviflora	Icumwa
	Panicum sp.	Umudihidihi
	Crassocephalum sp.	

- **Cohoha Lake marshy vegetation with *Cyperus papyrus***

On Cohoha Lake, the most important marshy vegetation is located at the Western termination of the lake on 1.63 km (of point 12 as in point 7 of figure 1). This is vegetation dominated by *Cyperus papyrus* which occupies deep waters of the lake. When progressing towards the edges of the lake, the depth decreases and it is *Typha domingensis* which occupies the ground from the edges to 80-100 m. As a whole, the provision of the vegetation creates a system of belting where *Cyperus papyrus* is always girdled by *Typha domingensis*. But, this situation disappears on the distributaries where *Typha domingensis* will occupy any space following the depth of water becoming small. When the quantity of waters is very small on a soft topography, the zone dominated by *Typha domingensis* becomes target for agriculture. This case is very remarkable in all the distributaries of Cohoha Lake. A good part of the band of *Typha domingensis* thus will constitute a zone of transition which, in the event of exondation, is uprooted for agriculture. It is thus after the cultures that one will observe several facials of vegetation which, in the event of rather important flood, and other than agriculture obviously, will leave place to *Typha domingensis*.

In order to visualize the aspect of the marshy vegetation of *Cyperus papyrus* a transect was traced on a length of 0.78 km following points 12 to 9 of the figure (at the deviation of the Kagali-Ngenda tributary). Another transect was traced from point 9 up to point 11 of the same figure. This work was facilitated by a channel traced in full water by repeated passages of the dugouts on a rather right line. According to fishermen of the locality, this channel separates Rwanda and Burundi and seems to be located at approximately 100 m of the Rwandan edge.

The transect thus passes to the junction between the vegetation of *Cyperus papyrus* dominating in the middle of bay and that of *Typha domingensis* dominating towards the edge. Throughout the first transect, the area is really dominated by *Cyperus papyrus*. A fern *Dryopteris gongylodes* marks its presence and threads in the low part of the vegetation. One will also notice other species like *Aspilia africana* and *Ludwigia leptocarpa* and *Polygonum pulchrum* which superimpose on this vegetation. *Ipomea rubens*, a voluble grass, reaching 4 - 5 m curves thatches of *Cyperus papyrus* (Fig. 6). When progressing with the length of the transect on a distance of 100 m, tufts of *Typha domingensis* abound and stop the homogeneity of *Cyperus papyrus*. At this place, at a depth of waters below 1 m, several other species appear particularly *Hydrocotyle ranunculoides*.

From point 9 towards point 11 of the Kagali-Ngenda tributary until approximately 200m, we still have the mixture of *Cyperus papyrus* tufts and those of *Typha domingensis*. It is in this place that one observes some individuals of *Nymphea nouchalii*. To approximately 300 m, the depth of waters is 60 cm and *Typha domingensis* abounds. It will be intersected by a mass of open waters. The limit of the band of *Typha domingensis* is marked by rice growing which extends on 60 m before reaching the belt of protection plantations made up of *Grevillea robusta*, *Cassia spectabilis*, *Leucena* and *Cedrela*, themselves girdled by *Caesalpinia decapetala*. Table 3 shows the species of this locality.

Fig. 6: The species as *Ipomea rubens, Ludwigia and Aspilia Africana are* associated to the marsh dominated by *Cyperus papyrus*

Table 3: Floristic composition of the marsh of Cohoha lake

Types of vegetation	Species	Local names
Vegetation of *Cyperus papyrus*	*Cyperus papyrus*	Urufunzo
	Typha domingensis	Umuberanya
	Dryopteris gongylodes	
	Polygonum pulchrum	Igorogonzi
	Ipomea rubens	
	Ludwigia leptocarpa	
	Panicum sp.	Urwiri rwomurufunzo
	Aspilia africana	Icumwa
	Cyperus laevigatus	
	Crassocephalum sp.	
	Phyla nodiflora	
	Hemarthria natans	
Végétation nageantes	*Nymphea nouchalii*	Irebe
	Pistia stratiotes	

- **Vegetations of edge of the Cohoha Lake Kagali-Ngenda tributary**

A transect was traced on a band of 40 m x 160 m, from the table water of the tributary pond (1,342) up to the level of the Hill of Kagali Ngenda to 1,457 m of altitude (Point 10 of Fig.1).

In the immediate edge of Kagali-Ngenda pond (1342 m of altitude), *Typha domingensis* form a band of vegetation with a width of 20 m (Fig. 7). Several other species particularly *Dryopteris gongylodes*, *Ludwigia leptocarpa* and some tufts of *Cyperus papyrus* add to it.

At the extreme of the population of typhas, post-farming vegetation installs on a recently cultivated ground. At this place, vegetation dominated by *Cyperus dives* over a distance of 25 m to the edge of the protection plantation. *Cyperus dives* marks a stage of evolution with accompanying species like *Polygonum pulchrum*. *Phyla nodiflora* and *Hydrocotyle ranunculoides* that stop the channels of drainage traced during the culture of rice. The small holes containing calm waters host *Azolla pinnatta*, *Lemna rwandensis* and *Spirodela polyrhiza.* The existence of certain ruderal species like *Bidens pilosa*, *Abutilon mauritianum, Ageratum conyzoides,* etc. shows that we are in the zone of transition towards the terrestrial milieu.

At the exit of this semi-aquatic zone, a protection plantation installs on a width of 50 m. The planted trees are currently 6 - 10 m high. *Markhamia lutea* and *Cassia spectabilis* are the most privileged at this place. This a buffer zone set up for the safeguard of Cohoha Lake. The analysis of the flora of the underwood gives more ruderal species particularly *Bidens pilosa* dominating, *Ageratum conyzoides*, *Tagetes minuta*, *Oxygonum sinuatum,* etc. This leads to think that this milieu is used from time to time for farming. This case is very frequent in fact, and crops of beans, sweet potato, etc. are frequently met there, thus conferring on the plantation more the role of agro-forestry than protection.

From 1,352 m of altitude, the protection plantation (buffer zone) leaves place to farming. Regarding the transect, a width fallow on a band of more than 100 m is intersected by young fields of cassava. The characteristic species of the fallow do not differ from those observed in plantations of

protection. But, the clearing carried out since long left small shrubs thus visualizing the settlement of old plants of the locality. These include particularly *Securinega virosa*, *Carissa edulis*, *Rhus natalensis*, *Maytenus arbutifolia*, etc. of the typical species of the xerophilous vegetations which prevailed at this place. Tufts of *Lantana camara* make irruption there. It is on this lower level of the slope (1,357 m of altitude) that one observes the first dwelling house (Fig. 8). The floristic composition of the vegetation is shown in table 4.

Fig. 7: A band of *Typha domingensis* with 20 m at Kagali-Genda

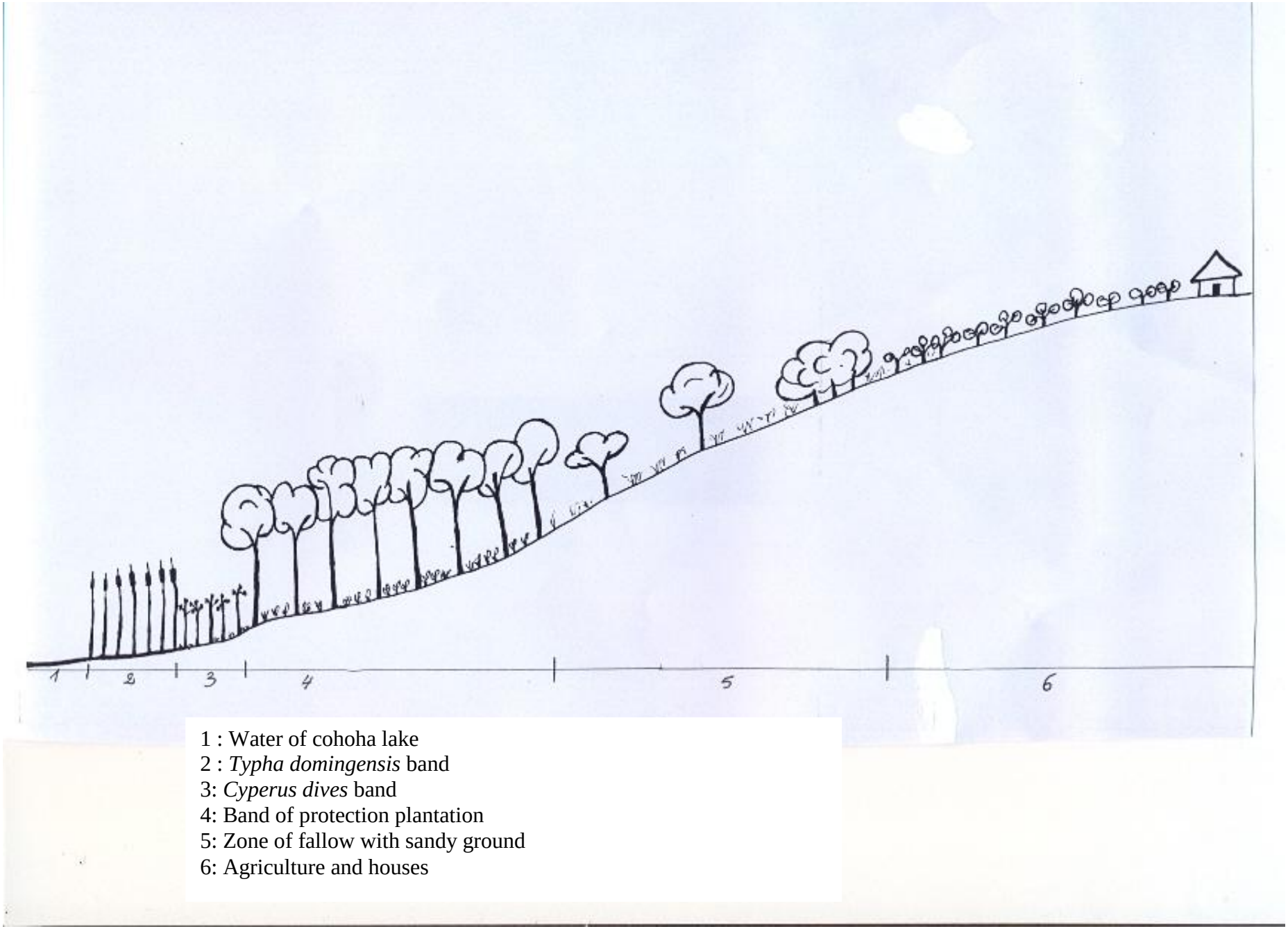


Fig. 8: Profile visualizing the distribution of the vegetation starting from the Cohoha lake tributary towards the hill of Kagali-Ngenda

Table 4: Floristic composition of the vegetation of Kagali-Ngenda tributary

Types of vegetation	Species	Local names
Vegetation of *Typha domingensis*	***Watery and semi-watery species***	
	Typha domingensis	Umuberanya
	Cyperus papyrus	Urufunzo
	Dryopteris gongylodes	
	Ludwigia leptocarpa	
	Cyperus laevigatus	
	Aspilia africana	Icumwa
Post-farming vegetation	***Watery and semi-watery species***	
	Cyperus dives	Ikigaga
	Typha domingensis	Umuberenya
	Polygonum pulchrum	Igorongonzi
	Polygonum strogosum	
	Phyla nodiflora	
	Hydrocotyle ranunculoides	
	Nymphea nouchalii	
	Ludwigia leptocarpa	
	Azolla pinnatta,	
	Commelina benghalensis	Inteza
	Lemna rwandensis	
	Spirodela polyrhiza	
	Crassocephalum sp.	
	Terrestrial species	
	Bidens pilosa	
	Abutilon mauritianum	
	Achyranthes aspera	
	Amaranthus viridis	
	Triumfetta rhomboidea	
	Ageratum conyzoides	
Plantation of protection	Planted species,	
	Markhamia lutea	
	Cassia spectabilis	
	Species of the underwood	
	Bidens pilosa	
	Ageratum conyzoides	
	Tagetes minuta	
	Achyranthes aspera	
	Justicia cf. *ruwenzorensis*	
	Asystasia gangetica	
	Achyranthes aspera	
	Oxygonum sinuatum	
	Recinum communis	
	Abutilon mauritianum	
	Cenchrus ciliaris	

Table 4: Floristic composition of the vegetation of Kagali-Ngenda tributary (Contiuation)

Types of vegetation	Species	Local names
	Eleusine indica	
	Mariscus longibracteatus var. *longebracteatus*	
	Crassocephalum sp.	
	Cynodon nlemfuensis	
	Digitaria abyssinica	
	Lagenaria abyssinica	
	Ipomea cairica	
	Sida diversifolia	
	Triumfetta tomantosa	
	Galisonga parviflora	
	Panicum heterostachyus	
	Tribulus terristris	
	Dactyloctenium aegyptium	
	Cyperus sumatrensis	
	Cyperus sp.	
	Justicia uncunilata	
	Oxalis corniculata	
	Rhynchelytrum repens	
Relictual species of agriculture zone	*Securinega virosa*	
	Carissa edulis	
	Rhus natalensis	
	Maytenus arbutifolia	
	Vernonia amygdalina	

II.2.3.2. Vegetation of Kagenge locality

Two sites were concerned by the floristic analysis in the locality of Kagenge:

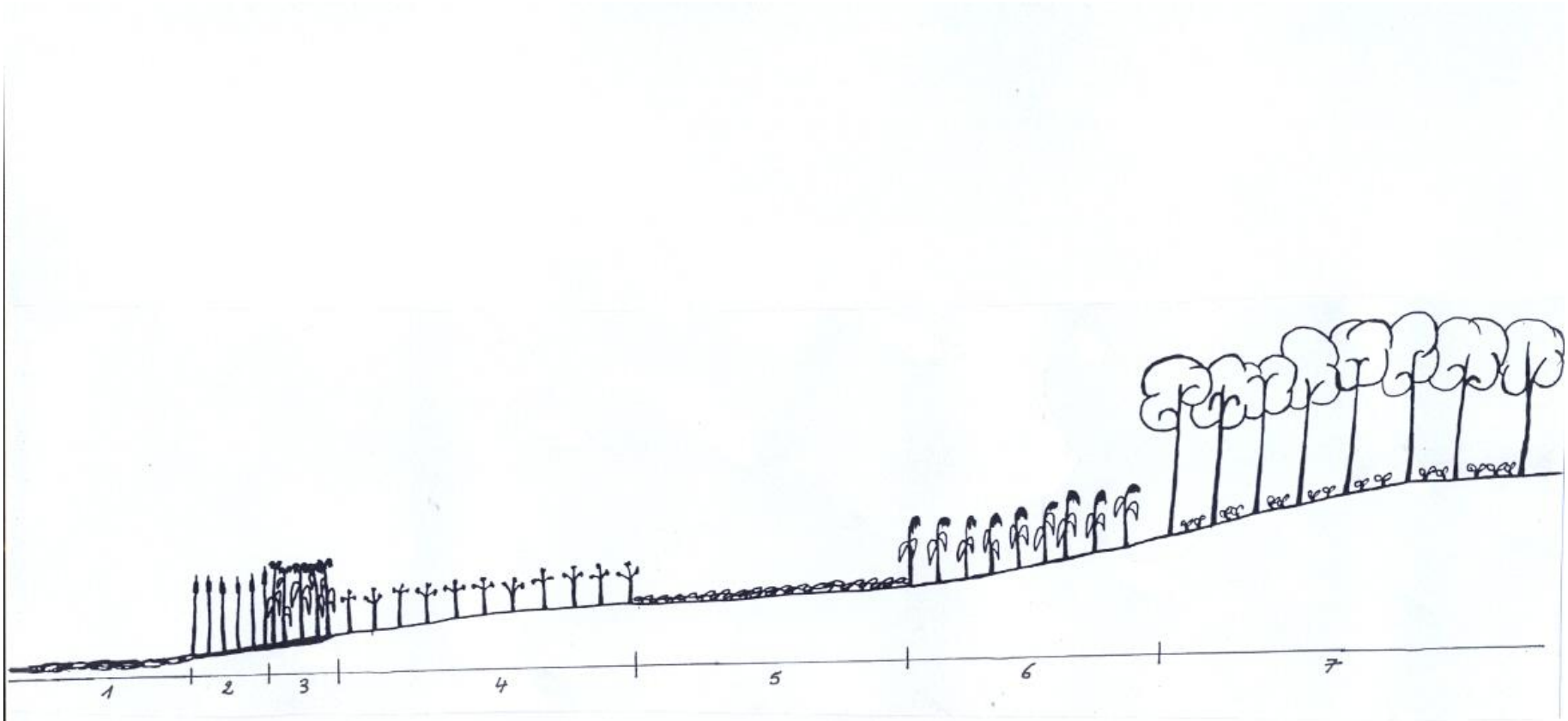
- vegetation of the branch of Cohoha Lake at Gahigiri (point 14, figure 1);
- vegetation of the beach of Rusamaza (point 13, figure 1).

- Vegetation of the Cohoha Lake Gahigiri tributary

The vegetation of the termination of the Gahigiri tributary of Cohoha Lake is a succession of populations of several species on a rather plane topography of 1,345 m altitude. It is thus the depth of the water which seems to delimit each population. Thus, from 150 m of the end of the tributary, *Nymphea lotus*, remarkable by its white flowers, covers the entire water surface. Some individuals of *Nymphea nouchalii* are remarkable by their blue flowers purplished on the whole of the floating cover. A band of *Typha domingensis* will thus surround the floating plants over a width of 40 m (Fig. 9). This is a practically monospecific vegetation to which some individuals of *Nymphea nouchalli* which occupy gaps caused by fishermen are added. On not very flooded zones, tufts of *Phragmites mauritianus* thus separate the band *Typha domingensis* and that of *Cyperus dives*. The latter, which extends over a 60 m length, is the result of a zone of recently abandoned culture following the hydrous conditions that become very intense (Fig. 10). The vegetation of *Cyperus dives* thus grows with several species particularly *Mariscus longibracteatus* var. *longibracteatus*, *Polygonum pulchrum*, *Polygonum strigosum*, *Aspilia africana*, etc. The channels of agricultural drainage also grow rich by the aquatic species like *Hydrocotyle ranunculoides*, *Phyla nodiflora* and *Azolla pinnatta*. Ruderalisation species also make irruption, particularly *Ageratum conyzoides*, *Commelina benghalensis*, *Bidens pilosa*, etc. When progressing in the direction of the tributary of the lake, varied crops proliferate up to 1,354 m of altitude corresponding at the lower level of the protection plantation. *Markhamia lutea* is the species of plantation privileged in the locality. The very rich underwood herbaceous species includes particularly *Bidens pilosa* clearly dominating, *Tagetes minuta*, *Ageratum conyzoides*, *Galinsoga parviflora*, *Justicia* cf. *ruwenzoriensis*, *Eleusine indica*, *Conyza sumatrensis*, *Lactuca capensis*, *Hibiscus diversifolium*, *Abutilon mauritianum*, etc. It is this floristic ruderal procession which continues in the cultures of banana trees which dominates the slopes (Fig. 11). The floristic composition of the vegetation is shown in table 5.

Fig. 9: A band of *Typha domingensis* surrounds a carpet floating of *Nymphea lotus* at Gahigiri

Fig. 10: A band of *Cyperus dives* in an abandoned field



1 : *Nymphea lotus* covering water
2 : Thpha domingensis band
3 : Tufts of *Phragmites mauritianus*
4: Cyperus dives band
5: *Ipomea batatas* culture
6: *Zea mays* culture
7 : Band of protection plantation

Fig. 11: Profile visualizing the distribution of the vegetation at Gahigiri tributary

Table 5: Floristic composition of the vegetation of Gahigiri

Types of vegetation	Species	Local names
Foating vegetation	***Floating species***	
	Nymphea lotus	Irebe
	Nymphea nouchalli	Irebe
Vegetation of *Typha domingensis*	***Watery and semi-watery species***	
	Typha domingensis	Umuberanya
	Nymphea nouchalli	Irebe
	Phragmites mauritianus	
	Hydrocotyles ranunculoides	
	Phyla nodiflora	
	Sesbania sesban var. nubica	
Vegetation of *Cyperus dives*	***Watery and semi-watery species***	
	Cyperus dives	Ikigaga
	Polygonum pulchrum.	Igorogonzi
	Polygonum strigosum	Igorogonzi
	Phyla nodiflora	
	Panicum humidicola	
	Hydrocotyle ranunculoides	
	Azolla pinnatta	
	Lemna rwandensis	
	Spirodela polyrhiza	
	Ludwigia leptocarpa	
	Mariscus longibracteatus var. *longibracteatus*	
	Terrestrial species	
	Bidens pilosa	Icanda
	Commelina benghalensis	
	Ageratum conyzoides	Akarura
Plantation of protection	***Planted species***	
	Markhamia lutea	
	Species of the underwood	
	Bidens pilosa	
	Ageratum conyzoides	
	Tagetes minuta	
	Achyranthes aspera	
	Justicia cf. *ruwenzoriensis*	
	Asystasia gangetica	
	Galinsoga parviflora	Kurisuka
	Eleusine indica	Urwamfu
	Conyza sumatrensis	
	Hibiscus diversifolium	
	Abutilon mauritianum	
	Trichodesma zeylanicum	

- Vegetation of Rusamaza

The locality of Rusamaza of the area of Kagenge is located towards the centre of Cohoha Lake (Point 14, fig. 1). Very diverse landscape conformity worked out two types of vegetations remarkably different from the edge of water. On very weak slope topography, the vegetation leaves many anthropic traces with many ruderal species. The steep slopes have xerophilous thickets in degradation (Fig. 12 A and B).

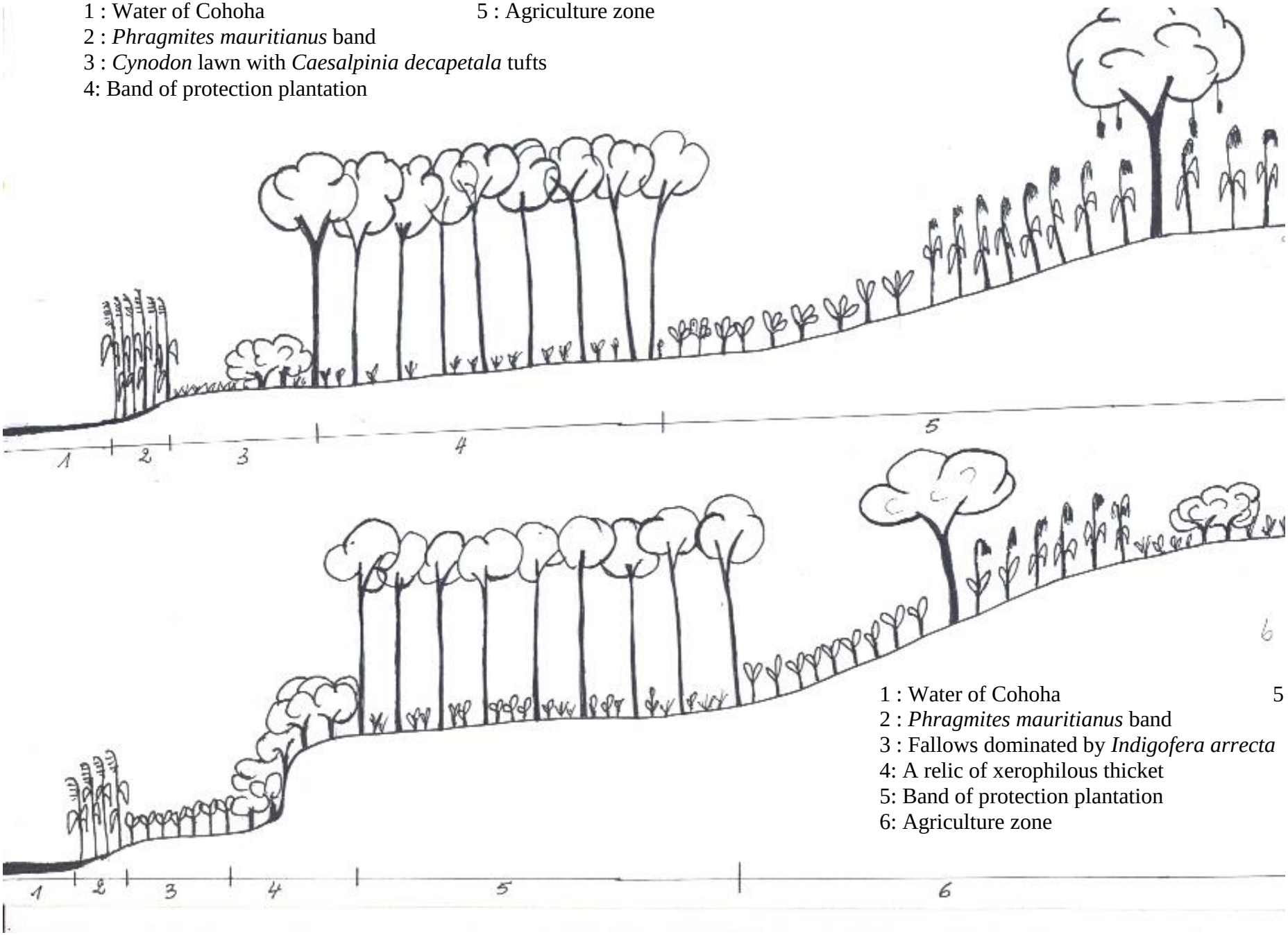
As a whole, the vegetation of edge of Cohoha Lake is made of a thin strip of 5 m broad dominated by *Phragmites mauritianus*. Only the species *Aspilia africana* and *Achyrantes aspera* are added to the vegetation. In an attended milieu, a lawn of *Cynodon nlemfuensis* follows the vegetation of *Phragmites* over a 50 m length throughout the lake. Several ruderal species thus emerge from the lawn like *Eleusine indica*, *Oxygonum sinuatum*, *Achyranthes aspera*, *Commelina benghalensis, Tribulus terrestris*, *Triumphetta diversifolium*. On several places, the lawn is intersected sometimes by *Caesalpinia decapetala* sometimes by *Lantana camara* which create impenetrable rustles, thus eliminating the underwood.

When progressing throughout the lake, the steep slope allowed the survival of the thickets which extend on more than 100 m. This is indeed of a relic of the old vegetation of the locality of Rusamaza preserved by topography unsuitable for agriculture (Fig. 13). The species charactering thickets are particularly *Capparis fascularis*, *Pappea capensis*, *Grewia similis*, *Grewia mollis*, etc.

A protection plantation over a width of 50 m occupies the higher level. The planted trees are *Cassia spectabilis* and *Markhamia lutea*. The species of the underwood show that the milieu is not ploughed and several small ligneous family develops easily, including *Cassia occidentalis, Tephrosia nana, Indigofera arrecta*, *Clerodendrum myrcoides, Abutilon mauritianum,* etc.

After the plantation, there is farming zone where certain species not cut down during the clearing still exist, like *Acacia polyacantha, Kigelia africana, Acacia hockii,* etc.. Everything leads to believe that the hills of Rusamaza were populated by wooded savannahs of contiguous *Acacia* of xerophilous thickets. The floristic composition of the vegetation is shown in table 6.

1 : Water of Cohoha
2 : *Phragmites mauritianus* band
3 : *Cynodon* lawn with *Caesalpinia decapetala* tufts
4: Band of protection plantation
5 : Agriculture zone



1 : Water of Cohoha
2 : *Phragmites mauritianus* band
3 : Fallows dominated by *Indigofera arrecta*
4: A relic of xerophilous thicket
5: Band of protection plantation
6: Agriculture zone

Fig. 12 (a, b): Profile visualizing the distribution of the vegetation starting from the Cohoha lake towards the Rusamaza hill: a) soft slope; b) steep slope

Fig. 13: A relic of a xerophilous thicket of *Pappea capensis* of Rusamaza

Table 6: Floristic composition of the vegetation of Rusamaza

Types of vegetation	Species	Local names
Vegetation of *Phragmites mauritianus*	***Watery and semi-watery species***	
	Phragmites mauritianus	Umuberanya
	Aspilia africana	Icumwa
	Ludwigia leptocarpa	
Lawn of *Cynodon nlemfuensis*	***Ruderal species***	
	Tribulus terrestris	
	Triumphetta diversifolium	
	Commelina benghalensis	Inteza
	Achyranthes aspera	
	Oxygonum sinuatum	
	Eleusine indica	
	Ageratum conyzoides	Akarura
	Bidens pilosa	
	Oldenlandia goreensis	
	Galisonga parviflora	
	Polygonum salicifolium	
	Euphorbia genuculata	
	Panicum heterostachyum	
	Panicum maximum	Igikaranka
	Asystasia gangetica	
	Cassia occidentalis	
	Lagenaria abyssinica	
	Digitaria abyssinica	
	Phyllantus odontadenius	
	Agrocharis incognita	
	Triumfetta tomentosa	
	Triumfetta rhomboidea	
	Tagetes minuta	
	Amaranthus viridis	
	Mariscus longibracteatus	
	Sorghum arundinacea	
	Vernonia sp.	
	Centella asiatica	
	Conyza sumatrensis	
	Abutilon mauritianum	
	Mariscus sumatrensis	
	Ipomea cairica	
	Ipomea sp.	
	Ocimum cf. *basilicumhn*	
	Kyllinga sp.	
	Desmodium salicifolium var. salicifolium	

Table 6: Floristic composition of the vegetation of Rusamaza (Continuation)

Types of vegetation	Species	Local names
	No ruderal species	
	Harrisonia abyssinicaij,	
	Caesalpinia decapetala	Umubambangwe
	Securinea virosa	
	Lantana camara	Umuhengerihengeri
Plantation de protection	***Planted species***	
	Markhamia lutea	Umusave
	Cassia spectabilis	Umutarabanyi
	Species of the underwood	
	Cassia occidentalis	
	Tephrosia nana	
	Bidens pilosa	
	Ageratum conyzoides	Akarura
	Indigofera arrecta	
	Achyranthes aspera	
	Clerodendrum myrcoides	
	Galinsoga parviflora	
	Eleusine indica	Urwanfu
	Conyza sumatrensis	
	Hibiscus diversifolium	
	Abutilon mauritianum	
	Lantana rhodesiensis	Umuhengerihengeri
	Trichodesma zeylanicum	
Xerophilous thickets in degradation	***Shrubby, sarmentous species or climbing lianas***	
	Capparis fascularis	
	Grewia similis	Umukoma
	Grewia mollis	Umukoma
	Pappea capensis	
	Cyphostemma adenaucole	
	Cissus oliveri	
	Cynanchum schistoglossum	
	Gongonema angolense	
	Jasminum fluminense	
	Olea africana	
	Jasminum dichotomum	
	Maytenus arbutifolia	
	Carissa edulis	
	Zizyphus micronata	
	Asparagus falcatus	
	Cynanchum validum	
	Bambekea racemosa	
	Teclea nobilis	
	Teclea trochocarpa	
	Maerua angolense	

Table 6: Floristic composition of the vegetation of Rusamaza (Continuation)

Types of vegetation	Species	Local names
	Rhus longipes	
	Pavetta oliverana	
	Ipomea cairica	
	Hyppocratea africana	
	Cissampelos mucronata	
	Maerua triphylla ssp. jahannis	
	Herbaceous of the underwood	
	Achyrantes aspera	
	Sansevieria dawei	
	Solanum nigrum	
	Pupalia lappacea	
Milieu de cultures	***Relictual species***	
	Acacia polyacantha	
	Kigelia africana	Umuremera
	Acacia hockii	Umugenge
	Acacia sieberana	Umunyinya
	Erythrina abyssinica	Umurinzi

II.2.3.3. Vegetation of the termination of the Cohoha Lake tributary at Yaranda

The Southern part of Cohoha Lake is very dendritic. The tributary of Yaranda is one of the most important branches of this part of the lake at point 15 of Figure 1 and 14. Physiognomically speaking, the vegetation of the tributary of Yaranda keeps the same floristic procession as the other distributaries of the lake with the same core of species. The small island of Ikirwa close to the head of the tributary was completely deforested and has only banana plantations but without human dwellings. The immediate edges of this small island consist of a small band of *Typha domingensis*. The figure **14 shows the distribution of the vegetation (points 1-6 and 18, Fig. 14).**

The vegetation of the tributary starts with a floating cover with a quite clear predominance of *Nymphea lotus* and some individuals of *Nymphea nouchalii* to a water depth of 1.5 m. A Lentibulariaceae, *Utricularia stellaris*, threads between the large leafs of *Nymphea* in contact with the papyrus fields.

In the direction of the slope, perpendicularly to the tributary, this cover of Nympheaceae is girdled by a band of *Typha domingensis* over a width of 40 m (Fig. 15). This is a zone very often ransacked by fishermen who regard it as very rich in fish. Then the gaps caused in the populations of the typhas are colonized by *Nymphea nouchallii*. After this band of *Typha domingensis*, *Vossia cuspidata* forms a small band over a width not exceeding 5 m. More species such as *Phyla nodiflora*, *Spilanthes mauritiana*, *Sphaeranthus suaveolens*, *Hydrocotyle ranunculoides* and *Ludwigia stolonifera* added to existing species. When progressing towards the slope, we then have very dense crops of banana trees. The remarkable element of this locality is the presence of the old *Markhamia lutea* tree occupying the whole catchment of this tributary. According to the population, these are not old plantation but rather original trees of the locality maintained on the spot because of their agro-forestry importance.

One also observes large trees like *Acacia polyacantha*, *Ficus vallis-choudae*, *Ficus thonninghii*, etc, and, in the event of fallow, ruderalisation abounds.

In the direction of the head of the tributary, the floating cover of *Nymphea lotus* (point 1-2, Fig. , with 310m) is delimited by a homogeneous population of *Cyperus papyrus* (point 2-3, Fig. , with 420m) in deep water, which, also is girdled by *Typha domingensis.* The latter will be also surrounded by *Vossia cuspidata* towards the edges (Fig. 16). However, this zonation is not always apparent following the various anthropic actions which often modify the aspect of the vegetation of edge. Indeed, the band of *Vossia cuspidata* which should girdle the typhas gave place to crops like sweet potato, corn, etc. on a long distance. One also notices places which directly open to *Cyperus papyrus* following the complete and repetitive cuts of the typhas for various uses particularly manufacture of plaits and ceilings or quite simply for agriculture. In place of this cut curtain, a low meadow will develop with *Panicum* sp. predominance accompanied by *Aspilia africana*, *Polygonum pulchrum*, etc. over a length of more than 180 m (point 3-4, Fig. 14). This is the zone of temporary culture following the periodic presence of water (flood and exondation). In the event of abandonment of human activities in the event of flooding, *Cyperus dives* makes irruption and dominates the meadow, thus preparing the ground for *Typha domingensis* (Fig. 17). In places where permanent water allowed the maintenance of the zonation, shrubs of *Sesbania sesban* develop, beginning of reforestation in wet milieus.

While still progressing towards the head of the tributary, the conditions of moistening are very attenuated all the year long. Thus varied cultures are practiced, including *Oryza sativa*, *Zea mays*, *Phaseolus vulgaris*, etc. (point 4-5, Fig. , with 290 m). The local population reports that before 1993, this zone was formerly covered by *Cyperus latifolius* whose few remaining tufts are observed on the channels of agricultural drainage.

The higher part of this zone (point 5-6, Fig. , with 860m), although still cultivated in places, is regarded as poor for agriculture following the old and repetitive ploughings and overgrazing which is still practiced. A farmer declares "Isi yaha yimbuka kera tukihatema, naho ubu haratiturye kubera urubumbabumba rwahadutse n'inka zihirirwa" (literally: "The ground in here was rich at the time of clearings, and currently, the clay soil and the overgrazing no longer allow production"). The termination of the tributary (point 6-18, Fig. , with 560m), which become unsuitable for agriculture, is marked by the presence of the big termites' nests of size 4 - 8 m in diameter and 2 - 3 m high, and separated one from another by a distance varying between 15 - 20 m (Fig. 18). This is a zone of intense pasture on the clay soil. The many termites' nests in the hollows worked out a landscape which can never pass unperceived for a passenger, even the less informed one. Thus is typical vegetation developed though different from the remainder of the tributary. These are indeed the xerophilous thickets with species like *Phoenix reclinata*, *Grewia similis*, *Grewia mollis*, *Capparis fascularis* and several lianas like *Cissus oliveri*, *Sarcostemma viminale*, etc.

A riparian adult man of the valley reports to us that this type of vegetation dates for a long time at this place but that his father had told him that water of Cohoha Lake arrived there at the time of monarchy. The projection of water followed the dry periods that Burundi knew, orchestrated by the action of the hoe searching for wet soils. This is, in our opinion, of a very interesting case capable of illustrating adequately the xerophilous phenomena already remarkable on the hills and likely to invade all the valleys under the combined effects of the current uncontrolled drainage and the already manifest climate changes in the area. If one considers the xeric character of the whole Bugesera area characterized by xerophilous thickets of the hills, one can already envisage a future "***Bugeserisation***" of the bottoms of valleys, to mean and announce this very probable descent of xerophily of hills towards the valleys which will make finally the area of Bugesera increasingly arid.

However, the current speed of invasion of *Lantana camara* will not be able to allow the expansion of the xerophilous thickets in the currently marshy bottoms of valleys. It is rather this very imposing species that will continue to spread. Let us note that the disturbances of certain thickets of the valley of Yaranda allowed the installation of *Lantana camara* on an important extent. The floristic composition of the vegetation is shown in table 7.

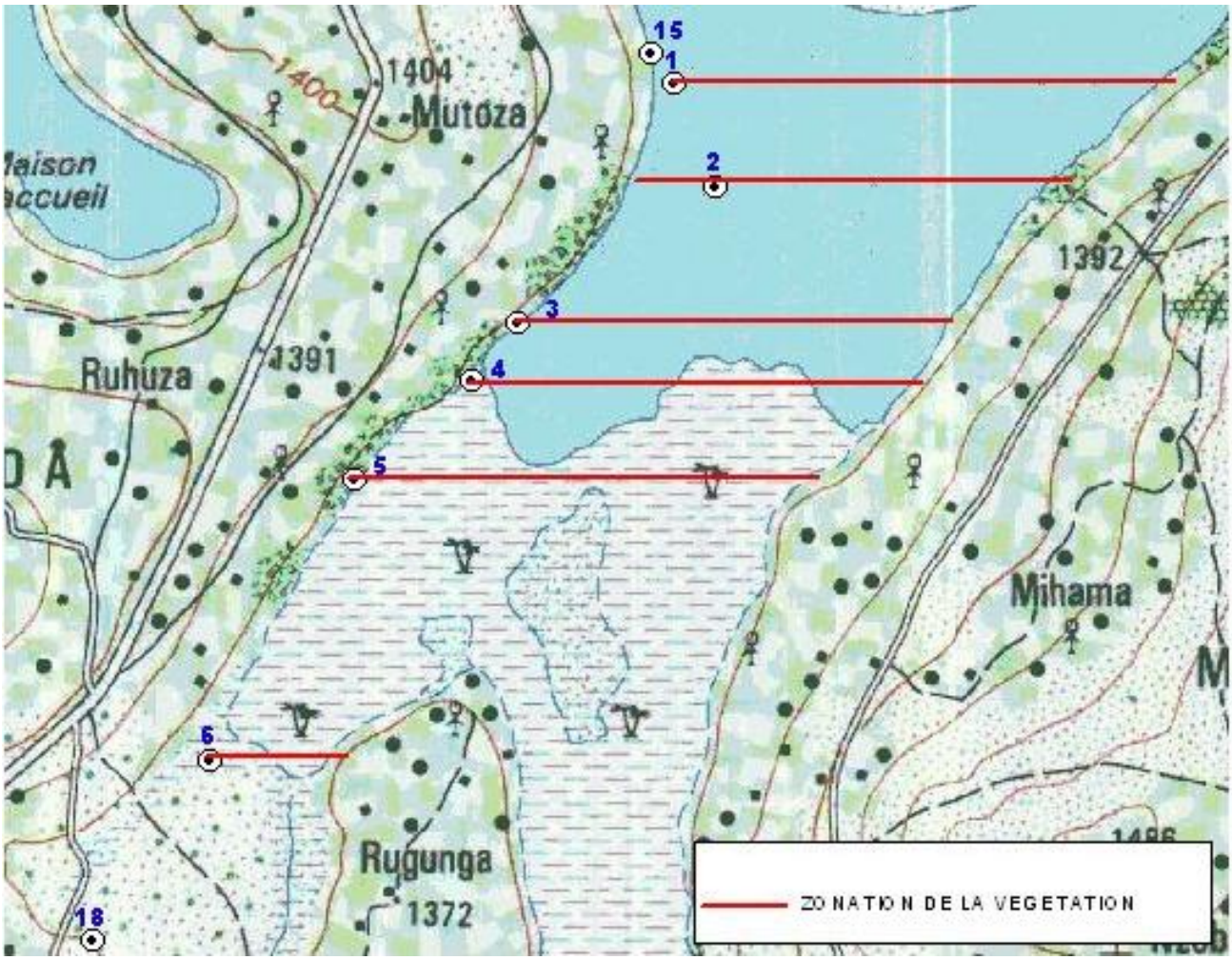


Fig. 14: A Map showing the various points of variation of the vegetation on the level of the Yaranda tributary.

Fig. 15: In the direction of the slope, *Nymphea lotus* girdled by a band of *Typha domingensis*

Fig. 16: *Typha domingensisis* surrounded by *Vossia cuspidata* towards the edges

Fig. 17: *Typha* is appearing in a grassy mass dominated by *Polygonum pulchrum*

Fig. 18: The degradation of the termination of Yaranda tributary is marked by the appearance of the thickets on termitarias

Table 7: Floristic composition of the vegetation of Yaranda tributary

Types of vegetation	species	Local names
Watery and semi-watery Vegetation	***Foatting species***	
	Nymphea lotus	Irebe
	Nymphea nouchalli	Irebe
	Utricularia stellaris	
	No floating species	
	Typha domingensis	Umuberanya
	Nymphea nouchalli	
	Phragmites mauritianus	Amarenga
	Hydrocotyles ranunculoides	
	Phyla nodiflora	
	Aspilia africana	Icumwa
	Ipomea rubens	
	Ludwigia stolonifera	
	Ludwigia leptocarpa	
	Vossia cuspidata	Umutete
Végétation de jachère en milieu inondable		
	Cyperus dives	
	Polygonum pulchrum	
	Polygonum strigosum	
	Phyla nodiflora	
	Hydrocotyle ranunculoides	
	Azolla pinnatta,	
	Lemna rwandensis	
	Panicum sp.	Urukeci
	Spirodela polyrhiza	
	Mariscus longibracteatus var. *longibracteatus*	
	Bidens pilosa	
	Commelina benghalensis	
	Ageratum conyzoides,	
	Bidens pilosa	Icanda
	Cyperus latifolius	
Vegetation in agriculture zone on slope	***Planted species***	
	Markhamia lutea	Umusave
	Ficus vallis-choudae	
	Ruderal species	
	Bidens pilosa	Icanda
	Ageratum conyzoides	
	Tagetes minuta	
	Achyranthes aspera	
	Asystasia gangetica	

	Galinsoga parviflora	
	Eleusine indica	
	Conyza sumatrensis	
	Abutilon mauritianum	
	Cardiospermum halicacabum	
	Thunbergia alata	
Vegetation of the thickets of the valley	*Grewia mollis*	
	Grewia similis	
	Allophylus africana	
	Rhoicissus tridentata	
	Hyppocratea africana	
	Phoenix reclinata	
	Capparis fascularis	
	Sarcostemma viminale	
	Cissus oliveri	
	Sansevieria dawei	
	Aloe bukobana	
	Lantana camara	
	Zizyphus micronata	
	Asparagus falcatus	
	Cynanchum validum	
	Teclea nobilis	
	Maerua angolense	

II.2.3.4. Vegetation of the tributary of Marembo

At point 16 of figure 1, the vegetation of termination of the tributary of Marembo is not different from that of other above-described distributaries. The head of the tributary is characterized by a floating cover of *Nymphea lotus* extending on 80 m length and girdled by a band of *Vossia cuspidata* with 50 m width. The latter is, in its turn, surrounded by *Cyperus dives* in the recently cultivated zone over a width of 100 m. The populations of the typhas in fine band colonize the edges of the tributary without reaching the head of the tributary. They are thus delimited by cultures of *Ipomea batatas, Solanum tabacum, Zea mays*, etc. Everything leads to believe that in periods of exondation, this tributary of the lake is ploughed until edges of water. On the catchment area of the tributary, one observes several trees dispersed in the fields, particularly *Markhamia lutea*, *Acacia polyacantha*, *Ficus vallis-choudae*.

II.2.3.5. Vegetation of Mugombwe

The vegetation of Mugombwe includes the marsh of the valley of Akanyaru and the savannah of the hill bordering this valley. As a whole, all the marshes of this valley were subjected to farming as well on the side of Rwanda and of Burundi. However, on the Burundi side, 15 buffer zones were installed throughout this river. A buffer zone is regarded as a fringe of marsh of 600 m width leaving the edge of Akanyaru River perpendicularly to the foot of the hill bordering the marsh (Fig. 19 et 20). The buffer zone is conceived as a zone of protection capable of storing water in order to keep the moisture of the ground for the remainder of cultivated surface.

At Mugombwe, the buffer zone leaves Akanyaru River until point 8 of figure 1, with a width of 600 m. The vegetation of the buffer zone is dominated by *Cyperus papyrus*.

Following the extension of farming milieu, the buffer zone no longer keeps its original dimensions. On the side of Akanyaru River, the buffer zone already lost more than 300 m put in culture. At the foot of the slope, the buffer zone is ploughed over a width varying between 10 - 30 m and, approximately 200 m are already removed from the band of 600 m which were fixed. The intense reduction in water of the marsh facilitates several human activities inside the buffer zone.

On a little disturbed extent, *Cyperus papyrus* marks its predominance. Other species particularly *Aspilia africana*, *Ipomea rubens* add to the place. On the dried up small ponds inside the buffer zone, a homogeneous vegetation of *Cyperus latifolius* develops.

Ploughing and overgrazing on both sides of the marsh in the buffer zone already remarkably modified its floristic composition which grow rich with ruderal and post-farming elements, with species like *Ageratum conyzoides*, *Bidens pilosa*, *Polygonum pulchrum*, *Cyperus dives*, *Panicum maximum*, etc.

At the beginning of the slope towards the hill, a band of banana trees was installed throughout the buffer zone (Fig. 21). Ruderal species are frequent there, particularly *Bidens pilosa* remarkably dominating, *Oxygonum sinuatum*, *Tribulus terrestris*, *Ageratum conyzoides*, etc. When leaving the banana plantation, the slope becomes increasingly stiff. This is the field of a savannah raised in full degradation on a rocky ground. This is vegetation formerly preserved following the soil that was unsuitable for agriculture. Currently, the cut of trees for various uses and the overgrazing already modified savannah completely and shrubs of suitable size became rare. The remarkable elements of savannah are *Parinari curatellifolia*, *Lannea schimperi*, *Ozoroa reticulata*, *Albizia adianthifolia*, *Combretum molle*, etc. The profile of the distribution of the vegetation is shown in figure 22 and the floristic composition in table 8.

Fig. 19: Degradation of *Cyperus papyrus* marsh in buffer zone of Akanyaru valley

Fig. 20: Agriculture in *Cyperus papyrus* marsh of buffer zone in Akanyaru valley

Fig. 21: At the beginning of the slope towards the hill, a band of banana trees is installed

1 : Cyperus papyrus marsh
2 : Zea mays culture
3 : Banana plantation band
4 : Wooded savannah on roch ground
5: Crops and houses

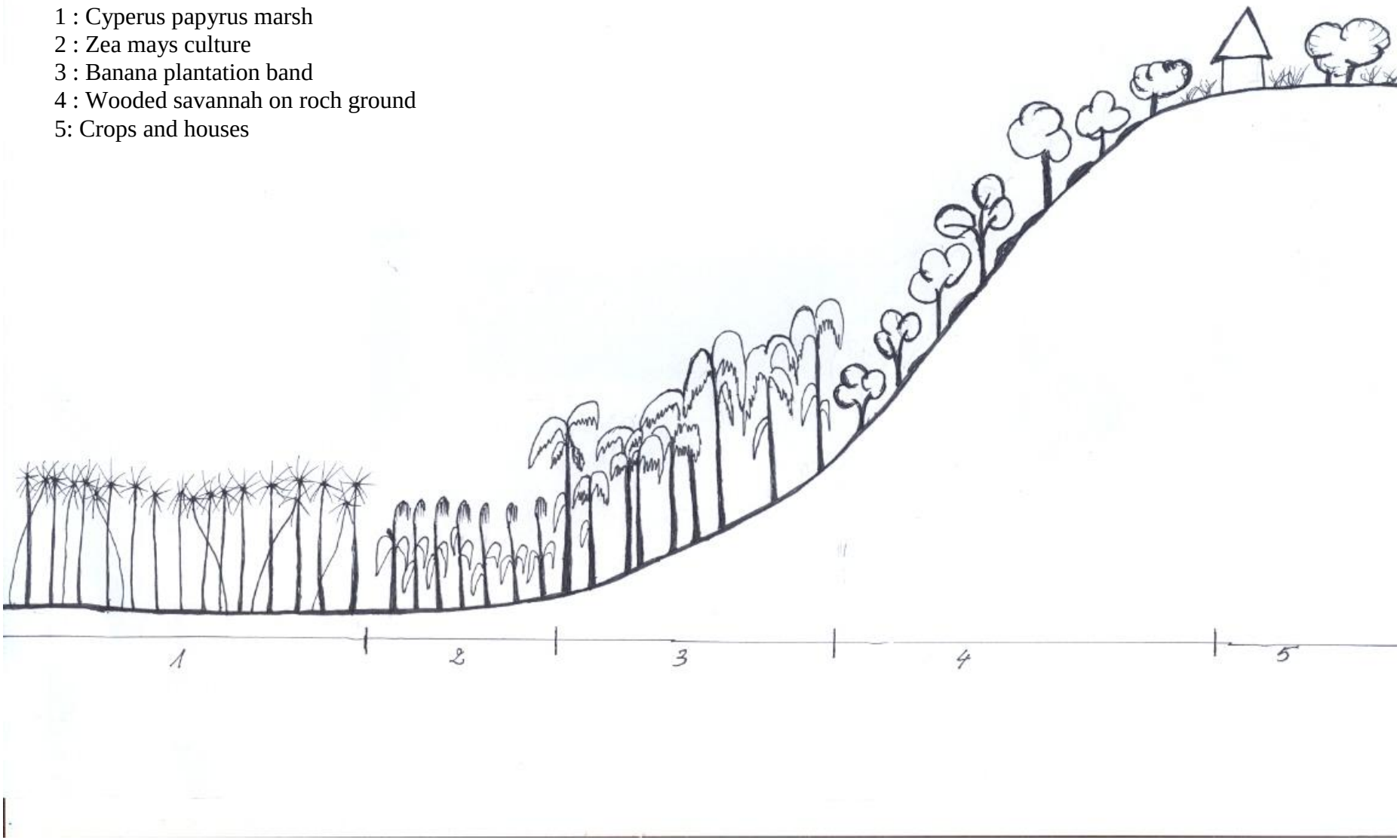


Fig. 22: The profile of the distribution of the vegetation at Mugombwe

Table 8: Floristic composition of the vegetations of Mugombwe

Types of vegetation	Species	Local names
Vegetation of buffer zone	***Marsh species***	
	Cyrepus papyrus	Urufunzo
	Cyperus dives	Ikigaga
	Cyperus latifolius	Urukangaga
	Ipomea rubens	Inkoba
	Aspilia africana	(Icumwa) Icyumwa
	Hydrocotyle ranunculoides	
	Phyla nodiflora	
	Ludwigia leptocarpa	
	Ludwigia stolonifera	
	Marsiscus longibracteatus var. longibracteatus	Umushimboshimbo
	Species of agriculture zone	
	Polygonum pulchrum	Igorogonzi
	Polygonum strigosum	Igorogonzi
	Pycreus capillifolius	
	Echnochloa colona	
	Panicum maximum	
	Cyperus dives	Ikigaga
	Bidens pilosa	
	Eragrostis sp.	
	Cyperus longibracteatus var. *longibracteatus*	
	Agrocharis incognita	
	Commelina bengalis	Inteza
	Ageratum conyzoides	Akarura
Vegetation on slope	***Ruderal species in banana plantation***	
	Bidens pilosa	Icanda
	Oxygonum sinuatum	
	Ageratum conyzoides	
	Panicum maximum	Igikaranka
	Oldenlandia herbacea	
	Spermacoce princecae	
	Aerva lanata	Akamongo
	Galisonga parviflora	
	Tagetes minuta	
	Tribulus terrestris	
	Savana species	
	Parinari curatellifolia	Umunazi
	Combretum molle	Umurama
	Combretum collinum	Umukoyoyo
	Ozoroa reticulata	
	Albizia adianthifolia	Umusebeya

Table 8: Floristic composition of the vegetations of Mugombwe

Famille	Espèces	Nom
	Albizia versicolor	Umububa
	Uvaria angolensis	
	Haplocoelum gallaense	Umujwiri
	Dalbergia nitidula	
	Melinis minutiflora	Ikinyamavuta
	Maytenus heterophylla	
	Canthium schimperanum	
	*Securidaca longededuncula*ta	
	Dovyalis macrocalyx	Umushubi
	Landolphia kirkii	
	Strychnos lucens	
	Pittosporum spathicalyx	Umunyerezankende
	Acokanthera schimperi	
	Lannea schimperi	
	Canthium lactensces	
	Ochna schweinfurthii	
	Vernonia perrotteti	

II.2.3.6. Xerophilous thickets of Gasenyi

The xerophilous thickets of Gasenyi form continuous vegetation connecting the vegetation of the military field of Rwanda and the vegetation of the Natural Reserve of Murehe in Burundi.

As a whole, a thicket is presented in the form of a forest in miniature of 4 - 10 m in diameter of which the tangle of climbing species make of it a closed circle set up on a termite's nest. The principal trees of the thickets are *Euphorbia candelabrum*, *Pappea capensis* and *Lannea schimperi*, reaching 6 -10 m height. The tangle appears on the lower layer with shrubby species, particularly *Canthium lactescens*, *Teclea nobilis, Gardenia ternifolia subsp. jovis-tonantis,* enriched with climbing species and rustles like *Grewia mollis*, *Grewia similis*, *Securinega virosa*, *Capparis fascularis*, *Zizyphus mucronata*, *Scutia myrtina*, etc. These plants create an impenetrable dense crown within which it is difficult to determine which branch belongs to which trunk. The tangle will be accentuated by lianas, including *Cissus oliveri*, which will cover the top, thus conferring on the thicket the characteristic hemispherical form (Fig. 23).

Under the shade created underwood, species like *Sansevieria dawei*, *Sensevieria parva*, *Aloe macrosiphon* appear.

Xeric lawns are intercalated between the thickets with species like *Brachiaria eminii* forming a very poor vegetable cover. Following the intense overgrazing, the lawns give place to the naked ground. The destruction of thickets leaves degraded milieus presenting stripped shelves covered with termite's nests. On the contrary, outside of the anthropic influences, the thickets are separated by small shrubs of *Acacia hockii* and *Dicrostachys cinerea* with some graminaceous like *Panicum maximum, Themeda triandra* and *Hyparrhenia filipendula* marking already the stage of much more advanced savanisation.

Towards the valleys, the thickets should give place to savannah of *Acacia Polyacantha* which was localized in the bottom of valleys where only a few feet still testify the existence to this species in the locality. The floristic composition of the vegetation is shown in table 9.

Fig. 23: The xerophilous thickets of Gasenyi

Table 9: Floristic composition of the xerophilous thickets of Gasenyi (Natural Reserve Murehe)

Types of vegetation	Species	Local names
Larges trees of thickets	*Euphorbia candelabrum*	Igihahe
	Pappea capensis	
	Lannea schimperi	Umumuna
Shrubby, sarmentous species or climbing lianas	*Acacia hockii*	Umugenge
	Acalypha cf. bipartita	Ingesegese
	Acokanthera schimperi	Umusagwe
	Albizia adianthifolia	Umusebeyi
	Albizia versicolor	Umububa
	Apodytes dimitiata	Umusivya
	Caesalpinia decapetala	Umubambangwe
	Canthium schimperanum	Umukiragi
	Canthium sp.	
	Capparis erythrocarpus	Uruzira
	Capparis fascicularis	Uruzira
	Carissa edulis	Umunyonza
	Cissus oliveri	Umugobore
	Clausena anusata	Umutana
	Clerodendrum myricoïdes	Umunywamazi
	Combretum collinum	Umukoyoyo
	Combretum molle	Umurama
	Commiphora africana	Umudahwera
	Crabbea velutina	
	Dalbergia nitidula	Umuyigi
	Dichrostachys cinerea	Umukamba
	Dodonea viscosa	Umusasa
	Entada abyssinica	Umusange
	Erythroccoca bongensis	Umutinti
	Euclea schimperi	Umucikiri
	Euphorbia candelabrum	Igihahe
	Gardenia imperialis	Umugondo
	Gardenia ternifolia subsp. jovis-tonantis	Umuterama
	Grewia mollis	Umugeregere
	Grewia similis	Umukoma
	Haplocoelum gallaense	Umujwiri
	Jasminum dichotomum	

Table 9: Floristic composition of the xerophilous thickets of Gasenyi (Natural Reserve Murehe) (Continuation)

Types of vegetation	Species	Local names
	Landolphia kirkii	Umubungobungo
	Lannea schimperi	Umumuna
	Maytenus arbutifolia	Umugunguma
	Maytenus heterophylla	Umugunguma
	Maytenus senegalensis	Umweza
	Olea europea var africana	Umunzenze
	Osyris lanceolata	Umuvyi
	Ozoroa riticulata	Umukerenki
	Pavetta assimilis	
	Pittosporum spathicalyx	Umunyerezankende
	Rhus longipes	Umusagara
	Rhynchosia resinosa	
	Rytigynia monanta	
	Sarcostemma viminale	Umunyari w'ishamba
	Schrebera alata	Umubanga
	Scutia myrtina	Umugasa
	Securinega virosa	Umubwirwa
	Senecio hadiensis	Icegera
	Strychnos innocua	Amahonyo
	Strychnos lucens	Amahonyo
	Strychnos spinosa	Umukome
	Teclea nobilis	Umuzo
	Ximenia caffra	Amasasa
	Zanthoxyllum chalybeum	Igugu
	Zizyphus mucronata	Umukugutu
Species of the underwood of thickets	*Aerva lanata*	
	Aloe bukobana	Inkakarubanmba
	Aloe macrosiphon	
	Asparagus flagellaris	Umunsabe
	Caraluma schweinfurthii	
	Chlorophytum sparsiflorum	
	Commelina elgonensis	Ikiteja
	Orchidaceae sp.	-
	Sansevieria dawei	
	Sensevieria cylindrica	

Table 9: Floristic composition of the xerophilous thickets of Gasenyi (Natural Reserve Murehe) (Continuation)

Types of vegetation	Species	Local names
Herbaceous inserted between the thickets	*Panicum maximum*	Igikaranka
	Themeda triandra	
	Hyparrhenia filipendula	
	Sida alba	
	Phyllantus odontadenius	
	Oxygonum sinuatum	Agahandanzovu
	Indigofera zenkeri	
	Indigofera arrecta	Umusorora
	Indigofera sp.	Umusorora
	Desmodium salicifolium var. densiflorum	
	Cassia occidentalis	Umuyokayoka
	Hibiscus diversifolia	Umukururantama

III. INTERRELATIONSHIPS BETWEEN THE FLORA AND THE WAY OF LIFE OF RIPARIAN COMMUNITIES

III.1. Ecological influences of the ecosystems on the socio-economic life of riparian populations

III.1.1. Ecological importance of the marshes

The distinctive characteristic of Cohoha Lake which confers a single statute to the lake is its lengthened and dendritic form with several distributaries penetrating territorially between the hills. This form makes it possible to have water and other aquatic resources for a very large riparian population and allows the moistening of soils on a very great surface.

The marshes of the Cohoha sub-basin constitute barriers against the alluvia and colluviums coming from the neighbouring hills and an important centre of purification for water which runs towards all the lakes.

Akanyaru River drains, during its long course, all the alluvia and colluviums very charged in earthy elements descended from the hills of its area catchment both in Rwanda and Burundi. These are then the polluted water which should be distributed in all the lakes and rivers of all the marshy system of Bugesera. However, being stations of purification par excellence, the marshes, dominated by *Cyperus papyrus*, slow down the circulation of water under the floating cover of the papyruses and so stop the contribution of alluvia and colluviums. Thus, well purified water will flow in the lakes to serve the riparian population which uses for drinking, cooking and other uses. This ecological role in the purification of water seems to be exploited by the population owing to the fact that most of water for various uses is drawn from the zones still carrying a vestige of marsh. The attenuation of sedimentation in the lakes by the marshes also ensures a protection of the aquatic biodiversity and allows the increase in the marine production.

Being distributed on soils of flooded valleys, the marshes are regarded as “kidneys of the landscape” for the functions which they fill in the hydrological and climatic cycles.

Since the most remote times, the action of man has completely modified the landscapes of Bugesera by intense deforestation in favour of agriculture. Only recently this area was regarded as attic of Burundi and Rwanda. Currently, with the aggravation of the aridity, the soils of the hills that become very arid, and the combined effects of the intense exploitation and erosion, become less and less productive.

In such circumstances, the climatological system of regulation lost on the stripped hills, remains in the valleys where the vegetation of the marshes and water of the lakes and rivers, maintain a certain humidity of the atmosphere of the area, thus attenuating the rigor of the climate.

Permanent moisture on the soils of the marshes and the edges of the lakes take part in the conservation of soils by the attenuation of the rigor of the climate characterized by an already manifest very marked aridity on the hills.

In Bugesera, the evaporation of surfaces of interstitial water and wetlands, plus the evapotranspiration of the aquatic plants, is of about a 1291 -1446 mm per annum against 780 - 1000 mm of precipitations. Consequently, interstitial water surfaces and the marshes evaporate definitely more water than they do not receive by direct precipitations (Ntakimazi, 1985).

Thus, on the Cohoha sub-basin, this deficit is made up by Akanyaru River waters during the rainy season, and preserved by the marshes of *Cyperus papyrus* which function like sponges retaining much water allowing the lakes and rivers to be maintained on a higher level, and to remain as such during the dry periods.

The marshes ensure conditions essential to the perpetuation of a great diversity of vegetable and animal species. Indeed, the vegetable species particularly *Cyperus papyrus*, *Typha domingensis*, *Vossia cupidata* and *Phragmites mauritianus* are always in dense populations under particular conditions of moisture permanently. These reedy marshes constitute zones of reproduction and food for fish (Fig. 24). They also serve in several socio-cultural and economic uses for a large rural population.

The marshes of the Cohoha sub-basin form a biotope ornithologically important, a site of rest, reproduction and passage for much of migrating species. The multiple population of birds of the Rwihinda Lake which influenced its name of "Lake of birds" survive thanks to the presence of all the marshy system of Bugesera, particular to the basin of Cohoha Lake, the lengthened and dendritic form of it offer a great possibility for the birds to exploit a greater field.

The marshes of Akanyaru River ensure the vital conditions for *Tragelaphus spekei*, antelope of marsh threatened everywhere in the country by the destruction of its biotopes.

In conclusion, the marshes and the lakes of Bugesera constitute a major asset for the socio-economic development of the area. However, a sustainable development can be possible only if all the marshy system is preserved. The permanent moisture of the soils, the quality and the quantity of the masses of water of the lakes and rivers maintained by the vegetation of the marshes, constitute conditions necessary for a sustainable agriculture. Moreover, the tourist attractions of the area of Bugesera are practically based on the natural habitats, particularly the lakes and marshes.

However, the valorisation of all these potentialities suppose beforehand reasoned interventions. A non-considered agriculture would be likely to endanger all the biodiversity of the Cohoha sub-basin and to worsen the aridity in an area which is in very precarious situation. Similarly, the development of tourism must be done through the conservation of the vegetation.

Fig. 24: La végétation de bordure du lac est très remuée par la pêche

III.1.2. Ecological importance of the thickets

The first ecological role of the thickets of Murehe is related to its xeric character. The relatively short trees are much ramified and especially thorn-bush, crassulescent and the reduced foliage, characters of adaptation in an area of the most severe aridity for Rwanda and Burundi.

Indeed, under this very marked arid climate, the xerophilous thickets of Bugesera had to develop structures and strategies to preserve water by avoiding the evapotranspiration. Certain species adapted their foliage to the lack of water by developing crassulescent leafs and stems. These are especially *Sarcostemma viminale, Cissus oliveri, Euphorbia candelahrum, Aloes macrosiphon,* etc. which are abundant in the thickets. Many plants could develop spines and particularly reduce the foliar size, including *Scutia myrtina, Haplocoelum gallaense, Acacia sieberana, Acacia hochii, Dichrostachys cinerea*, *Acacia polyacantha, Maytenus arbutifolia,* etc. Other species have a thick coat preventing an intense evaporation. Other adaptations are not more quickly visible; this is for example the capacity to collect water by roots and even to exploit a great volume of the ground and to develop radicular bodies underground: bulbs, rhizomes, persistent under the ground in the dry season.

Actually, this is vegetation with plant species adapted to the hardest conditions and their deforestation often leads to disastrous phenomena of desertification. The stripped hills evaporate as much water as they receive by precipitations. But under cover of xerophilous thickets, all the ground water is not continuously mobilisable for evaporation and, the evapotranspiration remains limited by the physiological state of this type of vegetation. According to Ntakimazi (1986) the value of evaporation and evapotranspiration in terrestrial environments is 950 mm, against precipitations varying between 950 - 1000 mm in Bugesera.

Being set up on termite's nests, the thickets play an important role in the control of the populations of the termites. Their elimination leaves naked soils surmounted of multiple termites' domes that very few plants could support due to the attacks of termites and also because of the scarcity of the rains. It is worth noting that the scarcity of woodlots in the area of Bugesera is primarily related to the attacks of the termites discouraging the interventions of forestry and agro-forestry. Actually, all these pedoclimatic conditions make understand that this area has forest vocation, obviously by the maintenance of this adapted vegetation.

The thickets of Bugesera form "microphone-habitats" having worked out a particular microclimate for a generally clean fauna. The last large mammalian of Bugesera could persist thanks to the thickets. *Tragelaphus scriptus*, *Sylvicapra grimmia* frequently thread and transform the interior of the thicket into a true a repository.

The thickets of Gasenyi provide many living resources for the riparian population. Several trees and shrubs are used in construction and are preferred to other introduced trees that are easily destroyed by the termites. The thickets constitute important sources of firewood. Their position on the hills fights against erosion and protects agriculture in the bottoms valleys.

III.2. Socio-economic Value of the Floristic Resources

From the socio-economic point of view, the ecosystems of Bugesera include several vegetable species taking part in several uses such as firewood, food, pharmacopoeia, construction of houses, manufacture of various tools, particularly the dugouts, mortars and rammers as well as baskets.

III.2.1. Description of the modes of use

III.2.1.1. Vegetable resources in the construction of houses

In the Cohoha sub-basin, several local species are requested during construction. The basic elements are the tree trunks and shrubs which are used as poles to set up the walls. The species used are particularly *Acacia hockii*, *Acacia sieberana*, *Rhus longipes*, *Vernonia amygdalina* and *Haplocoelum gallaense* (table 10). The latter, much appreciated by the population thanks to its very hard wood, becomes increasingly rare in the area of Bugesera. The poles are then supported by young stems of still flexible plants using the cords manufactured on the basis of *Cyperus papyrus* stems (Umuhotora). The whole is clogged with mud. The exploitable species inventoried by the population for construction come from savannahs, the thickets and the marshes. The roof of these houses, before the deposit of sheets or especially straw dominated by *Typha domingensis* or sometimes *Hyparrhenia* is made on the basis of *Phragmites* and cord resulting from *Cyperus papyrus*.

Table 10: Vegetable species used in the construction of the houses

Species	Local names	Uses
Acacia hockii	Umugenge	Poles
Acacia sieberana	Umunyinya	Poles
Albizia versicolor	Umububa	Poles
Annona senegalensis	Umukanda	Support of the poles
Combretum molle	Umurama	To set up the walls
Cyperus papyrus	Umufunzo	Cords
Dalbergia nitidula	Umiyigi	Poles
Entada abyssinica	Umusange	Support of the poles
Erythrina abyssinica	Umurinzi	Poles
Euclea schimperi		Support of the poles
Grewia similis	Umugeregere	Poles
Landolphia kirkii	Umubungobungo	Support of the poles
Markhamia lutea	Umusave	Poles
Mytenus heterophylla	Umushubi	Poles
Olea africana	Umunzenze	Poles
Pappea capensis	Umumena	Poles
Parinari curateliforia	Umunazi	Poles
Phragmites mauritianus	Amarenga	Support of the poles, enclose, roof, ceilings
Rhus natalensis	Umusagara	Poles and support of the poles
Strychnos lucens	Amahonyo	Support of the poles
Typha domingensis	Umubere	Ceilings, roof
Vitex doniana	Umuvyiru	Poles
Zizyphus mucronata	Umukugutu	Poles
Haplocoelum gallaense	Umujwiri	Poles

III.2.1.2. Firewood and carbonisation

In spite of the lack of coal exploitation in Bugesera, wood is exploited for other uses, particularly firewood. Certain species are preferred to others, particularly *Acacia* div. sp., *Grewia imiles, Pappea capensis, Dichrostachys cinerea* and *Combretum molle* (Table 11). There are other plants not taking fire quickly, consequently not used. These include *Euphorbia candelabrum, Psorospermun febrifugum, Ozoroa insignis, Cussonia arborea.* Savannahs and the thickets constitute the principal sources of firewood, brickyards, etc. However, the clearing operated in the area of Bugesera for long made rare the firewood. Moreover, the trees and the shrubs which had been saved from clearing in order to serve in certain uses are now rare. In certain localities deprived of forest ecosystems, the population makes recourse to large marsh herbaceous like *Cyperus papyrus* (Fig. 25).

Fig. 25: *Cyperus papyrus* **is used as firewood in certain localities where wood is rare**

Table 11: Vegetable species used as firewood

Species	Appreciation by population	Local name
Acacia hockii	Very appreciated	Umugenge
Acacia polyacantha	Very appreciated	Umugunga
Acacia sieberana	Very appreciated	Umunyinya
Acokanthera schimperi	Appreciated	Umusagwe
Albizia versicolor	Appreciated	Umububa
Apodytes dimitiata	Appreciated	Umusivya
Canthium schimperanum	Appreciated	Umukiragi
Carissa edulis	Very appreciated	Umunyonza
Combretum collinum	less appreciated	Umukoyoyo
Combretum molle	Very appreciated	Umurama
Cyperus papyrus	less appreciated	Urufunzo
Dalbergia nitidula	less appreciated	Umuyigi
Dichrostachys cinerea	Very appreciated	Umukamba
Entada abyssinica	less appreciated	Umusange
Gardenia ternifolia	less appreciated	Umuterama
Grewia mollis	Very appreciated	Umugeregere
Grewia similis	Very appreciated	Umugeregere
Haplocoelum gallaense	Very appreciated	Umujwiri
Harrisonia africana	less appreciated	Umuganzacaro
Kigelia africana	less appreciated	Umuremera
Lannea schimperi	Very appreciated	Umumuna
Lannea schimperi	Appreciated	Umufute
Maesopsis eminii	Very appreciated	Umuguruka
Markhania obtusifolia	less appreciated	Umukundambazo
Maytenus arbutiolia	less appreciated	Umugunguma
Maytenus heterophylla	less appreciated	Umusongati
Maytenus senegalensis	less appreciated	Umweza
Olea africana	less appreciated	Umunzenze
Osyris lanceolata	less appreciated	Umuyivyi
Pappea capensis	Very appreciated	Ikimuna
Parinari curatellifolia	Very appreciated	Umunazi
Pavetta imperialis	less appreciated	Imigondo
Pavetta ternifolia	less appreciated	Umufotifoti

Table 11: Vegetable species used as firewood

Species	Appreciation by population	Local name
Pittosporum spathicalyx	Appreciated	Umunyerezankende
Rhus longipes	Very appreciated	Umusagara
Rhus natalensis	Very appreciated	Umusagara
Rhus vulgaris	Very appreciated	Umusagara
Strychnos spinosa	less appreciated	Umukome
Teclea nobilis	less appreciated	Umuzo
Vernonia amygdalina	Appreciated	Umubirizi
Xymenia caffra	Appreciated	Umusasa (Mushereke)
Zizyphus mucronata	Appreciated	Umukugutu

III.2.1.3. Edible species

Fruits are obviously excellent sources of mineral salts and vitamins and bring sometimes a considerable energy ration. However, wild fruits do not occupy an important place in the foodstuffs of the population of Bugesera (Table 12). They are generally consumed fresh by the shepherds who spend their great time in natural environments, behind the herds of cows. The reduction of natural ecosystems was accompanied by the scarcity of edible plants and only the thickets and savannahs still contain much fruits. The population of Kiri in Burundi announces already the scarcity of *Strychnos lucens, a* species with much appreciated fruits, which would deserve to be cultivated. *Acokanthera schimperi* is a plant whose fruits are very appreciated but the roots are known as poison by the population, and the hunters used them to extract the poison of arrows. During these recent years of crisis in Burundi, the tubers of *Nymphea lotus* allowed a large population to survive. The population reported that they recorded several cases of fortunately momentary intoxication in the event of confusion of *Nymphea nouchalli* and *Nymphea lotus.* The manufacture of beer containing *Phoenix reclinata* is common in Bugesera. However, this plant is threatened of extinction.

Table 12: Edible fruits of plants

Species	Organs haversted	Local names	Appreciation by population
Acokanthera schimperi	Fruit	Umusagwe	Very appeciated
Carisa edulis	Fruit	Iminyonza	Less appreciated
Landolphia kirkii	Fruit	Umubungobungo	Very appeciated
Lannea schimperi	Fruit	Imimuna	Less appreciated
Nymphea lotus	Tubers	Irebe	Very appeciated
Pappea capensis	Fruit	Imimena	Appreciated
Parinari curatelifolia	Fruit	Amanazi	Appreciated
Phoenix reclinata	Fruit, sap	Ibisandasanda	Very appeciated
Rhus natalensis	Fruit	Imisagara	Less appreciated
Strychnos innocua	Fruit	Amahonyo	Appreciated
Strychnos lucens	Fruit	Umutegengeri	Very appeciated
Strychnos spinosa	Fruit	Imikome	Appréeciated
Uvaria angolensis	Fruit	Umuzirampfizi	Very appreciated
Ximenia caffra	Fruit	Amasasa	Very appreciated

III.2.1.4. Medicinal species

It was noted that pharmacopoeia is very common in Bugesera. All the surveyed population testifies that this practice is transmitted from generation to generation between members of the same family (Table 13). This is the result of a Burundian traditional habit which requires that a child has to inherit the trade of his parents. All the identified species are almost known of everyone and are of everyday usage, given that modern medicine is too expensive for the peasants. The species which are subjected to extraction are in the natural environments or in the fields of crops. The extraction is done by digging at the level of the neck to extract the roots, by peeling the trunk to remove the barks and by collecting leafs. The extraction of leafs and roots particularly is very intense. The barks are also collected at a considerable extent. In their habit, neither the wizards, nor the healers or others, never expose a medicinal product in public places such as markets. Nevertheless, traditional medicine constitutes a source of income in the households.

Table 13: Some medicinal plants used in Cohoha sub-basin

Species	Local names	Organs used	Treated disease	Instructions
Zanthoxylum chalybeum	Igugu	Roots, barks	Verminose	To crush (roots, barks), to mix with water and to take a half glass.
Albizia versicolor	Umububa	roots	Lumbago	To crush, mix with water and to drink a small quantity.
Dodonea viscosa	Umusasa	leaves	Cough	To chew the leaves, to swallow the liquid.
Carissa edulis	Umunyonza	Roots	Imizimu	To crush, then to coat all the body.
Aloe bukobana	Inkakarubamba	leaves	Hepatitis	To slightly crush to mix with beer, to drink ½ glass.
Aloe macrosifon	Inkakarubamba	leaves	Wound, tineas	To crush the leaves mixed with gum collected on *Acacia sieberana* and to spread on the part of the sick body
Olea africana	Umunzenze	leaves	Cough	To chew the leaves, to swallow the liquid
Thunbergia alata	Iganzamwonga	Roots	Verminose	To dry the barks of roots, to mix with the banana juice and to drink a small quantity after fermentation.
Euclea schimperi	Umucikiri	roots	poisons	To crush the barks and to mix with water. To boil the mixture and drinking a small quantity.
Vernonia amygdalina	Umubirizi	Leaves	Verminose	To prepare a juice using the sheets mixed with water and to drink ½ glasses periodically.
Kigelia africana	Umuremera	Fruits	Mammite	To prepare a decoction and to apply to the sick centres
	Umunyiragisaka	Leaves	abdominal Pain	To crush the barks and to mix with water. To boil the mixture and to use like purgative.
Entada abyssinica	umusagwe	Racines	Against the poison	To crush the roots and mix with water and to drink in the event of poisoning
Haphocoelum gallaense	Umujwiri	Leaves	Cough	To chew the leaves, to swallow the liquid
	Ikizirankugwe	Leaves	Otitis	To make pass the leaves on fire and to extract a juice by pressing and to introduce it into the ear of the patient
Securidaca longependunculata	Umunyagasozi	Racines	Constipation auguë	To crush the roots and to mix with water and to drink
Clausena anusata	Umutana	Leaves	Verminose	To boil leaves and to extract a juice with drinking
Schrebera alata	Umubanga	Leaves or roots	difficult Childbirth	To boil leaves or roots and to extract a juice and to drink
Helinus mystacinus	Umubimbafuro	Leaves	Suffering eye and headaches	To boil leaves and to extract a juice with drinking
Kalanckoe grantii	Umukoni	Leaves	Headaches	To burn the leaves and to lick the powder
Acanthus pubensens	Igitovu	Leaves	Hepatitis	To crush the roots and to mix with water and to drink
Ximenia caffra	Umusasa	Racines	Difficult Childbirth	To crush the leaves and to extract from the juice one drinks
Crassocephalum montuosum	Igifurufuri	Leaves	Mammite	To crush the leaves and to extract from the juice which one drinks and a good quantity is widespread on the sick centre
Indigofera arrecta	Umusorora	Leaves	Verminose	To crush the leaves and to extract from the juice one drinks
Indigofera arrecta	Umusorora	Roots	Against the poison	To crush the roots and mix with water and to drink in the event of poisoning

III.2.1.5. Plants in handicraft use

The population of Bugesera extracts local vegetable resources for the manufacturing of handicrafts, baskets, plaits, etc. Some plants are used in entirety, and for others, one uses the barks or leafs. These extractions are done in the marshes, thickets, savannahs and even in the fields (Table 14).

Since most of the houses are built in a traditional way, the sawing of wood for the production of boards is almost non-existent. The marketed forest products resulting from sawing are the fishing dugouts whose prices vary from FBu 10,000 to 19,000. This sale is done at the residence of the sawyer and not at the market. The preferred species are *Grewia mollis, Pappea capensis, Markhamia lutea, Cordia africana.*

Several species are used in the manufacturing of baskets (amakapo) often found at the local markets. The leafs of *Phoenix reclinata* are used to manufacture baskets and bags. *Acalypha bipartita* provides baskets used in several uses in households.

The marshy grasses, *Cyperus papyrus, Cyperus laevigatus, Typha domingensis*, *Phragmites mauritianus, Cyperus latifolius* are mostly exploited women. Exploitation of these plants for various uses (basket making, construction of the fences, etc…) is a source of income for a very great number of households both in Rwanda and Burundi. It is worth noting that more than 80% of the population of Bugesera use plaits of *Cyperus latifolius* and *Typha domingensis* as traditional mattress of bed and carpet. The plaits are also used for the drying of the agricultural produce. These species are also used in socio-cultural activities. Indeed, several households of Bugesera do not have financial means to buy coffins in the event of death. They pack their deceased ones in plaits at the time of burial. The transport of a patient is done with a stretcher (Inderuzo) on which one spreads out plaits. *Euphorbia dawei* is used in the manufacturing of musical instruments like Inanga, Ikembe (Fig. 26 a b c d e).

a

b

c

d

e

Fig. 26. : a) Wemen after *Cyperus latifolius* haversting, b) System of Typha domingensi drying for plaits making, c) Plait making, d) Ceilings manufactured on the basis of *Cyperus papyrus*, e) Baskets from *Acalypha bipartita* plant.

Table 14: Floristic species in the artisanal uses

Species	Lacal names	Products manufactured	Market
Markhamia obtusifolia	Umukundambazo	Mortars, chairs, doors, rammers	C+
Markhamia lutea	Umusave	Mortars, boards	
Maesopsis eminii	Umuhumuro	Dugouts, boards	
Euphorbia candelabrum	Igihahe	Musical instrument	
Euphorbia dawei	Umurara	Musical instrument	
Smilax kraussiana	Imisuri	Hives for the bee-keeping, vans, cords	
Strychnos lucens	Umuhonyo	Hives for the bee-keeping, vans, cords	
Cissus oliveri	Umugobore	Hives for the bee-keeping, vans	
Paullinia pinnata	Umunyakagongo	Hives for the bee-keeping, vans	
Phoenix reclinata	Igisandasanda	Baskets, bags	C+
Cyperus latifolius	Urukangaga	Plaits, basket	C+++
Cyperus papyrus	Urufunzo	cords	C+++
Cyperus laevigatus	Indava	Plaits, basket	C+
Eleusine indica	Urwamfu	Corbeilles	C++
Typha domingensis	Urubere (Umuberanya)	Plaits, basket	C+++
Pittosporum spathicalyx	Umunyerezankende	Mortars, rammers, Dugouts	C+
Grewia mollis	Umugeregere	Arc of hunting	
Grewia similis	Umukore	Arc of hunting	
Acalypha bipartita	Umugese	Hives for the bee-keeping, basket	C +++
Helinus mytasinus	Umubimbafuro	Twist to braid the hives	
Phragmites mauritianus	Irenga (Umuseke)	Contruction of the ceilings, the fences	C +++

C+ : Trade observed; C++ : Frequent trade ; C +++ : Very traded

III.2.1.6. Melliferous plants

The bee-keeping is a profitable activity for the population bordering the thickets and savannahs of Bugesera. Several traditional hives were counted. Several species are known as melliferous particularly *Erythrina abyssinica, Grewia similis,* various species of *Acacia* etc. The branches of certain shrubs help the bee-keepers to install their hives, particularly *Lannea schimperi, Erythrina abyssinica* and *Pappea capensis* (Fig. 27).

Fig. 27: *Erythrina abyssinica* is melliferous plant and its branches help the bee-keepers to install their hives.

III.2.1.7. Fodder plants

The herbaceous vegetation of the underwood of the terrestrial environments is used as pasture. The most grazed species are *Brachiaria eminii*, *Panicum maximum*, etc. The marshes with Cyperaceae also offer extremely appreciated zones of pasture. Certain marshes are intensively exploited.

III.2.1.8. Local plants in forestry and agro-forestry

The lack of domestication skills is a problem for integrating trees in farms. The local species that were incorporated in the farms by the population include *Markhamia lutea, Ficus vallis-choudae, Ficus thonningii, Vernonia amygdalina, Erythrina abyssinica, Maesopsis eminii, Cordia africana.* In most cases, these species resist the attacks of the termites. These are the species that are used in several activities by the population and in agro-forestry. Other plants were not cut during the clearing for agriculture. These are species that are currently met in the fields. Some of them are left because they are considered as agro-forestry species, particularly *Acacia polyacantha* and *Acacia sieberana*, others provide various products, particularly *Grewia mollis, Combretum molle*, etc. which gives preferred firewood. *Zanthoxyllum chalybeum,* a species with very corrosive spines, is however left in the fields thanks to its medicinal virtues.

Table 15: Autochtones plants in forestry and agroforestery

Species	Domesticated plants	Plants not cut during the clearing for agriculture
Acacia polyacantha		x
Acacia sieberana		x
Albizia versicolor		x
Combretum molle		x
Carissa edulis		x
Clausena anusata		x
Combretum collinum		x
Erythrina abyssinica	x	x
Euphorbia candelabrum		x
Ficus thonningii	x	
Grewia mollis		x
Lannea schimperi		x
Markhamia lutea	x	
Olea africana		x
Pappea capensis		x
Pittosporum spathicalyx		x
Rhus natalensis		x
Rhus vulgaris		x
Rhus longipes		x
Typha domingensis		
Vernonia amygdalina	x	x
Ximenia caffra		x
Zanthoxyllum chalybeum		x
Cordia africana	x	
Ficus vallis-choudae	x	
Maesopsis eminii	x	

III.2.2. Utilisation extent and abundance of the floristic resources

The population of Cohoha sub-basin attaches an essential importance and a particular accent on the local species to meet their needs (Table 16). Most of the local species are multi-purpose, particularly *Olea africana, Pappea capensis, Albizia versicolor, Grewia similis, Grewia mollis, Rhus natalensis, Rhus longipes, Maesopsis eminii, Markhamia lutea.*

Several species appeared highly exploited, including *Zanthoxyllum chalybeum, Cyperus papyrus, Typha domingensis, Phragmites mauritianus,* etc. Moreover, the cutting of wood for construction, firewood and carbonisation relates to several woody species.

Table 16: Various uses and levels of use for each indigenous species in the under-basin of the lake Cohoha

Species	Artisanal Plants	Construction	Firewood, carbonisation	Edible species comestibles	Medicinal plants	Total	Abundance	Degree of utilisation
Acacia hockii		x	x			2	less abundant	TU
Acacia polyacantha			x			1	Rare	FU
Acacia sieberana		x	x			2	Rare	TU
Acalypha bipartita	x					1	abundant	
Acanthus pubescens					x	1	abundant	
Acokanthera schimperi			x		x	2	less abundant	FU
Albizia versicolor		x	x		x	3	Rare	TU
Aloe bukobana					x	1		
Aloe macrosifon					x	1		
Annona senegalensis		x				1	less abundant	FU
Apodytes dimitiata			x			1	Rare	MU
Canthium schimperanum			x			1	less abundant	FU
Carisa edulis			x	x	x	3	less abundant	MU
Cissus oliveri	x					1		
Clausena anusata								
Combretum collinum			x			1	less abundant	FU
Combretum molle		x	x			2	less abundant	TU
Crassocephalum montuosum					x	1		
Cyperus laevigatus	x					1	Rare	MU
Cyperus latifolius	x					1	Rare	TU
Cyperus papyrus	x	x	x			3	less abundant	TU
Dalbergia nitidula		x	x			2	Rare	TU
Dichrostachys cinerea			x			1	less abundant	MU
Dodonea viscosa					x	1		
Eleusine indica	x					1		

Table 16: Various uses and levels of use for each indigenous species in the under-basin of the lake Cohoha (continuation)

Species	Artisanal Plants	Construction	Firewood, carbonisation	Edible species comestibles	Medicinal plants	Total	Abundance	Degree of utilisation
Entada abyssinica		x	x		x	3	less abundant	MU
Erythrina abyssinica		x				1	less abundant	FU
Euclea schimperi		x			x	2	less abundant	FU
Euphorbia candelabrum	x					1	less abundant	FU
Euphorbia dawei	x					1	very rare	FU
Gardenia ternifolia			x			1	less abundant	FU
Grewia mollis	x	x	x			3	abundant	TU
Grewia similis	x	x	x			3	abundant	TU
Haplocoelum gallaense		x	x		x	3	very rare	TU
Harrisonia africana			x			1	less abundant	FU
Helinus mytasinus					x	1	abundant	FU
Indigofera arrecta					x	1	Very abundant	FU
Kalanckoe grantii					x	1	Abondant	FU
Kigelia africana			x		x	2	very rare	FU
Landolphia kirkii		x		x		2	Rare	FU
Lannea schimperi			x	x		2	less abundant	MU
Maesopsis eminii	x	x	x			3	abundant	TU
Markhamia lutea	x	x	x			3	abundant	TU
Markhamia obtusifolia	x		x			2	less abundant	MU
Maytenus arbutifolia			x			1	less abundant	FU
Maytenus heterophylla		x	x			2	less abundant	MU
Maytenus senegalensis		x	x			2	less abundant	FU
Nymphea lotus				x		1	abundant	FU
Olea africana		x	x		x	3	less abundant	MU
Osyris lanceolata			x			1	less abundant	MU

Table 16: Various uses and levels of use for each indigenous species in the under-basin of the lake Cohoha (continuation)

Species	Artisanal Plants	Construction	Firewood, carbonisation	Edible species comestibles	Medicinal plants	Total	Abundance	Degree of utilisation
Pappea capensis		x	x	x		3	less abundant	TU
Parinari curatellifolia		x	x	x		3	less abundant	TU
Paullinia pinnata	x					1	abundant	FU
Pavetta imperialis			x			1	less abundant	FU
Gardenia jovis-tonantis			x			1	less abundant	FU
Phoenix reclinata	x			x		2	very rare	MU
Phragmites mauritianus	x	x				2	less abundant	TU
Pittosporum spathicalyx	x		x			2	Rare	MU
Rhus longipes		x	x	x		3	abundant	TU
Rhus natalensis		x	x	x		3	abundant	TU
Rhus vulgaris			x			1	abundant	TU
Securidaca longependunculata					x	1	abundant	FU
Smilax kraussiana	x					1	abundant	FU
Strychnos innocua				x		1	less abundant	FU
Strychnos lucens	x	x		x		3	less abundant	TU
Strychnos spinosa			x	x		2	less abundant	FU
Teclea mobilis			x			1	less abundant	FU
Thunbergia alata					x	1	abundant	FU
Typha domingensis	x	x				2	abundant	TU
Uvaria angolensis				x		1	Rare	FU
Vernonia amygdalina			x		x	2	abundant	MU
Vitex doniana		x				1	less abundant	FU
Ximenia caffra			x	x	x	3	less abundant	MU
Zanthoxylum chalybeum					x	1	less abundant	TU
Zizyphus mucronata		x	x			2	less abundant	FU

TU: Very much used**, MU:** Fairly Used**, FU :** Slightly used

III.4. Impacts of the Anthropic Actions on the Vegetation of Cohoha Sub-basin

III.4.1. Degradation of the vegetation of the sub-basin

III.4.1.1. Degradation of the vegetation of hills

Analyses of existing data showed that the climatic phenomena characterized by overdrawn rains are ancient in Bugesera. It is for this reason that the area recorded since the most remote times xerophilous vegetation well adapted to the conditions of most marked aridity and dryness of the basin.

However, following the anthropic action, this adapted vegetation underwent a long standing continual deterioration often leading to lawns or naked grounds. The timbered savannahs, the xerophilous thickets and the sclerophyllous forests which covered the hills of Bugesera few years ago, disappeared under the blow of the axe, the hoe and especially of bushfire. Thus, there no longer exists the Cohoha sub-basin any representatives of the natural vegetation of the hills which are in conformity with the descriptions of Liben (1960).

The basins slopes throughout catchments of Cohoha sub-basin are mainly occupied by crops. In these various fields, a few stalks of much dispersed trees show the old vegetable formations (Fig. 28).

Shrubby savannah with *Loudetia simplex* and *Pappea capensis* of Liben (1960), invaded since 1960, was replaced by a xeric lawn maintained by overgrazing.

The sclerophyllous forests of Bugesera, which were already in danger in 1960, do not exist any more. Only a very untenable scrap exists in Burundi (Fig. 29). The forest of *Apodytes dimidiata* which still occupied the sides exposed to the West of some hills is completely destroyed. The population of Bugesera underlines the progressive disappearance of *Haplocoelum gallaense*, *Apodytes dimidiata* and *Euphorbia dawei*.

The xerophilous thickets which were located on several hills of Bugesera are now localized in the only terrestrial zone which materializes the Burundo-Rwandan border at the Natural Reserve of Murehe in Burundi and in the military field of Rwanda.

Under normal conditions, the thicket visualizes a structure with all the layers (higher shrubby layer, lower shrubby layer, suffrutescent layer, lower layer). However, most of the thickets of Gasenyi consist of the higher shrubby layer and a lower shrubby layer which is very disturbed. It is this layer of the tangled up thorn-bushes which is often eliminated during the clearing for agriculture of as well as the large trees of the higher layer.

Today, the presence of households dispersed inside the thickets obliges the latter to make recourse to the various resources in order to cater for the most elementary needs, particularly house construction and firewood.

Moreover, the lawns with *Brachiaria* which separate the thickets constitute excellent pastures. Many herds of cows which currently exist in this area reduce appreciably the xerophilous thickets, and the lawns are degraded in covered stripped beaches of ferruginous concretions strewn by numerous termite's nests (Fig.30).

These activities are at the origin of the deforestation of already precarious vegetation, characterized by xerophily, a sign of the process of desertification already started in this area. Following the progressive reduction of the thickets and savannahs, several species are condemned to disappear if serious measures of protection are not taken.

These include *Pappea capensis, Grewia similis, Olea africana, Zizyphus mucronata, Zanthoxylum chalybeum, Acacia hockii, Acacia gerrardii, Acokanthera schimperi, Dalbergia nitidula, Euphorbia candelabrum, Dichrostachys cinerea, Strychnos lucens, Teclea nobilis* and *Ximenia caffra*.

These are in fact the same trees that are considered as "masters of the landscape" which should normally form forest covers able to play a role of climatic and hydrological regulation, but also to serve as shelters for an important fauna. With the progressive regression of the thickets and savannahs of Bugesera, an ecological imbalance already expressed its effects, particularly by the precipitations that become less and less abundant probably because of the unrestrained courses of the trade winds coming from the Indian Ocean which cross deforested areas and which do not meet in Bugesera any obstacle to cause a mechanism of precipitations. The fact of exposing the soils caused the formation of armour unsuitable to agriculture and, in the event of the hazardous rains, erosion is intense.

Currently, the proliferation of bushes with *Lantana camara* deserves a detailed attention. This very invading species already occupies spaces evaluated per thousands of hectares in the area of Bugesera. Observations on the ground show that *Lantana* supplants very maliciously all the vegetation of Bugesera. This a plant which adapts very easily even under the hardest conditions.

The invasion of this area of Bugesera by *Lantana* is an undeniable threat and is due, from our point of view, to man. Indeed, this species distributed in all the corners of the terrestrial environment settles after the clearing, inhibits finally the other species and occupies the ground.

In flower almost all the year, *Lantana camara* emits many seeds and, each time an open site is discovered, shows up and invades the zone. This problem is likely to be even more serious in the event of opening of the xerophilous thickets.

It is very deplorable to note that an area initially well stocked with game became a faunistic desert. Considerable losses of fauna are already recorded in this area where the zoo-climax gave place to the cow-climax. The Atlas of Burundi visualizes rare distribution maps of a mammalian fauna currently disappeared such as *Loxodonta africana, Syncerus caffer, Panthera leo, Kobus ellipsiprymuns defassa, Aepyceros melampus*. The rare species currently met, particularly *Tragelaphus scriptus* and *Sylvicapra grimmia* are endangered.

Fig. 28: Agriculture in a destroyed xerophilous thicket

Fig. 29: Clearinf of the last sclerophyllous forests of *Euphorbia dawei*

Fig. 30: Cows destroy xerophilous thickets at Gasenyi

Table 17 : Some condiderations given by population on species threats

Species	**Local names**	**Threatened of disappearance**	**Disappeared**
Acacia polyacantha	Umugunga	x	
Acacia sieberana	Umunyinya	x	
Acokanthera schimperi	Umusagwe	x	
Albizia versicolor	Umububa	x	
Apodytes dimitiata	Umusivya	x	
Cyperus latifolius	Urukangaga	x	
Cyperus papyrus	Umufunzo	x	
Euphorbia dawei	Umurara	x	
Haplocoelum gallaense	Umujwiri		x
Kigelia africana	Umuremera		x
Landolphia kirkii	Umubungobungo		x
Pappea capensis	Umumena	x	
Phoenix reclinata	Ibisandasanda	x	
Phragmites mauritianus	Amarenga (Umuseke)	x	
Pittosporum spathicalyx	Umunyerezankende	x	
Strychnos lucens	Amahonyo	x	
Typha domingensis	Umubere(Umuberanya)	x	
Uvaria angolensis	Umuzirampfizi	x	
Zanthoxylum chalybeum	Igugu		x

III.4.1.2. Degradation of the valley of Akanyaru

This large frontier marsh between Burundi and Rwanda included a few years ago, vast papyrus fields rich in fauna. The marsh has just been subjected to fast and spontaneous agricultural drainage (Fig. 31). To the side of Burundi, the marsh of Akanyaru is subdivided in 13 “buffer zones” including 5 in Ntega commune and 8 in the commune of Bugabira. Unfortunately these “buffer zones” are now encroached. Moreover, all the marsh of the secondary valley which connects Akanyaru to Cohoha Lake is eliminated and crops proliferate.

The installation of these marshes not being always controlled, the results are irreversible losses of the fertility of the sought grounds, the disappearance of flora fauna, as well as the reducing of the ground water and the aridity of the grounds.

Moreover, the insufficient pastures on the hills oblige the stockbreeders, especially in the province of Kirundo, to move their herds towards the valley of Akanyaru where fodder persists even during the dry season.

The disappearance of the marsh of Akanyaru is already a clear threat of desertification on the hills which descent towards the valleys. Indeed, being the lung of the marshy system of Bugesera, the disturbance of this marsh risks to commit the hydrological and ecological conditions in an area with already marked aridity.

The species of the marsh of Akanyaru, particularly *Cyperus papyrus* and *Cyperus latifolius* is becoming rare due to repeated crops not allowing their regeneration. The two species are already said to be threatened everywhere in Burundi. The few animal species which populated the valley of Akanyaru are endangered, particularly *Tragelaphus spekei*, an antelope of marsh threatened of extinction everywhere in Burundi, *Phacochoerus aethiopicus, Leptailurus serval, Cercopithecus aethiops, Herpestes paludinosus,* etc.

Fig. 31: The Akanyaru marsh has been destroyed by irrational agricultural drainage .

III.4.1.3. Degradation of Cohoha Lake and its surroundings

In Burundi and in Rwanda, crops reach the immediate edges of Cohoha Lake. Except for its branches which are often prolonged by short marshes, there are no marshes surrounding the lake. The edges of all these branches are nibbled for the agriculture of rice, sorghum and banana trees. During the dryness which stuck the area of Bugesera in recent years, the projection of water towards the interior of the lake left spaces directly occupied by agriculture. In the middle of this lake stands the island of Rutega which is occupied by crops of banana trees. During the farming clearing, the rare *Cyperus papyrus, Vossia cuspidata, Typha domingensis, Cyperus latifolius* and *Phragmites mauritianus* are uprooted.

The wooded savannah with *Acacia seyal* and *Panicum maximum* of Liben (1960) which was localized on the humus-bearing alluvia around the lake is complement cleared. Some rare trees of *Acacia sieberiana* and *Acacia polyacantha* remain in the fields. One observes an intense exploitation with traditional farming practices.

The elimination of vegetable cover in the edge of Cohoha Lake is an undeniable threat for animals like the hippopotamuses and the crocodiles, which become increasingly rare in the area.

III.4.2. Degree of threat of the vegetable species in Cohoha sub-basin

III.4.2.1. Vulnerability of the vegetable species

The logical, visible and immediate consequence of the exploitation of the species is that certain regress while others continuously undergo pressures so extreme that they end up disappearing if special measures of protection and rational use are not adopted and are not carried out in a very urgent way.

In this analysis of vulnerability of the vegetable species, two simple criteria were fixed:

- The diversification of the use and the level of extraction of the species represent a strong threat on their existence. Thus, the more a species is requested the more it is vulnerable.
- The brittleness of the habitat or an ecosystem obviously translates the degree of vulnerability of its component species. The more the habitats do not regenerate in the event of continual deterioration, the more the component species are vulnerable.

Thus, three levels were established:

- Will be thus ***very vulnerable***, any species whose habitat does not exist any more or is found in a state which will not be able to require ground any more;
- Will be ***vulnerable,*** any species which is very much used or whose habitat, although still existing, is likely to be endangered by the continual human pressure;
- Will be ***less vulnerable***, any species fairly or slightly used but whose habitat is subjected to a certain protection measure.

Thus, the observations made on the ground, the information collected by means of investigations and inventories, made it possible to highlight the levels of vulnerability of the identified species. We drew aside from this analysis all the very abundant or even abundant species which, according to the population, cannot be exhausted by a simple extraction or disappearance of the habitat, particularly the ruderal species or post-farming species (Table 16). We also took care not to analyse species whose habitats do not exist any more or are very fragmented but that the population could domesticate, e.g. *Maesopsis eminii* and *Markhamia lutea.* The table 18 highlights 8 very vulnerable local species, 25 vulnerable local species and 22 not very vulnerable local species.

Table 18: Categorization of the vulnerable species of the Cohoha sub-basin

Very vulnerable species	**Vulnerable species**	**Less vulnerable species**
Acacia polyacantha	*Acacia hockii*	*Canthium schimperanum*
Acacia sieberana	*Albizia versicolor*	*Combretum collinum*
Apodytes dimitiata	*Carisa edulis*	*Dichrostachys cinerea*
Cyperus latifolius	*Combretum molle*	*Erythrina abyssinica*
Euphorbia dawei	*Cyperus laevigatus*	*Euphorbia candelabrum*
Haplocoelum gallaense	*Cyperus papyrus*	*Gardenia ternifolia*
Kigelia africana	*Dalbergia nitidula*	*Harrisonia africana*
Phoenix reclinata	*Entada abyssinica*	*Landolphia kirkii*
, vulnerable,	*Euclea schimperi*	*Markhamia obtusifolia*
	Grewia mollis	*Maytenus arbutifolia*
	Grewia similis	*Nymphea lotus*
	Lannea schimperi	*Osyris lanceolata*
	Maytenus heterophylla	*Gardenia jovis-tonantis*
	Maytenus senegalensis	*Rhus vulgaris*
	Olea africana	*Strychnos innocua*
	Pappea capensis	*Strychnos lucens*
	Parinari curatellifolia	*Strychnos spinosa*
	Rhus longipes	*Teclea mobilis*
	Rhus natalensis	*Typha domingensis*
	Strychnos lucens	*Vernonia amygdalina*
	Vernonia amygdalina	*Vitex doniana*
	Zizyphus mucronata	*Ximenia caffra*
	Phragmites mauritianus	
	Zanthoxylum chalybeum	
	Typha domingensis	
8	**25**	**22**

III.4.2.2. Categorisation of the threatened species

To identify the threatened species, two criteria were used, i.e. the extent of vulnerability (very vulnerable, vulnerable, less vulnerable) and the imminence of disappearance of each species. The imminence of disappearance is defined according to the abundance of each species (very abundant, abundant, less abundant, rare, and very rare). Thus, in order to adequately categories the species according to the various levels of threat, the matrix formula was used. This formula stipulates that a very vulnerable and abundant species is less threatened than a less vulnerable and very rare species (Table 19). Thus, the table 20 gives 11 very threatened species, 21 threatened species and 22 less threatened species in the Cohoha sub-basin. It should be mentioned that some species like *Phoenix reclinata, Euphorbia dawei, Zanthoxyllum chalybeum, Cyperus latifolius, Cyperus papyrus* and *Typha domingensis* are already declared as being endangered in Burundi.

As a whole, it is worth noting that the very threatened species are those having lost their habitats, particularly savannahs with *Loudetia simplex* and *Pappea capensis, the* sclerophyllous forests of Bugesera, the forest with *Apodytes dimidiata* and wooded savannah with *Acacia seyal* and *Panicum maximum.* The threatened and less threatened species constitute species that are effectively endangered if man does not cease making pressure on the very vulnerable habitats, particularly the xerophilous thickets, the marshes, the papyrus fields and reedy marshes of the edges of the lakes.

Table 19: Formulate used to determine the species threatened in leu only under-basin of the lake Cohoha

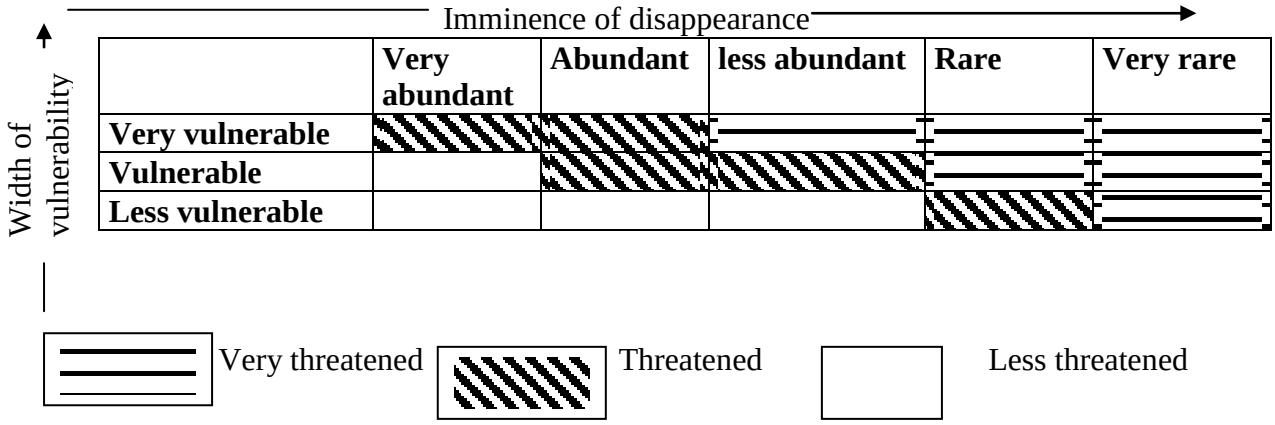


Table 20: Categorization of the species threatened in the under-basin of the lake Cohoha

Espèces très menacées	**Espèces menacées**	**Espèces peu menacées**
Acacia polyacantha	*Acacia hockii*	*Canthium schimperanum*
Acacia sieberana	*Carisa edulis*	*Combretum collinum*
Apodytes dimitiata	*Combretum molle*	*Dichrostachys cinerea*
Cyperus latifolius	*Cyperus papyrus*	*Erythrina abyssinica*
Euphorbia dawei	*Entada abyssinica*	*Euphorbia candelabrum*
Haplocoelum gallaense	*Euclea schimperi*	*Gardenia ternifolia*
Kigelia africana	*Grewia mollis*	*Harrisonia africana*
Phoenix reclinata	*Grewia similis*	*Landolphia kirkii*
Albizia versicolor	*Lannea schimperi*	*Markhamia obtusifolia*
Cyperus laevigatus	*Maytenus heterophylla*	*Maytenus arbutifolia*
Dalbergia nitidula	*Maytenus senegalensis*	*Nymphea lotus*
	Olea africana	*Osyris lanceolata*
	Pappea capensis	*Gardenia jovis-tonantis*
	Parinari curatellifolia	*Rhus vulgaris*
	Rhus longipes	*Strychnos innocua*
	Rhus natalensis	*Strychnos lucens*
	Strychnos lucens	*Strychnos spinosa*
	Vernonia amygdalina	*Teclea mobilis*
	Zizyphus mucronata	*Typha domingensis*
	Phragmites mauritianus	*Vernonia amygdalina*
	Zanthoxylum chalybeum	*Vitex doniana*
	Typha domingensis	*Ximenia caffra*
11	**21**	**22**

Conclusion: *The massive deforestation of all the hills resulted into the erosion of the ground that was accentuated in the Western part of the Cohoha sub-basin. In several localities, the edge of Cohoha Lake is much eroded. This is also facilitated by the existence of the tracks descending towards the lake and followed by colluviums at the time of rains. The case of erosion on the slopes is amplified in Burundi where the contour lines remain rare. The non-controlled drainage of the marshes led to the reduction in the capacity of retention of water in the papyrus fields and the drying up of lake and spring waters. This adds to increasing disturbances of the climate and the progressive reduction of the natural water reserves in the region.*

III.4.3. Conservation of the vegetation and safeguard of the endangered species

Through the analysis of degradation of the vegetation and the extent of threat of the species in Cohoha sub-basin, it was necessary to give guidelines capable of helping in their management and their conservation.

Accordingly, based on Articles 8 and 9 of the Convention on Biological Diversity (UICN, 1996), we must first consider the in situ conservation which is recognised as the privileged method of conservation and the conservation ex-situ that supplements the first one if needed.

Moreover, conservation should not be understood in the traditional sense where man is regarded as a destabilizing element, but rather, it should be perceived in its current sense of conservation, sustainable use and equitable sharing which are the same objectives as the Convention on Biological Diversity.

Thus, it would be very utopian to want to constitute ecosystems that disappeared long time ago from the Cohoha sub-basin because of the current occupation of the ground by man. However, taking account of the importance of the component species, the objective action which is essential is the setting in culture of all the species concerned. In the area of Bugesera, an arboretum with these adapted species is necessary. This action could be accompanied by a census of the sensitive zones which carried these types of vegetable formations, particularly in Kiyonza for the thicket of *Euphorbia dawei* and in Mugombwa for the savannah of *Combretum* in order to subject them to a system of conservation which should not be necessarily the system of protected areas. The enrichment of these zones from the local species is necessary.

It is necessary to set up a monitoring system allowing the halting of the reduction or the degradation of the surfaces of distribution of the species concerned. It is necessary moreover to stop the exploitation of these species classified as very threatened.

For the case of the xerophilous thickets of the Natural Reserve of Murehe in Burundi and military field of Rwanda, the essential action to be carried out is to reinforce the protection measures. Since this is about transboundary vegetation, it is necessary to install cooperation between Rwanda and Burundi for the safeguarding of this ecosystem.

Also considering that the xerophilous thickets and savannahs disappeared in several localities in the region of Bugesera, it is necessary to begin research for the setting in culture of the component species especially the most useful ones for the population.

The marshes of Akanyaru and the vegetation of the edges of Cohoha Lake require an integral protection with a precise aim of saving all the marshy system of Bugesera. Burundi and Rwanda must jointly set up a single system of conservation of these ecosystems. It was noted that the population of Cohoha sub-basin uses several floristic resources. Thus, among the measures of conservations to be taken, the traditional methods of use of the biological resources must be encouraged and integrated in management. This obviously supposes the setting in place of plans of rational exploitation of these resources.

IV. MANAGEMENT SYSTEMS AND LEGAL AND INSTITUTIONAL ARRANGEMENTS

IV.1. Management Systems in the Cohoha Sub-basin

V.1.1. Legal framework governing the marshes and the lakes

In Rwanda, the law on the environment was published in April 2005 as an organic law. This law amongst other things has the role of governing the environment, the species and their habitat, establishing the fundamental principles relating to the environmental protection, and any cause able to degrade the environment with the aim of promoting the natural resources while discouraging any unforeseeable or destructive factor. This law seeks also to establish strategies likely to protect and reduce the harmful effects on the environment and to rehabilitate the degraded environment.

The Ministry for Lands, Environment, Forests, Water and Mines established the ministerial decree n°2 of 24/9/01 relating to the exploitation and the management of the marshes in Rwanda in September 2001. This decree stipulates that any activity of improvement or exploitation of the marsh must be preceded by an impact assessment of the aforesaid activity on human life and the environment. The activities must start only after the approval by the Minister responsible for environmental protection.

There is also the organic law n° 04/2005 dated 8/04/2005 on methods of protecting, safeguarding and promoting the environment in Rwanda. In its article 17, the law stipulates that the use and management of water resources must in no way use imprudent exploitation methods which can be at the origin of certain disasters, like flooding or dryness. Any activity in connection with water resources like irrigation, installation of the marshes and others must be beforehand subjected to an environmental impact assessment.

Article 19 stipulates that the flooding plains must be subjected to special protection. This protection takes account of their role and value in the conservation of biological diversity.

In the sector of land, the organic law n° 08/2005 dated 14/07/2005 on land tenure determines the methods of use and management of land in Rwanda. It also fixes the principles applicable to the rights recognized on the lands located on the territory, and all that is linked or incorporated, either naturally or artificially.

In its article 12, this organic law stipulates that the public land field of the State is made up of all the lands which are assigned to a public use or utility and the public lands which are reserved for the environmental protection of the nation. These include particularly the beds of lakes, rivers and watercourses thus classified by decree of the Minister responsible for Water; edges of lakes and rivers up to a length determined by decree of the Minister responsible for the Environment, from the most distant point reached by water during successive floods, except the exceptional floods and the national lands intended for environmental protection and consisting of the natural forests, the parks, the protected marshes, the tourist gardens and places.

In Burundi, the lakes, rivers and other navigable watercourses in the public domain of the State are governed by the decree of August 8, 1983 in its article 7. By way of extension, this same provision widens the mode of the public belonging to the edges of the above-mentioned watercourses; on a 10 m width starting from the line formed by the highest level reached by waters in their periodic rising.

Since independence, no legislation specific to the marshes was elaborated. The changes which one can raise result nevertheless from some provisions incidentally referring to the marshes, but built-in in laws promulgated to govern matters presenting certain dependence with the marshes. Since these laws were issued successively at different periods, the provisions relating to the marshes which were inserted are themselves incomplete and miss coherence. Be it before or after independence, the legal device in connection with the marshes remained theoretical. In the ignorance of law, the populations gradually lined up on imposed practices, the need for curing the insufficiency and the overexploitation of lands on hills.

The protection of the potentially and ecologically significant sites is based on specific laws. These include the government decree n°1/6 dated 3 March on the creation of protected areas in Burundi. This decree, in its article 1, stipulates that "national parks and natural reserves are created on the territory of Burundi. The sites chosen to constitute parks or reserves, the delineations, the mode of protection and conservation of the flora and fauna will be determined by a decree".

The government decree n°1/02 dated March 25, 1985 on forest code requires the protection of the lands covered with a vegetable formation containing trees or shrubs able to produce wood or other forest products, or exerting an indirect effect on the climate, the mode of water or the land and the grounds which were covered with forests recently cut or set afire but which will be likely to regenerate naturally.

The law n° 1/010 of June 30, 2000 on the Environmental Code in Burundi fixes the fundamental rules intended to allow management of the Environment and protect the environment against all forms of degradation, in order to safeguard and develop the rational exploitation of the natural resources, to fight against pollution and harmful effects, and to improve the living conditions of the population in the respect of the balance of the ecosystems.

All these existing laws give right to Rwanda and Burundi to operate a judicious choice to preserve, in cooperation, the vulnerable zones of the Cohoha sub-basin.

IV.1.2. Management policy

The ratification of the Convention on Biological Diversity by Burundi and Rwanda is the concretisation of the will of these two countries to preserve the biodiversity and to manage it in a sustainable way. This act supplements the other decisions regarding the safeguarding of the biological resources for their sustainable use, particularly through the various legal texts, the creation and the organisation of the institutions concerned with the environment. Currently, Burundi and Rwanda have their national strategies and action plans as regards biological diversity. These are the documents of policy highlighting all the questions in connection with the conservation of the biodiversity, the sustainable use of the biological resources and the equitable distribution of the benefit rising from the exploitation of the genetic resources.

Moreover, in order to adequately manage the wetlands, these two countries ratified the Convention on Wetlands of International Importance, particularly the Habitats of Water Birds (Ramsar Convention). Rwanda already ratified the Convention of Bonn on the Conservation of the Migrating Species belonging to wild fauna (Convention of Bonn) and Burundi already started processes of ratification.

To join the other nations of the world in the fight against the harmful effects of dryness and degradation of lands, these two countries ratified the Convention of the fight against the degradation of lands and already have their action plans as regards degradation of lands.

IV.1.3. Management and installation activities in the sub-basin

IV.1.3.1. On-going interventions

In Rwanda, several activities are undertaken within the framework of the environmental projects registered in the action plan of the District of Bugesera.

In the field of afforestation, the Ministry for Lands, Environment, Forests, Water and Mines **(MINITERRE)** implemented the plan of afforestation, and the ISAR is responsible for producing seeds under the ad hoc budget of the MINECOFIN. The district distributes these seeds and the budget to the Cells via the Sector. It is thus the cell which puts the seeds in seedbeds and maintenance is reserved for "Umuganda[1]" or NGOs. The seedlings are distributed free to the population which plants them in their fields and on some public spaces identified by the Cell (MINAGRI, 2006).

In Cohoha sub-basin, the significant action of afforestation is the band of plantation around the whole Cohoha Lake up to 50 m of the edge. This band also girdled by *Caesalpinia decapetala*, consists of species like *Markhamia lutea, Cassia spectibalis, Calliandra, Leucena, Grevillea robusta*, etc. This protection plantation aims at creating a vegetable barrier to decrease the anarchistic frequentation of the lake by man or herds of cows. This action is the work of the implication of several partners, especially NGOs and Projects like RDO/HIMO under the financing of the Rwandan government. Moreover, BAMPOREZE Association already started planting bamboos around Cohoha Lake under the financing of UNDP. This plantation of bamboos seeks to protect the lake but also to provide to the riparian population a biological resource (*Bambusa vulgaris*) that is used in several handicrafts.

MINAGRI is the agency responsible for the interventions ***of fighting against erosion of soils***. The method of digging ditches and earthwork is used in the region of Bugesera. This method of relatively effective earthwork is used in almost all the fields of the District of Bugesera (MINAGRI, 2006). In Cohoha sub-basin, PAPSTA carries out a project of protection of the basins slopes on pilot sites and carries out plantation of shrubs.

Under the supervision of MINAGRI, POPSTA carries out activities ***of installation of marshes*** for agriculture. It is within this framework that the marshes of Akanyaru River were drained in favour of agriculture. In Rwanda, the ***divagation of the cattle*** is banished in favour of permanent stalling.

In Burundi, the interventions of management and developing of the natural resources are carried out through several programs set up in various official and private sectors.

In the field of afforestation, the Ministry for Land Use, Environment and Public Works, through the Forestry Department, is responsible for supervising all the afforestation activities. The production of seeds is made through several projects supported by several financial donors, including UNDP, FAO and the NBI (micro-grants) in favour of the populations.

In Cohoha sub-basin, the actions of afforestation are very limited in Burundi. Contrary to Rwanda, there is not any protection system planted around Cohoha Lake. However, with the financing of NBI (Micro-grants), Africa 2000 Network will soon start the activities of plantation of bamboos on 2 km around Cohoha Lake. This is a transboundary project common to both Rwanda and Burundi.

The activities of ***fighting against soil erosion*** are done within the framework of the anti-erosive Campaign of the Ministry for Public Works and Environment and Land Use through the Department of the Agricultural Engineering and Protection of the Real Estate.

[1] Umuganda : Mobilization of the community for manual work of public interest Activities such as the rehabilitation of roads, fighting against erosion, afforestations are generally carried out within the framework of Umuganda. Now, Umuganda takes place every last Saturday of each month (MINAGRI, 2006).

But in Cohoha sub-basin, the interventions of this department are very limited. It is however necessary to note the isolated actions of Catholic Relief Service (CRS) of installing contour lines in favour of the populations of Marembo, in the South-East of Cohoha Lake.

In Burundi, the zero-grazing system is very premature. ***Divagation of the cattle*** remains dominant. Herds of cows are still led towards the marshes and the vegetation of Murehe where the negative effects by trampling are manifest.

In the field of marsh installation, it is the Department of Agricultural Engineering and Protection of the Real Estate which undertook activities of drainage of the marshes of Akanyaru River. In order to fight against the draining of the marshes, buffer zones of 600 m width are delimited and left intact during the drainage. These are the buffer zones that must retain water to be used for agriculture during the various farming seasons.

In the field of conservation, the National Institute for Environment and Conservation of the Nature (INECN) has recently undertaken a study of identification for the creation of the "Protected Aquatic Landscape of Bugesera". This Landscape includes all the marshy complex of the North of Burundi and the associated natural hills. With this protection, INECN aims at "maintaining natural characteristic landscapes of national importance, of harmonious interaction between man and land, while giving to the public the possibility of enjoying, through activities of leisure and tourism, normal way of living and economic activity of these areas. These are mixed, natural and cultural landscapes having a raised aesthetic value where the traditional modes of land use are maintained" (Nzigidahera and Al., 2005).

In the considered protection system, Cohoha Lake and the associated marshes are classified as a "*Natural Managed Reserve*" in the sense of IUCN (1994), whose global objective is: "To guarantee the maintenance of the natural conditions necessary for protecting species, groups of species, biological communities or physical features of national importance when their perpetuation can require a specific intervention of man. Controlled extraction of certain resources can be authorized". The management objectives are:

- Conservation and improvement of the biological conditions of the lake biodiversity and the associated marshes;
- Integration of the interests of the population by a rational exploitation of the resources of these lakes;

Management activities to be undertaken;
- To delimit and establish 50m-belts starting from the edge of the lakes;
- To ensure a monitoring of crossing points and transport in general;
- To organise the fishermen in associations around a system of sustainable fishing;
- To organise the sustainable exploitation of *Cyperus papyrus* and other marsh grasses.

The vegetable formation of Murehe is classified in the category of "*Integral Natural Reserve*" whose objective is: "To protect nature and to maintain the natural processes in a pristine state in order to have representative examples of the natural environment for scientific studies, the continuous monitoring of the environment, education and the maintenance of genetic resources in a dynamic and evolutionary state" (IUCN, 1994). It aims at conserving intact vegetable associations and regenerating the degraded vegetation and protecting the endangered animals and their milieus of life.

In order to operationalise this plan of conservation, INECN has set up a staff for the management of this landscape with a body of 26 rangers distributed on all the lakes and the Reserve of Murehe. Materialisation of the limits of the Reserve of Murehe is on-going under the financing of the NBI (eligible project). It is worth noting that Rwihinda Lake is already regarded as a Ramsar site.

IV.1.3.2. Critical analysis of on-going interventions

When thoroughly analyzing the activities undertaken for the protection of Cohoha sub-basin, one notices a clear difference between the two countries. In the field woodlots, the protective strip installed in the Rwandan part does not exist yet in Burundi. Similarly, the vision of protecting the lake buffer zone is not conceived in the same way as in Burundi. Burundi claims to install a 50 m-line limit on the edge of the lake like that which was already made on Rwihinda Lake. This is in fact a line of plantation aiming at visualising the limits of the fields of the population and the zone to be subjected to protection in order to allow regeneration of the edge vegetation. This case is quite different from that of Rwanda where the 50m-band of plantation does not aim at protecting the edge vegetation. Indeed, over all its length, as far as topography allows, the zone between the edge of the lake and the band is cultivated. Moreover, in several localities, the crops are installed under the trees of the band of plantation considered as agro-forestry species. Here, one will thus understand that the band of plantation does not play an effective role in protecting Cohoha Lake.

In the field of fighting against soil erosion, there is a clear difference between Rwanda where hills bordering the lake have ditches and terraces of protection compared to the non-protected soils with intense erosion in Burundi. This is also the case for the divagation of cattle which is allowed in Burundi and banished in Rwanda.

In the field of marsh installation, the system of buffer zones installed in Burundi does not exist in Rwanda. This creditable action remains unfortunately opportune owing to the fact that these buffer zones are now encroached for agriculture and do not play any more their role of maintaining the hydrous balance. One could also wonder whether the 15 bands, of 600 m width each, which are installed in the whole valley of Akanyaru are enough to maintain the ecological balance on the entire Cohoha sub-basin.

In the field of conservation, the Aquatic Protected Landscape system being built in Burundi remains ignored in Rwanda.

As a whole, there is a difference between the two countries in the interventions of protecting Cohoha sub-basin. One noticed that there exist in these two countries efforts of protection which deserve to be shared and reinforced. Given the transboundary aspect of Cohoha sub-basin and in order to better protect it, the following actions are required:

- *Harmonisation of the interventions aiming at safeguarding the whole marshy system of Bugesera;*
- *Definition of a common vision and options to protect the marshy system of Bugesera;*
- *To work out a transboundary strategic plan adopted at the highest political level and set up a common structure for its implementation.*

IV.2. Proposed vegetation management guidelines

IV.2.1. Guiding principle

The conservation of the lakes, the marshes and the thickets and savannahs of Bugesera is a need for an area which frequently knows imbalances of climatic, hydrological and ecological nature. For this, it is of most important to take effective and efficient measures for the protection and the conservation of these natural ecosystems and to integrate the conservation and protection into the adapted policies, e.g. tourism, agriculture, fisheries policies, etc.

Joint efforts between Rwanda and Burundi to protect and preserve the transboundary ecosystems of Bugesera are not provided yet. These spaces must thus be provided and delimited in order to benefit from a special statute related to a common policy of sustainable management.

The recognition of these ecosystems as a shared natural and cultural heritage, as well as their ecological value and the functions that they play for man and nature is an important step for the protection of the ecologically significant sites, which play a crucial part on the environment in the region.

The intensive use that the local populations make of the lakes, terrestrial marshes and ecosystems means that the populations must be involved in the design and implementation of measures of environmental conservation and monitoring. These systems of management and multiple uses by local communities are part of the most effective means of protecting the natural resources which abound in the Bugesera ecosystems. If this local support is missing, it is not very probable that measures of conservation produce expected results in the long term.

IV.2.2. Systems of installation on arable land

Most of the slopes of hills are already used for agriculture. As a result, the natural ecosystem in this place is not great value. Consequently the impact of this absence of terrestrial ecosystem is felt both on the hills and the valleys. There are several already existing preventive technical methods in the course of introduction which can be used as model. The prevention of erosion of soils by contour lines, the afforestation and the agro-forestry can easily be installed. A great need to take into account the introduction of afforestation as one of the components of development is felt in this area of Bugesera. Considering that certain vegetable species are in regression following their participation in varied uses, it is of primary importance to promote forestry based on local species of undeniable economic and ecological importance.

IV.2.3. Systems of developing the natural ecosystems

The anarchistic exploitation of lands up to the immediate edge of the lakes and the recourse to the traditional farming practices on the basins slopes of the hills overhanging the lakes are important factors which threaten their biodiversity and the level of water. This results into the need to establish a 50 m-belt of protection of the edge of Cohoha Lake. This belt must aim at regenerating the maintenance of the vegetation of edge. This zone requires a real protection by prohibiting any activity at its interior. The safeguarding of the integrity of the vegetation of Gasenyi, the valley of Akanyaru and other marshy zones is inevitably essential. Delineation of a common zone of thickets to be protected in Bugesera will make it possible to save what remains of this endangered vegetation.

The idea of the creation of the “Aquatic Protected Landscape” in Burundi should be supported and reinforced. Moreover, Rwihinda Lake already profited from a status of protection as a “Ramsar Site”. Similarly, the Rwandan Government intends to establish some Ramsar sites in this District of Bugesera (MINAGRI, 2006). It is thus of primary importance that Cohoha Lake and the valley of Akanyaru are placed under this status. This will make it possible to preserve a transboundary site of ecological, hydrological and climatic importance for the survival of all the marshy system of Bugesera. The rationale of this statute is that it can in no case enter in contradiction with the other possible protection systems. It could for instance reinforce the “Protected Aquatic Landscape” envisaged in Burundi.

Any creation of a protected area requires beforehand the installation of a legal mechanism which governs it. Moreover, the success of the implementation of the legislation as regards conservation requires a rigorous assistance on behalf of the local authorities, and the adhesion of the populations to all these creative steps. This will be realisable only thanks to the support of all local and external partners.

IV.2.4. Preventive action against invasive plants

The water Hyacinth, *Eichhornia crassipes*, which is found throughout the marshes of Rweru Lake and Akagera River, constitutes a serious threat for their biological resources and the fishing activities in the whole basin. Among the harmful effects of the Hyacinth, one can quote the deterioration of the water quality since it covers water and leads to the reduction of the quantity of dissolved oxygen, pH and the temperature; the direct result is the reduction and disappearance of the biodiversity of affected water.

Considering its fast expansion, it is very probable that Cohoha Lake, which is currently pristine, is likely to be affected very soon. The eradication of this plague in the marshy system of Bugesera requires efforts of all the countries. In the current state, one needs sensitising the whole populations with a view to prevent the expansion of this invading plant in Cohoha Lake.

The expansion of *Lantana camara*, invading plant par excellence, passes unperceived to the eye of man who apparently regards it as a local plant. However, the supplantation of the local species by this exotic plant is very manifest in all the region of Bugesera. With the current rate of this invasion, one could say that within 10 years, the plant will have eliminated all the local species and conquered every space. It is most important that very serious efforts be deployed to eradicate the spreading of this plant.

IV.2.5. Rational use of the vegetable resources

The effective protection of Cohoha sub-basin must inevitably take into account the various socio-cultural and economic aspects of the vegetable resources. The exploitation of various vegetable species for the manufacturing of various objects must be developed. In order to rationalize the cuts, one needs studies leading to management plans for these resources. For the very vulnerable vegetable resources, it is necessary to envisage the setting in culture of certain local species undeniable interest. Other activities at lower cost, especially the introduction of improved stoves could take part in the reduction of the quantities of wood consumed for cooking.

IV.3. Legal and Institutional Arrangements

Since the question of Cohoha sub-basin is transboundary, the effort to protect this area will have to be also a concern of higher authorities of two countries. This consideration shows with sufficiency that protecting ecosystems of sub-basins must start with the resolution of the major constraints likely to impede this activity. Initially, the various actors must be identified and involved in the action. Then, a framework of cooperation accompanied by a law must be installed between Burundi and Rwanda.

IV.3.1. Identification of the various stakeholders

IV.3.1.1. Identification of stakeholders in Burundi

Biodiversity, being a cross-cutting issue, involves several ministries, i.e. the Ministry for Public Works and Environment and Land Use; the Ministry for Agriculture and Livestock; the Ministry for Trade and Industry; the Ministry for Energy and Mines and the Ministry for National Education and Culture. However, the responsibilities to coordinate and carry out the activities aiming at facing the principal challenges related to the biodiversity belong mainly to two ministries, namely the Ministry for Public Works and Environment and Land Use (MINATETAP) and Ministry for Agriculture and Livestock.

The MINATETAP is responsible for designing and carrying out the national policy as regards environment and land use, especially defining and implementing the suitable policies for land use, the protection and the conservation of water, soils and the biodiversity.

The mandate of protecting the biodiversity is carried out within the General Directorate of Forestry, Tourism and the Environment (DGFTE) that deals with artificial woodlots and the National Institute for Environment and Conservation of the Nature (INECN) that deals with the natural ecosystems.

The Ministry for Agriculture and Livestock is in charge of the development and the implementation of the agricultural policies (extension and research). Provincial Directorates of Agriculture and Livestock (DPAEs) under the Directorate-General of Mobilisation for Self-Development and Agricultural Extension (installed in each province), constitute decentralized instruments which implement, with the local government and the populations, the policies in connection with agriculture and livestock. The Institute of Agronomic Sciences of Burundi (ISABU) is the publicly-owned establishment attached to this Ministry, which is specialised in agronomic research.

In the field of biodiversity, these two ministries are supplemented by the University of Burundi, particularly the Faculty of Agronomy (FACAGRO) and the Faculty of Science under the Ministry for National Education and Culture. They are also supported by the Institute of Agronomic and Zootechnical Research (IRAZ) set up within the framework of the Economic Community of the Great Lakes Countries (CEPEGL) for Burundi, the Democratic Republic of Congo and Rwanda.

In addition to the Ministries and Public Institutions, several national and International Non-Governmental Organizations (CRS, FAO, UNDP, IFAD, etc) take part in the implementation of the national policies of protection and management of the biodiversity.

At the local level, it is the provincial administration which is the leader of development activities, but the development and implementation of development programs are carried out by communes. For the precise case of Cohoha sub-basin, the interveners are particularly the provincial Administration and the riparian communes. Technically speaking, these administrative structures are supported by Provincial Directorates of Agriculture and Livestock (DPAEs) and the Office of the INECN in charge of the Protection of the "Aquatic Protected Landscapes of Bugesera". The field of woodlots is supervised by the Provincial Inspection of Forests. Several national and local NGOs (Association for the Protection of Birds in Burundi, Africa 2000 Network, Green Belt Action Association, etc) are working in the sector of the environment and agriculture.

The interventions carried out by these various actors are mainly under the external financing by FAO for the drainage of the marshes, the World Bank through PRASAB Project for the activities of drainage of the marshes and delineation of Rwihinda and Gacamirinda lakes.

IV.3.1.2. Identification of the stakeholders in Rwanda

National structures for the management of lands and environment were installed in Rwanda. The field of the Environment falls within the competence of the Ministry for Lands, Environment, Forests, Water and Natural Resources MINITERRE. It is supported by the Rwandan Environmental Management Authority (REMA).

The field of Agriculture and the Livestock falls within the competence of the MINAGRI whose role is to formulate policies and strategies for the operational programs of the "Agricultural Transformation Strategic Plan" with the local authorities at the decentralized levels. The MINAGRI is also responsible for planning, coordination, monitoring, and evaluation and reporting.

The Institute of Agronomic Sciences of Rwanda (ISAR) supports the MINAGRI and aims at promoting the scientific and technical development of agriculture and animal resources in Rwanda.

Under the patronage of the MINAGRI, the Rwandan Agency of Agricultural Development (RADA) has the role of reinforcing the additional activities of the farmers, including the improved practices of commercial farming.

Regarding decentralised operations, it is the central Government which must set up national policies and programmes, mobilise the local and external resources, ensure institutional capacity building and the monitoring and evaluation. The provincial Administration, as a decentralized entity of the Central Government, must above all check that the development plan of the local government corresponds to the national policies and promotes the socio-economic development of the Province based of its own resources. The District is a legal entity responsible for the general coordination of the economic development, planning, financing and implementation of the services at the level of Sector, as well as promotion of cooperation with the other local governments. The Sector coordinates the activities of the Cells and ensures the management of some basic services such as developmental planning, collection of local taxes, statistics, education and social affairs, land use planning, the habitat and other local infrastructures, etc. The Cell is mainly focused on the action for community mobilisation.

In Bugesera, there is a unit responsible for land titles, town planning, habitat and infrastructures in the District of Bugesera. This unit includes consists of the Director of the Unit, the Officer for Infrastructure and an Officer for the Environment and the Natural Resources (MINAGRI, 2006).

IV.3.2. Installation of a joint institutional and legal framework

Through the various analyses made in the natural environmental management in the Cohoha sub-basin, differences and contradictions in the interventions between the countries appeared. Moreover, it was noted that the safeguarding of the Cohoha sub-basin requires a framework of collaboration between the two countries around a shared vision with the implication of all the actors.

Initially, an agreement should be signed between the two Republics aiming at the joint protection of the sub-basin of the lake but also of the whole marshy system of Bugesera. This agreement, once signed, should be placed under the responsibility of the Ministries responsible for the environment and agriculture in both countries. These are the ministries which would have to set up a structure (the Bugesera Marshy System Transboundary Council) consisting of all the stakeholders at the ministerial provincial (District), communal (Sector) level, including the private sector). This council would be under the supervision of the Ministry responsible for the environment. This council would have the following mission:

- To conduct activities of development and validation of a strategic Plan of Conservation of the Bugesera marshy system and to make it adopted by the highest level;
- To mobilise the financial resources for the installation of this plan;
- To make joint visits for the evaluation of the state of implementation of the Strategic Plan.

A Strategic Plan of Conservation of the Bugesera marshy system should not be an action plan or a work program. It is a document of policy fixing a shared vision, strategic objectives and joint orientations. It must also include the mechanism of its implementation by highlighting particularly the methods of financing. This document with very simplified structure must rather be precursory to several other planning documents and control programs for the natural resources in the region.

Secondly, a local operational structure must be installed in each country for the implementation of the strategic plan. This structure is a local council of monitoring and evaluation of the intervention carried out by the ordinary services of agriculture, environment, the NGOs, etc. This council will include the persons in charge for the various services involved on the ground, including representatives of the local communities.

To be sustainable, the Strategic Plan and the councils to be set up should be supplied with a similar law for the two countries. This law could also extend on the practical methods of management and installation with a precise aim to avoid possible contradictions compared to other internal laws in connection with the same natural resources. It must also include key element of environmental impact assessment.

CONCLUSION AND RECOMMANDATIONS

This study of the Cohoha sub-basin vegetation shows the existence of vegetation of the terrestrial environment and that of the wetlands. The terrestrial vegetation relates to the xerophilous thickets of Gasenyi forming continuous vegetation connecting the vegetation of the military field of Rwanda and the vegetation of the Natural Reserve of Murehe in Burundi. The wetlands include primarily the marshes and some submerged plants on the Cohoha Lake and Akanyaru River.

As a whole, the vegetation of the Cohoha sub-basin is very anthropic. The presence of man is marked by crops installed from the immediate edges of Cohoha Lake and Akanyaru River by the elimination of the marshes, to the hills by the deforestation of terrestrial vegetations. There is no strict zone of natural transition between the aquatic vegetation and that of firm grounds following the agricultural activities installed in the semi-aquatic zones.

To the ecological point of view, the lengthened and dendritic shape of Cohoha Lake makes it possible for a major part of the riparian population to have aquatic water and other resources and allows soil moistening on a very great surface. The marshes of Cohoha sub-basin constitute barriers against the alluvia and colluviums coming from the neighbouring hills and an important centre of purification for water running towards all the lakes. They also ensure the essential conditions to perpetuate a great diversity of vegetable and animal species.

The first ecological role of the thickets of Murehe is related to its xeric nature as vegetation adapted to the conditions of the most severe aridity of an area with forestry vocation. The thickets of Bugesera also form "micro-habitats" having worked a particular microclimate for a generally clean fauna. Their position on the hills fights against erosion and finally protects agriculture from bottoms valleys.

From the socio-economic point of view, it was noted that the ecosystems of Bugesera include several vegetable species taking part in several uses such as firewood, cooking, pharmacopoeia, house construction, the manufacture of various tools including dugouts, mortars and rammers and basket making. The participation of marshy dominant grasses in basket making constitutes a source of income for several households.

However, the massive deforestation of all the hills and the drainage of the marshes put in danger several extents and species. The case of erosion on the slopes is amplified in Burundi where the contour lines remain rare. The non-controlled drainage of the marshes led to the reduction in the capacity of water retention in the papyrus fields. This adds to the increasing climate disturbances and the progressive reduction of the natural water reserves in the region.

Everything leads to consider that the marshes of the Akanyaru and the vegetation of the edges of Cohoha Lake require an integral protection with the aim of protecting the entire Bugesera marshy system. Burundi and Rwanda should sit together and develop a joint unique system of conservation of these ecosystems taking into account the traditional methods of use of the biological resources.

Existing laws and the signed environmental international conventions give right to Rwanda and Burundi to operate a judicious choice to preserve, in cooperation, the fragile zones of the Cohoha sub-basin. The preservation of these ecosystems should also be based on the actions in progress. Having already noted that there is a difference between the two countries in the interventions of protection of the Cohoha sub-basin, a whole set of prior actions are necessary, particularly their harmonisation and the definition of a shared vision. This requires an effective framework of cooperation for the Conservation of the Bugesera marshy system.

The situation of Cohoha sub-basin vegetation invites to make the following recommendations:

a) Considering the socio-economic and cultural value of the Cohoha sub-basin vegetable resources, it is recommended for the two countries to:

- set up management plans for rational exploitations;
- begin research activities for the setting in culture of these resources;
- identify alternatives for very fragile biological resources.

b) Considering the current state of degradation of the Cohoha sub-basin vegetation, it is recommended that:

- All the countries reinforce the conservation of the Cohoha Lake and the marshes of Akanyaru by the halting of farming activities and delineation of the buffer zone;
- Burundi carries out the delineation of the buffer zone;
- Rwanda stops the farming installed between the band of plantation and the edges of the lake to allow the regeneration of the buffer zone;
- Burundi quickly takes protection measures of the Natural Reserve of Murehe by implementing the objectives of protection of the "Bugesera Aquatic Protected Landscape".

c) Considering the transboundary nature of the issue of protecting the Bugesera marshy system, it is recommended for the two countries to:

- design a framework of agreement aiming at the shared protection of the Bugesera marshy system;
- develop a strategic plan together with a law for the conservation of the Bugesera marshy system
- set up a M&E structure for all the interventions;
- analyse the various interventions carried out with an aim to harmonise;
- develop a shared programme to eradicate invading plants;
- develop a shared model of environmental assessment for any action in the region;
- set up a system of eradication and monitoring of the invading plants.

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ANNEX :

Table : List of inventoried floristic species

Species	Kirundi or Kinyarwanda Names	Families
Abutilon mauritianum		
Acacia hockii	Umugenge	Mimosaceae
Acacia polyacantha	umugunga	Mimosaceae
Acacia polyacantha	Umugunga	Mimosaceae
Acacia sieberana	Umunyinya	Mimosaceae
Acalypha bipartita	Umugese	Euphorbiaceae
Acanthus pubescens	Igitovu	Acanthaceae
Achyrantes aspera		Acanthaceae
Acokanthera schimperi	umusagwe	Apocynaceae
Aerva lanata	Akamongo	Amarantaceae
Ageratum conyzoides	Akarura	Asteraceae
Agrocharis incognita		Apiaceae
Albizia adianthifolia	Umusebeya	Mimosaceae
Albizia versicolor	Umububa	Mimosaceae
Allophyllus africanus	Umuvumereza	Sapindaceae
Aloe bukobana	Inkakarubamba	Liliaceae
Aloe macrosifon	Inkakarubamba	Liliaceae
Amaranthus viridis		Amaranthanceae
Annona senegalensis	Umukanda	Annonaceae
Apolytes dimidiata	Umusivya	Icacinaceae
Arundinaria alpina	Umugano	Poaceae
Asparagus africanus	Umusaba	Asparagaceae
Asparagus falcatus		Asparagaceae
Asparagus flagellaris	Umunsabe	Asparagaceae
Aspilia africana	Icumwa (Icyumwa)	Asteraceae
Asystasia gangetica		Acanthaceae
Azolla pinnata		Azollaceae
Bambekea racemosa		Cucurbitaceae
Bidens pilosa	Icanda	Asteraceae
Bridelia micrantha	umugimbu	Euphorbiaceae
Bridelia scleuroneura	umurembera	Euphorbiaceae
Caesalpinia decapetala	Umubambangwe	Mimosaceae
Canthium lactescens		Rubiaceae
Canthium schimperanum	Umukiragi	Rubiaceae
Canthium sp.		Rubiaceae
Capparis erythrocarpus	Uruzira	Capparaceae
Capparis fascicularis	Uruzira	Capparaceae
Caraluma schweinfurthii		Asclepiadaceae
Cardiospermum halicacabum		Sapindaceae
Carisa edulis	Umunyonza	Apocynaceae
Cassia accidentalis	umuyokayoka	Caesalpiniaceae
Cenchrus ciliaris		Poaceae
Centella asiatica		Apiaceae
Chlorophytum sparsiflorum		Liliaceae
Cissampelos mucronata		Menispermaceae

Species	Kirundi or Kinyarwanda Names	Families
Cissus oliveri	Umugobore	Vitaceae
Clausena anusata	Umutana	Rutaceae
Clerodendrum myrcoides	Umunyankuru	Verberaceae
Combretum collinum	umukoyoyo	Combretaceae
Combretum molle	umurama	Combretaceae
Commelina benghalensis	Inteza	Commelinaceae
Commelina elgonensis	Ikiteja	Commelinaceae
Commiphora africana	Umudahwera	Burseraceae
Conyza sumatrensis		Asteraceae
Cordia africana	umuvugangoma	Boraginaceae
Crabbea velutina		Acanthaceae
Crassocephalum montuosum	Igifurufuri	Asteraceae
Crassocephalum sp.		Asteraceae
Cynanchum schistoglossum		Asclepiadaceae
Cynanchum validum		Asclepiadaceae
Cynodon nlemfuensis		Poaceare
Cyperus articulatus	Ubumburi	Cyperaceae
Cyperus dives	Ikigaga	Cyperaceae
Cyperus laevigatus	Indava	Cyperaceae
Cyperus latifolius	Urukangaga	Cyperaceae
Cyperus longibracteatus var. *longibracteatus*		Cyperaceae
Cyperus papyrus	urufunzo	Cyperaceae
Cyperus sp.		Cyperaceae
Cyperus sumatrensis		Cyperaceae
Cyphostemma adenaucole		Vitaceae
Cyperus papyrus	Urufunzo	Cyperaceae
Dactyloctenium aegyptium		Poaceae
Dalbergia nitidula	Umuyigi	Fabaceae
Desmodium salicifolium var. densiflorum		Fabaceae
Dichrostachys cinerea	Umukamba, Uruhago	Mimosaceae
Digitaria abyssinica		Poaceae
Dodonea viscosa	Umusasa	Sapindaceae
Dovyalis macrocalyx	Umushubi	Salicaceae
Dryopteris gongylodes (Thelypteris interrupta)		Thelypteridaceae
Echnochloa colona		Poaceae
Eleusine indica	Urwamfu	Poaceae
Entada abyssinica	Umusange	Mimosaceae
Eragrostis sp.		Poaceae
Erythrina abyssinica	Umurinzi	Fabaceae
Erythroccoca bongensis	Umutinti	Euphorbiaceae
Euclea schimperi	Umucekeri	Ebeniaceae
Euphorbia candelabrum	Igihahe	Euphorbiaceae
Euphorbia dawei	Umurara	Euphorbiaceae
Euphorbia genuculata		Euphorbiaceae
Ficus thonningii	Ikivumu	Moraceae

Species	**Kirundi or Kinyarwanda Names**	**Families**
Ficus vallis-chaudae	Igikuyu	Moraceae
Galinsoga parviflora	Kurisuka	Asteraceae
Gardenia imperalis	umugondo	Rubiaceae
Gardenia ternifolia subsp. *jovis-tonantis*	Umuterama	Rubiaceae
Gongonema angolense		Asclepiadaceae
Grewia mollis	Umugeregere	Tiliaceae
Grewia similis	Umukoma	Tiliaceae
Haphocoelum gallaense	Umujwiri	Sapindaceae
Harrisonia africana	Umuganzacaro	Rutaceae
Helinus mystacinus	Umubimbafuro	Rhamnaceae
Hemarthria natans		Poaceae
Hibiscus diversifolia	Umukururantama	Malvaceae
Hydrocotyle ranunculoides		Apiaceae
Hyparrhenia filipendula		Poaceae
Hyppocratea africana		Hyppocrateaceae
Indigofera arrecta	Umusorora	Fabaceae
Indigofera sp.	Umusorora	Fabaceae
Indigofera zenkeri		Fabaceae
Ipomea cairica	Umudandaranda	Convolvulaceae
Ipomea rubens	Inkoba	Convolvulaceae
Ipomea sp.		Convolvulaceae
Jasminum dichotomum		Oleaceae
Jasminum fluminense		Oleaceae
Justicia cf. *ruwenzoriensis*		Acanthaceae
Justicia uncunilata		Acanthaceae
Kalanchoe integra	ikizirankugwa	Crassulaceae
Kigelia africana	Umuremera	Bignoniaceae
Kyllinga sp.		Cyperaceae
Lagenaria abyssinica		Cucurbitaceae
Landolphia kirkii	Umubungobungo	Apocynaceae
Lannea schimperi	Umumuna	Anacardiaceae
Lantana camara	umuhengerihengeri	Verbenaceae
Lantana rhodesiensis		Verbenaceae
Lemna rwandensis		Lemnaceae
Ludwigia leptocarpa		Onagraceae
Ludwigia stolonifera		Onagraceae
Maerua angolense		Capparaceae
Maerua triphylla ssp. jahannis		Capparaceae
Maesopsis eminii	Umuguruka umuremvya, umuhumuro	Rhamnaceae
Mariscus longibracteatus var. *longebracteatus*		Cyperaceae
Mariscus sumatrensis		Cyperaceae
Markhamia lutea	Umusave	Bignoniaceae
Markhamia obtusifolia	Umukundambazo	Bignoniaceae
Maytenus arbutifolia	Umugunguma	Celastraceae
Maytenus heterophylla	Umusongati	Celastraceae
Maytenus senegalensis	Umweza	Celastraceae
Melinis minutiflora	Ikinyamavuta	Poaceae

Species	Kirundi or Kinyarwanda Names	Families
Nymphea lotus	Irebe	Nympheaceae
Nymphea nouchalii	Irebe	Nympheaceae
Ochna schweinfuthiana	Umuryago	Ochnaceae
Ocimum cf. *basilicumhn*		Lamiaceae
Oldenlandia goreensis		Rubiaceae
Oldenlandia herbacea		Rubiaceae
Olea africana	Umunzenze	Oleaceae
Orchidaceae sp.	-	Orchidaceae
Osyris lanceolata	Umuyivyi	Santalaceae
Oxalis corniculata		Oxalidaceae
Oxygonum sinuatum	Agahandanzovu	Polygonaceae
Ozoroa reticulata	Ngubwa, Umukerenki	Anacardiaceae
Panicum heterostachyum		Poaceae
Panicum humidicola		Poaceae
Panicum maximum		Poaceae
Panicum sp.	Urwiri rwomurufunzo, Umudihidihi	Poaceae
Pappea capensis	Umumena	Sapindaceae
Parinari curatelifolia	Amanazi	Chrysobalanaceae
Paullinia pinnata	Umunyakagongo	Sapindaceae
Pavetta assimilis		Rubiaceae
Pavetta imperialis	Umugondo	Rubiaceae
Pavetta oliverana		Rubiaceae
Phoenix reclinata	igisandasanda	Arecaceae
Phragmites mauritianus	Amarenga (Umuseke)	Poaceae
Phyla nodiflora		Verbenaceae
Phyllantus odontadenius		Euphorbiaceae
Phytolocca dodecandra	umwokora	Phytolaccaceae
Pistia stratiotes		Araceae
Pittosporum spathicalyx	Umunyerezankende	Pittosporaceae
Plectranthus barbartus	Igicuncu	Lamiaceae
Polygonum pulchrum	Igorogonzi	Polygonaceae
Polygonum salicifolium	Igorogonzi	Polygonaceae
Polygonum strigosum	Igorogonzi	Polygonaceae
Pupalia lappacea		Amaranthaceae
Pycreus capillifolius		Cyperaceae
Recinum communis		Euphorbiaceae
Rhoicissus tridentata		
Rhus longipes	Umusagara	Anacardiaceae
Rhus natalensis	Umusagara	Anacardiaceae
Rhus vulgaris	Umusagara	Anacardiaceae
Rhynchelytrum repens		Poaceae
Rhynchosia resinosa		Fabaceae
Rytigynia monantha		Rubiaceae
Sansevieria dawei		Liliaceae
Sarcostemma viminale	Umunyari w'ishamba	Asclepiadaceae
Schrebera alata	Umubanga	Oleaceae
Scutia myrtina	Umugasa	Rhamnaceae
Securidaca longepedunculata	umunyagasozi	Polygalaceae

Species	**Kirundi or Kinyarwanda Names**	**Families**
Securinega virosa	Umubwirwa	Euphorbiaceae
Senecio hadiensis	Icegera	Asteraceae
Sansevieria cylindrica		Euphorbiaceae
Sesbaria sesban var. *nubica*	umunyegenyege	Fabaceae
Sida alba		Tiliaceae
Sida diversifolia		Tiliaceae
Smilax kraussiana	umusuri	Smilaceae
Solanum nigrum	isogo	Solanaceae
Sorghum arundinacea		Poaceae
Spermacoce princecae		Rubiaceae
Spirodela polyrhiza		Lamnaceae
Stereospermum kunthianum	uminaniranzovu	Bignoniaceae
Strychnos innocua	Amahonyo	Loganiaceae
Strychnos lucens	Amahonyo	Loganiaceae
Strychnos spinosa	umukome	Loganiaceae
Synadenium grantii	umukoni	Euphorbiaceae
Tagetes minuta		Asteraceae
Teclea mobilis	Umuzo	Rutaceae
Teclea trochocarpa		Rutaceae
Tephrosia nana		Fabaceae
Themeda triandra		Poaceae
Thunbergia alata	Iganzamwonga	Acanthaceae
Tribulus terrestris		Zygophyllaceae
Trichodesma zeylanicum		Boraginaceae
Triumfetta rhomboidea		Malvaceae
Triumfetta tomantosa		Malvaceae
Triumphetta diversifolium		Malvaceae
Typha domingensis	Umubere (Umuberanya)	Typhaceae
Utricularia stellaris		Utriculariaceae
Uvaria angolensis	Umuvyindira, Umuzirampfizi	Annonaceae
Vernonia amygdalina	Umubirizi	Asteraceae
Vernonia perrotteti		Asteraceae
Vernonia sp.		Asteraceae
Vitex doniana	Umuvyiru	Verbenaceae
Vossia cuspidata		Poaceae
Ximenia caffra	Amasasa, (Mushereke), umunyonza	Olacaceae
Zanthoxyllum chalybeum	Igugu	Rutaceae
Zizyphus mucronata	Imikugutu	Rhamnaceae