

PART 2: STATE OF THE ENVIRONMENT

CHAPTER 5: BIODIVERSITY AND GENETIC RESOURCES

Current state of biodiversity

Biodiversity can be defined as the variability of life expressed at the ecosystem, species and genetic levels. It provides a large number of goods and services that sustain our lives. Biodiversity is the combination of life forms and their interactions with each other and with the rest of the environment that has made the earth a uniquely habitable place for humans ([SCBD 2000](#)). The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans.

Although Rwanda is a small country, it has a remarkable variety of ecosystems and of flora and fauna. Its location at the heart of the Albertine Rift eco-region in the western arm of the Africa's Rift Valley is a contributory factor. This region is one of Africa's most biologically diverse regions. It is home to some 40 per cent of the continent's mammal species (402 species), a huge diversity of birds (1,061 species), reptiles and amphibians (293 species), and higher plants (5,793 species) ([Chemonics International Inc. 2003](#), [MINITERE 2005](#)).

Ecosystem and habitats

The Albertine Rift is considered to have the highest species richness in Africa. It is considered a biodiversity hotspot containing more endemic mammals, birds, butterflies, fish and amphibians than anywhere else in Africa. Habitats supporting such an array of biodiversity are very varied. Being at the heart of the Albertine Rift, Rwanda's habitats are equally varied, ranging from afro-montane ecosystems in the northern and western regions to lowland forests, savannah woodlands and savannah grasslands in the southern and eastern regions. There are other habitats around volcanic hot springs and old lava flows, especially in the northern and western part of the country. Rwanda also has several lakes and wetlands which are rich in different species. Though not yet well surveyed, all these ecosystems host a rich variety of fauna and flora and micro-organisms.

Besides these natural ecosystems, as an agrarian country, Rwanda agro-ecosystems comprise cultivated land, agro-pastoral areas, grassland, grazing and fallow land ([MINITERE 2003a](#)).

Species Diversity

Flora

Rwanda harbours very diverse flora due to a considerable geo-diversity and a climatic gradient from west to east. The number of vascular plants is estimated at around 3000 species originating from the different bio-geographical regions ([Fischer and Killmann 2008](#)).

Rwanda constitutes the eastern limit for plants from the Guineo-Congolian region. An example of these plants is the *Thonningia sanguinea* (Balanophoraceae), widespread in Western and Central Africa. It is only found in the Cyamudongo forest in western Rwanda. Plants from the afromontane region are confined to higher altitudes, such as the orchid *Disi robusta* found in Nyungwe forest. The Eastern African savannah elements comprise the Zambezi floral region, and most these plants are found in the Akagera National Park and its surroundings ([Fischer and Killmann 2008](#)).

About 280 species of flowering plants from Rwanda are considered to be endemic to the Albertine Rift. Of these endemic species, about 20 are restricted to Rwanda, 50 species confined to Rwanda and Eastern Congo and 20 species found only in Rwanda and Burundi. Twenty one species are found additionally in the forests of western Uganda, eastern Congo, Rwanda and Burundi. Examples of these distribution types are *Impatiens bequaertii* (Balsaminaceae), *Impatiens mildbraedii* (Balsaminaceae), *Monathotaxis orophila* (Annonaceae) or *Liparis harketii* (Orchidaceae) (Fischer and Killmann 2008).

Rwanda has 56 local endemic flowering plants, out of which 47 are confined to Nyungwe National Park (including Cyamudongo forest). Examples of these plants are the recently discovered species *Impatiens nyungwensis* Eb.Fisch., Detchuvi & Ntaganda, (Balsaminaceae) *Afromomum wuertii* Dhetchuvi & Eb. Fisc (Zingiberaceae), *Diaphananthe delepierreana* Lebel & Geerinck (Orchidaceae) and *Ypsilopus liae* Delpierre and Lebel (Orchidaceae) all endemic to Nyungwe National Park (Fischer and Killmann 2008). The number of these newly discovered species shows that the number of plant species found in Rwanda is far from being totally known.

The afro-montane ecosystems comprised of the Volcanoes and Nyungwe National Parks, Gishwati and Mukura Natural Forests, and other small forests found at the Congo-Nile Ridge, is varied and rich in plant species.

The biodiversity in the lowlands of the eastern part of Rwanda comprises mainly savannah with grasses, bushes and trees, mountain rainforests in the Akagera National Park and gallery forests in the eastern part of Rwanda. Gallery forest around lakes and other water bodies are mainly found in the Akagera complex, where they cover almost 163 hectares (Twarabamenye and Gapusi 2000 in MINITERE 2003a). The flora of these forests comprise 66 species including *Acacia kirkii*, *Acaccia polycantha*, *Acacia sieberana*, *Albizia gummiifera*, *Cordia Africana*, *Crotonmacrostachis*, *Dombeya burgessia*, *Dombeta kirkii*, *Erythria absysniica*, *Newtonia buchananii* and *Techlea nobilis*. There are also some rare or threatened species such as *Impantiens irvingii*, *Markhamia lutea*, *Eulophia guineensis* and *Pterygota mildbraedii*, considered a fossil plant (MINAGRI 1998).

An Acacia tree in Akagera National Park



Photo credit: REMA

Most of the plant species found in these forests are used in traditional medicine and some plants reveal important biochemical extracts. This is the case with *Blighia unijugata*, *Grewia forbesi*, *Rhus vulgaris*, *Pterygota mildbraedii* and *Ficus* species (MINITERE 2003a).

With more than 104 flower species, wetlands and aquatic ecosystems are also rich in biodiversity. Some lakes such as Kivu, Bulera and Ruhondo are poor in macrophytes (MINITERE 2003a). About 50 species of plankton are found in these ecosystems distributed in the following families: *Chlorophyceae*, *Cynophyceae*, *Pyrophytes*, *Bacillariophyceae*, *Cynophyceae*, *Pyrophytes*, *Euglenophyceae*, and *Diatomophyceae*. There are reports of colonization of *Nymphaea nouchalii* and *Nymphaea lotus* in the lakes of the eastern region. The Water hyacinth (*Eichhornia crassipes*) presents a big threat to the biodiversity of these lakes. The flora is dominated by *Cyperus papyrus*. Some of these lakes are associated with gallery forests with the dominating species being those of the genus' *Phoenix*, *Bridelia*, *Ficus*, *Aeschynomene* and *Echinochloa*. Ferns are also found and in some places there are *Echinochloa pyramidalis*.

The agro-ecosystems have food crops species like *Sorghum*, *Phaseolus vulgaris*, *Eulisine corocan*, *Colocasia antigonum*, *Zea mays*, *Oryza sativa*, *Triticum sp.*, *Hordeum vulgare*, *Pisum sativum*, *Soja hispada*, *Arachis hypogea*, *Ipomea durcis*, Irish potatoes, *Manihot esculenta* and the banana (*Musa*). They are also commercial crops like coffee, tea and pyrethrum. The agricultural production systems also accommodate many related wild species, the most common being *Eragrostis sp.*, *Bidens pilosa*, *Digitaria sp.*, *Conyza sumatrensis*, *Cyperus sp.* There are also plant forage crops including *Tripsacum laxum*, *Setaria sp.*, *Desmodium sp.*, *Pennisetum purpureum*, *Mucuna pruriensis*, *Cajanus cajan*, *Calliandra calothyris*, *Leucaena diverifolia*, and *Sesbania sesban* (MINITERE 2003a).

Tree species found in Rwanda include *Ficus thoningii*, *Euphorbia tirucalli*, *Erythrina abyssinica*, *Verminia amygdalena*, *Dracaena afromontana*, among others. The first afforestation efforts took place between 1920 and 1948 during which time *Eucalyptus* was introduced. Other species introduced later included *Pinus sp.*, *Callistris sp.*, *Grevillea robusta*, *Cedrella sp.*, and *Cupressus*. (MINITERE 2003a).

Fauna

Rwanda shelters 151 different types of mammal species, eleven of which are currently threatened and none of which are endemic. Among them are the primates (14 to 16), with half of the remaining world population of mountain gorillas (*Gorilla gorilla berengei*). The gorillas are found in the Volcanoes National Park. Others includes the owl-faced monkey (*Cercopithecus hamlyni*), the mountain monkey (*Cercopithecus hoesti*) in Nyungwe, the Chimpanzee (*Pan troglodytes*) in Nyungwe and Gishwati, and the Golden monkey (*Cercopithecus mitis kandti*) found in Volcanoes National Park. There are also 15 species of antelope, and a wide diversity of species such as buffalo, zebra, warthog, baboon, elephant, hippopotamus, crocodile, tortoise and rare species such as the giant pangolin (Chemonics International Inc. 2003, MINITERE 2005).

A family of Mountain Gorillas



Photo credit: REMA

Rwanda is one of the top birding countries with 670 different birds having been recorded. Four of species of birds in Rwanda are threatened with extinction: the shoebill (*Balaeniceps rex*) found in Akagera; Grauer's rush warbler (*Bradypterus graueri*) found in Volcanoes National Park in Nyungwe and in the swamps of Rugezi; the Kungwe apalis (*Apalis argentea*) found in Nyungwe; and the African or Congo barn owl (*Phodilus prigoginei*) found along Lake Kivu ([Chemonics International Inc. 2003](#)).

Animal races bred in Rwanda are mixed with native and non-native races. These include cattle (*Ankole*, *Sahiwal*, *Frison*, *Alps brown* and the *Australian Milk Zebu*), goat (*Alpine* and *Anglonubian*), sheep (*Karakul*, *Merinos* and *Dorper*), pig (*Large white* and *Landrace*, *Piértrain*), poultry (*Leghorn*, *Rhodes Island Red*, *Derco*, *Sykes* and *Anak*), fish (*Tilapia* and *Clarias*) ([MINITERE 2003 a](#)).

Fish species found in aquatic ecosystems comprise *Haplochromis*, *Synodontis*, *Barbus*, *Labeo*, *Tilapiines*, and *Clarias* species. *Raimas moorei* and *Limnothrissa miodon* were introduced into Lake Kivu at the end of the 1950s ([MINITERE 2003a](#)).

Conservation status of biodiversity

This rich biodiversity is mainly conserved in protected areas (three national parks, natural forests, wetlands). These cover almost 10 per cent of the national territory while the rest of the country is densely populated.

The Volcanoes National Park is home to about 30 per cent of the global population of Mountain Gorilla (*Gorilla gorilla beringei*). It has other 115 mammals' species, including the golden monkey (*Cercopithecus mitis kandti*), elephants, buffaloes, 187 bird species, 27 species of reptiles and amphibians and 33 arthropod species. CITES consider *Rana anolensis*, *Chameleo rudi* and *Leptosiaphos grauer* endangered ([MINAGRI 1998](#), [Chemonics International Inc. 2003](#)). It has also 245 plants, 17 of which are threatened; and 13 species of orchids including *Disa starsii*, *Polystachya kermessia*, *Calanthes sylvatica*, *Chamaengis*

sarcophylla, *Cyrtorchis arcuata*, *Habenaria praestans*, *Stolzia cupuligera*, *Eulophia horsfallii*, among others ([Chemonics International Inc. 2003](#)).

Nyungwe National Park has 75 species of mammals, including 13 species of primates with some on the IUCN Red list such as the Eastern Chimpanzee (*Pan troglodytes schweinfurthii*), owl-faced guenons, (*Cercopithecus hamlyni*) and the Angolan Colobus monkey (*Colobus angolensis ruwenzorii*). The national park is also considered an African Important Bird Area (IBA) with 285 bird species comprising 25 endemic to the Albertine Rift ([Plumptre et. al. 2002](#), [Fischer and Killmann 2008](#)). Of the 1,200 plant species inventoried in the Nyungwe National Park - 265 species were trees and shrubs and of these 24 are endemic to the Albertine Rift. Among the plant species in the park, 5 species of trees and 6 species of grass are endemic to the park. These include *Oricia renieri*, *Pentadesma reyndersii*, *Pavetta troupinii*, *Psychotria palustris* and *Tarenna rwandensis*. The flora of the park also comprises 148 species of orchids, of which 19 are endemic ([MINITERE 2005](#)). The following species of orchids found on the CITES list are also found in the park: *Diaphananthe biloba*, *Disa eminii*, *Disperis kilimanjarica*, *Euggelingia ligulifolia*, *Eulophia horsfallii*, *Polystachya fabriana*, *Polystachya hastate* and *Tridactyle anthomaniaca* ([MINITERE 2005](#)).

The wildlife in the **Akagera National Park** comprises 90 species of mammals, 530 bird species and 35 fish species. The most threatened species are rhinoceros, large carnivores, particularly lions. Many species in the Akagera National Park are protected by the CITES convention such as *Loxodonta africana* (African elephant), *Syncerus caffer* (buffalo), *Panthera leo* (leopard) and *Tragelaphus spekii* (sitatunga). ([MINITERE 2003a](#), [MINITERE 2005](#)). The flora of the Akagera National Park is diverse and 6 species of orchids are recorded. The grass savanna is dominated by *Themeda triandra* and *Hyparrhenia* sp. accompanied with normal species like *Sporobolus pyramidalis* and *Botriochloa insculpta*. Acacias are the most trees found in the forest savannah, and the following species are recorded: *Acacia senegal*, *A. Sieberiana*, *A. polyacantha campylacantha*, *A. gerardii* and *A. brevispica*. Species of *Combretum* are also found in the park ([MINITERE 2005](#)).

Buffaloes in Akagera National Park



Photo credit: REMA

Natural forests are rich in fauna species. Gishwati forest includes species such as *Pan troglodytes schewinfurthii*, *Colobus angolensis ruwenzorii*, *Potamochoerus porcus*, *Cephalophus nigrifrons*, *Dendrohyrax arboreus*, *Felis serval* and *Felis aurata* (MINAGRI 2002 in Munanura et. al, 2006). The Tree squirrel (*Funisciurus pyrrhopus*), Rwenzori sun squirrel (*Heliosciurus ruwenzori*), Ground hog (*Thryonomys swinderianus*) and the jackal species (*Canus spp.*) are found in Mukura forest. Makura is also rich in birds with 59 species recorded, among them 7 Albertine Rift endemic species: *Tauraco johnstoni*, *Apalis personata*, *Apalis Ruwenzori*, *Cynnyris regia*, *Zoothera tanganjicae*, *Bradypterus graueri* and *Parus fasciiventer* (Munanura et. al. 2006).

Rugezi wetland is habitat to an endangered bird and hosts 60 per cent of the global population of Grauer's swap-warbler (*Bradypterus graueri*). It is also habitat to 19 bird species, including two species of *Threskiornithidae*, protected by CITES. Apart from *Clarias liocephalus* and *Haplochromis sp.*, the wetland is not rich in fish species. A low number of mammals are also identified: several species of Muridae, *Tragelaphus spekei* and *Aonyx capensis*. (MINITERE 2003a). The orchid *Disa stairsii*, a specie protected by CITES is also found in Rugezi wetland (MINITERE 2003b).

Apart from these places of in-situ conservation, there are also some cases of ex-situ conservation mainly for flora. These include herbaria in some institutions (Institute of Scientific and Technological Research (IRST) and Karisoke Research centre), an arboretum and seed bank as follows:

- Institut des Sciences Agronomiques du Rwanda (ISAR) has an arboretum in Huye district (Ruhande) established in 1933 containing 205 mostly indigenous plus other introduced species. It is considered the best arboretum in Africa.
- ISAR has also a seed centre started in 1978 which projected Rwanda into the Organisation for Economic Corporation and Development (OECD) seed scheme in 1993. There are only two other African countries in this entry which includes Madagascar in 1998. Ghana and Uganda are being considered for entry possibly by Sept 2008. This seed centre also serves as a gene bank collection containing both crop and tree species and also medicinal species. The collections are kept at 4°C.
- There is a national herbarium at IRST which is supposed to include all plants species in Rwanda. Karisoke Research Centre has also a herbarium.

Threats to biodiversity

With the highest population density in Africa, coupled with its dependence on agriculture, the major threats to the biodiversity and genetic resources in Rwanda are mainly linked to population pressure and the problem of land scarcity. Other threats to the biodiversity are linked to human activities such as loss of habitat by conversion of natural habitats, mining, agriculture and the introduction of alien species.

Habitat loss

The high population density has resulted in a sustained conversion of ecosystems and habitat that is threatening biodiversity in Rwanda. For instance, the total surface area of national parks in the country, have been reduced since 1960s in search for land for cultivation and settlements. In some cases these reductions resulted from illegal encroachments or legal authorization by the government. However, even in cases of the authorized reduction of protected areas, no consideration was given to ecological facts. This is the case for the new

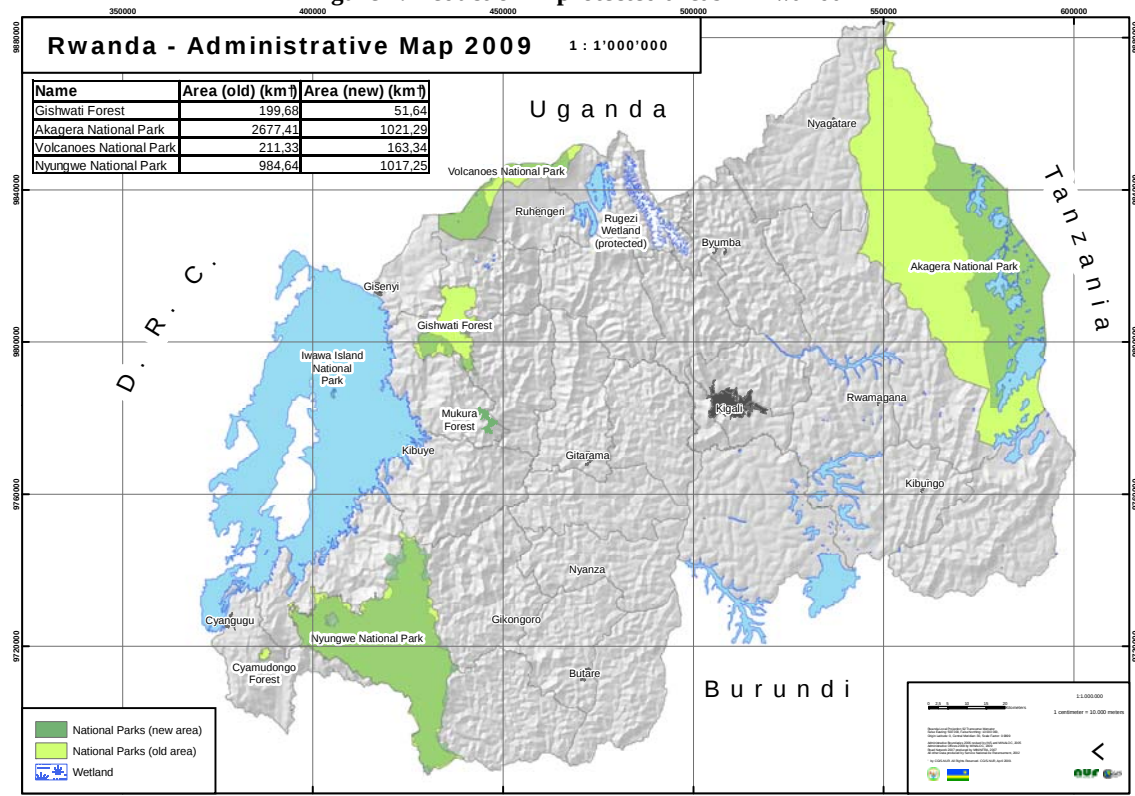
boundaries of the Akagera National Park and the settlement in Gishwati Natural Forest. This has led to a number of environmental problems. Table 1 below shows a decline in the number of animals in the Akagera National Park while figure 1 highlights the decline in land under protected area status.

Table 1: Trends in numbers of wildlife in Akagera National Park

Species	1990	1997-1998	% change	2002	% change
Buffalo	10,000	2260	-77	791	-78
Eland	325	103	-68	114	+11
Impala	30,000	5660	-81	1890	-67
Reedbuck	1890	n/a		74	-96
Topi	7500	2020	-73	713	-65
Warthog	1500	380	-75	383	+1
Waterbuck	1600	350	-78	191	-54
Zebra	3800	3050	-20	652	-79

Source: Chemonics International Inc. 2003

Figure 1: Reduction in protected areas in Rwanda



Map production : REMA

Loss of genetic resources

The intensification of agriculture and husbandry affects the natural habitats of species. Threats to the natural genetic resources (which are more resistant to the local conditions) also arise from breeding with improved and high productive varieties. This phenomenon if not addressed will mainly affect the cattle, where natural cattle varieties are running the risk of genetic erosion.

Another risk associated with genetic resources, which is not well documented, is linked to bamboo cutting in Nyungwe and Volcanoes National Parks. This problem is being aggravated by the on-going campaign for the use of bamboo, in the successful handicraft market. Over the last two years, it has to an increase in the traffic of bamboos from the two parks.

Related to genetic resources, is the problem of illegal detention of wildlife and in some cases traffic of wildlife mainly from the DRC. The illegal detention of wildlife concerns mainly the 'Royal Crane' kept in private gardens, some tortoises and other birds and reptiles. This phenomenon is a threat to these species as in most cases they cannot reproduce outside their natural habitat. There is urgent need for national legislation on the access to genetic resources, especially for research purpose. In this way Rwanda will be able to protect its natural genetic resources from being trafficked without government consent.

A royal crane photographed in a private garden in Rwanda



Photo credit: REMA

Introduction of alien species

The water hyacinth *Eichhornea crassipes* which was introduced as an ornamental plant. It has since has invaded lakes in Rwanda from Muhazi to Rweru from the River Nyabarongo, and even reached Lake Victoria through Akagera River. The water hyacinth has invaded several lakes in the Akagera complex. Lake Mihindi has now been completely covered by this plant (MINITERE 2003). The water hyacinth is a major biodiversity problem in the inland water ecosystem of the Lake Victoria Basin.

Lantana camara, also introduced as an ornamental plant, has become a weed and in some areas a habitat for tsetse flies.

Other documented introductions include fish such as *Astatoreochromis alluandi*, *Schilbe mystus* and *Cyprinus carpio* introduced into Lake Mugesera; these have spread to all the water bodies of the Akagera complex. There is also *Protopterus aethiopicus* introduced in Lake Muhazi in 1989 which is considered by many as invasive ([Chemonics International Inc. 2003](#), [MINITERE 2003b](#)).

In the last few years, uncontrolled introduction of plants has been taking place. In some instances they are propagated without undertaking enough studies on their ecology. Such plants include Macadamia, Moringa, Neem, mulberry-trees, and recently Jatropha for bio-fuels. These introductions are made without meeting the phytosanitary and confinement requirements in ISAR field trials. This may lead to the introduction of invasive species or other pathogens in Rwanda.

Opportunities provided by biodiversity

There are a multitude of anthropocentric benefits from biodiversity in the areas of agriculture, science and medicine, industrial materials, ecological services, in leisure, and in cultural, aesthetic and intellectual value. There are many benefits that are obtained from natural ecosystem processes. Some ecosystem services that benefit society are air quality, climate moderation (global, regional and local CO₂ sequestration), water purification, disease control, biological pest control, pollination and prevention of erosion. Along with those come non-material benefits that are accrued from ecosystems: spiritual and aesthetic values, knowledge systems and the value of education that we obtain today.

Economic and livelihood support

Through domestication and direct harvesting from the wild, Rwandans derive food, medicines and a wealth of other products from biodiversity and genetic resources. The range of agro-biodiversity found around the country contributes significantly to livelihoods, food security and poverty alleviation due to their superior adaptation to the local environmental conditions and are likely to contribute more even in the future. For instance the value of ecological goods and services provided by Nyungwe forest is estimated at a minimum US\$ 285 million a year, with the major beneficiaries being ELECTROGAZ, Regideso Burundi, the Public Offices in Charge of Tea and Coffee (OCIR), the Rwanda Tourism Board Offices (ORTPN), tour operators, the rice farmers' cooperative in Bugarama and the global community ([Masozera 2008](#)).

With a large number of flowering plants and its richness in orchid species, Rwanda can develop its horticulture sector. In 2009 flowers are projected to earn the country US \$0.57 million in exports and over the three year period (2008-2010) the value of flower exports is projected to increase by an average of 23 per cent per year ([MINECOFIN 2007](#)).

There are also emerging opportunities for biodiversity including the carbon credit market. Stored carbon in Nyungwe Forest is valued at an estimated US\$ 162 million a year, whereas watershed protection services, water supply for irrigation, human consumption and industries, as well as flood protection are worth at an estimated US\$ 117 million annually ([Masozera 2008](#)). The monetary value of biodiversity maintenance amounts to US\$ 2 million, and recreation and tourism is good for at minimum US\$ 3.3 million a year.

Tourism opportunities

Nature-based tourism is one of the fastest growing tourism sectors worldwide and in Africa (UNEP 2006). Although a non-traditional export sector for Rwanda, tourism has the potential to contribute significantly to the country's export base. From a negligible base of a less than US\$5 million in 2002, tourism receipts hit US\$33 million in 2006 and are on track to exceed this figure in 2007 (ROR 2007). It is worth noting that Rwandan tourism is mainly based on visits in national park, with the Volcanoes National Park, the most visited park. The rich biodiversity of Rwanda, including bird-watching provide an opportunity for the development of the tourism sector in Rwanda.

An antelope in Akagera National Park



Photo credit: REMA

Research and medicinal purposes

Genetic resources can be used as biochemical precursors in the synthesis of pharmaceutical and agricultural products and in cosmetics. Examples of genetic resources of interest includes the *Prunus africana* found in Nyungwe which serves as a basis for prostate cancer, *Aloe vera* which widespread in Rwanda and is used in the pharmaceutical and cosmetic industry, and other medicinal trees and plant species.

As shown before, the biodiversity of Rwanda has not been exhaustively studied and there are opportunities for research in new taxa or new species and also for bio-prospecting. For example there are some components of biodiversity used for traditional medicine or other uses that need to be documented.

Strategies to improve Rwanda's biodiversity

Policy, legislation and institutional framework

The relative importance of biodiversity is clearly captured in the EDPRS policy matrix which includes a policy indicator for the rehabilitation of national ecosystems (MINIRENA 2009). This places the biodiversity programme at the highest level of national support with the involvement of varied national institutions.

Different institutions are involved in biodiversity and genetic resources management and conservation. These include ministries, parastatals, institutions of higher learning and a number of national and international NGOs. These institutions are however hindered by a lack of local capacity and expertise in biodiversity. However, efforts are being made to reinforce their capacity.

With regard to the legal framework, there is a need to have a law that addresses the status of wildlife outside national parks, which is regulated only by the decree of 26/04/1974, which gives a list of protected animal species. This list has recently been updated by a Ministerial Order (2008). However, it is not clear which institution has the responsibility for the animals outside the protected areas, as ORTPN is responsible for wildlife in national parks only. It is expected that the ongoing preparation of the wildlife act will help in clarifying this aspect.

Improving the biodiversity knowledge base

In order to improve on the conservation of biodiversity, Rwanda has prepared policies, strategies and laws related to the management of environment and biodiversity. The country is also a signatory to many international treaties such as the Convention on Biological Diversity, the Convention on International Trade in Endangered Species and the Ramsar Convention, among others. Localisation of these conventions is necessary if they are to be effectively and efficiently implemented and enforced at the national level.

In the case of biodiversity, decision makers have been grappling with a range of challenges in the face of incomplete or conflicting data.

In order to enhance the process evidence-based policy, specific interventions have targeted improving the knowledge base of the national biodiversity stock. The current activities in that area include the Karisoke Research Center (KRC) which maintains databases on gorilla behaviour, demography, group composition and group ranging activities first begun by Dian Fossey in the late 1960s. The center also supports more focused short-term studies on gorillas, such as a Tourism Impact Study and a variety of other gorilla studies. It supports a number of other studies on the key aspects of biodiversity (fauna and flora) of the Volcanoes National Park and the entire Virunga Volcanoes area, endemic bird and primate species, amphibians, and key habitats.

In addition, REMA is planning to undertake inventories of biodiversity in Rwanda in 2009. This will be with support from the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

Conclusion and recommendations

Rwanda has a rich biodiversity and there is a need to have an effective framework for its conservation, not only to comply with international obligations, but because it is the basis of the Rwandan livelihoods and provides opportunities for economic development. In order to get the best opportunities for the rich biodiversity, it is important to broaden the focus and not only rely on few species and protected areas. For this, Rwanda needs to have an effective legal framework on biodiversity, including a legal framework for access to genetic resources. Rwanda does not have a legal framework for access and sharing of benefits from the use of these genetic resources. This is an open door for possible bio-piracy. There is also need to have sustained capacity building not only in conservation related fields but in new tools such environmental valuation and modelling.

There is a need to have a cost-efficient legal and institutional framework for biodiversity management. Without a policy and law on biodiversity and wildlife, it is difficult to protect and regulate the use of the rich biodiversity in Rwanda. This legislation will need to include wildlife outside national parks, the regulation of research on biological resources, bio-prospecting, and other elements such as the protection of traditional knowledge. Enforcement of existing laws, especially on species introduction, will need to be improved.

There are also some areas of the country that are habitat to threatened species or rich with biodiversity and that need to have a certain status of protection. These include some wetlands considered as Important Birds Areas, some areas with very rare and threatened plant species such as Mashyuza and Nyarubuye (Fischer 2008).

The knowledge base of national biodiversity is limited and there is a need to close that gap. This will require the building of capacity in fields such as taxonomy, ethno-biology and ecology.

References

Chemonics International Inc (2003). *Rwanda Environmental Threats And Opportunities Assessment*. Task Order No. 818 under the Biodiversity & Sustainable Forestry (BIOFOR) IQC USAID Contract No. LAG-I-00-99-00014-00. Also available on: http://www.encapafrica.org/documents/biofor/Rwanda_2003.pdf

Fischer (2008). *Personal Communication*. On the occasion of the Conference on Gorilla Naming ceremony.

Fischer and Killmann 2008 Eberhard Fischer and Dorothee Killmann (2008). *Illustrated Field Guide to the Plants of Nyungwe National Park*. Kigali (ISBN978-3-941326-00-2)

Masozera M. (2008). Valuing and capturing the benefits of ecosystem services of Nyungwe Forest National Park, SW Rwanda, University of Florida. Gainesville, U.S.A.

MINAGRI (1998). *Rapport National sur la Convention de la Diversité Biologique*. Ministère de l'Agriculture, de l'Élevage, de l'Environnement et du Développement Rural (MINAGRI), Kigali.

MINECOFIN (2007). *Budget Framework Paper 2008-1010*. Ministry of Finance and Economic Planning (MINECOFIN), Kigali.

MINIRENA (2009). *Joint Sector Review*. Ministry of Natural Resources (MINIRENA), Kigali.

MINITERE (2003a). *National Strategy and Action Plan for the Conservation of Biodiversity in Rwanda*. Ministry of Lands, Resettlement and Environment (MINITERE), Kigali.

MINITERE (2003b). *Etudes relatives à la protection intégrée et conservation des ressources naturelles des zones humides critiques du Rwanda: Evaluation de la diversité biologique des zones humides*. Ministère des Terres, de la Réinstallation et de la Protection de l'Environnement (MINITERE), Kigali.

MINITERE (2005). *Deuxième Rapport National sur la Convention de la Diversité Biologique*. Ministère des Terres, de l'Environnement, des Forêts, de l'Eau et des Mines (MINITERE), Kigali.

Munanura I., Mulindahabi F., Barakabuye N. and Mukakamali (2006). *Report of Biodiversity Survey of Mukura Forest*. ARECO Rwanda Nziza and Wildlife Conservation Society, Kigali.

Plumptre, A.J., M., Masozera, P.J. Fasching, A., McNeilage, C. Ewango, B.A. Kaplin and I. Liengola. 2002: *Biodiversity Survey of the Nyungwe Forest Reserve in S.W. Rwanda..* World Conservation Society (WCS), Kigali.

ROR (2007). *Economic Development And Poverty Reduction Strategy, 2008-2012*. Ministry of Finance and Economic Planning, Republic of Rwanda (ROR) Kigali.

SCBD (2000). *Sustaining Life on Earth*. Secretariat of the Convention on Biological Diversity (SCBD), Montreal. ISBN 92-807-1904-1

UNEP (2006). *Africa Environment Outlook 2: Our Wealth, Our Health*. United Nations Environment Programme (UNEP), Nairobi.