1. Forests of the Congo Basin

Overview

Following the Amazonian forests, the forests of the Congo Basin constitute the second largest area of dense tropical rainforest in the world. They stretch from the coast of the Gulf of Guinea in the west to the mountains of the Albertine Rift in the east[1] and cover about seven degrees of latitude on either side of the equator. They are mostly within the Guinea-Congo forest structure, of which they constitute over 80% of the total area. In the west of Cameroon and the east of the Democratic Republic of Congo, they also include the Afromontane forests.

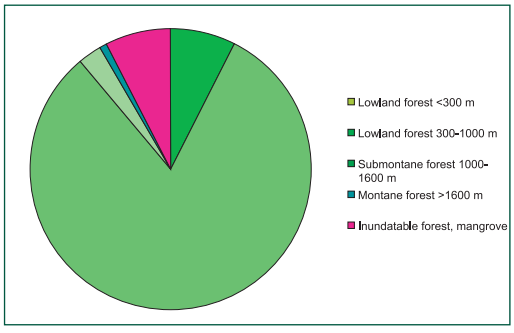
This report focuses on the forests of the countries forming part of the CBFP partnership - Cameroon, Equatorial Guinea, Gabon, the Central African Republic (CAR), the Republic of Congo and the Democratic Republic of Congo (DRC). The area of these forests nears 200 million hectares (Figure 1.1); however estimates of their area vary considerably. Certain estimates are at the least surprising[2], but even the weakest estimates vary depending on what one considers to be forests. According to the FAO, which uses a wide definition, the area of the forests was 227.61 million hectares in 2005. According to MODIS and GLC2000 maps, the area was 180.46 million hectares in 2000 (page 82).

Relief and altitude

Unlike the tropical forests of Southeast Asia or West Africa, but similar to those of Amazonia, the forests of Central Africa still form a vast and more or less continuous block. However, whereas the Amazonian forests are largely situated just above sea level, 80% of the forests of Central Africa are located between 300 and 1000 m of altitude (Figure 1.2). Only the forests in the coastal sedimentary basin, which represent 7% of the total area of the forests and are located mainly in Cameroon and Gabon, are at a height of less than 300m (page 82).

The submontane forests, at an altitude of between 1,000 and 1,600 m, cover 2.8% of the forest area and the montane forests, above 1,600 m, cover only 0.8% of the area. These forests are spread over two fragmented blocks separated by over 2,000 km. Comparable forests in South America form an almost uninterrupted strip all along the Andes Chain. Forests showing clear submontane influences cling to the mid-altitude features (650-1,200 m) which run parallel to the gulf coast of Guinea 100-200 km inland and capture the Atlantic clouds, especially in the dry season. Along with continual climatic variations that have affected and continue to affect Central Africa, this spatial configuration of the forests has played an important role in the evolution of its flora and fauna[3].

Figure 1.2. Relative abundance of the principal types of vegetation (Source: JRC).



Climate

Precipitation is the main factor determining vegetation in a tropical environment. Overall, precipitation varies between 1,600 and 2,000 mm a year on average. However, three areas with noticeably higher rainfall can be identified: the eastern edge and the center of the Congo Basin, with precipitation of around 2,000 to 2,500 mm per year on average, and the coastal area from Libreville in Gabon to the foot of Mount Cameroon, with precipitation averaging 3,000 to 11,000 mm a year (Figure 1.3).

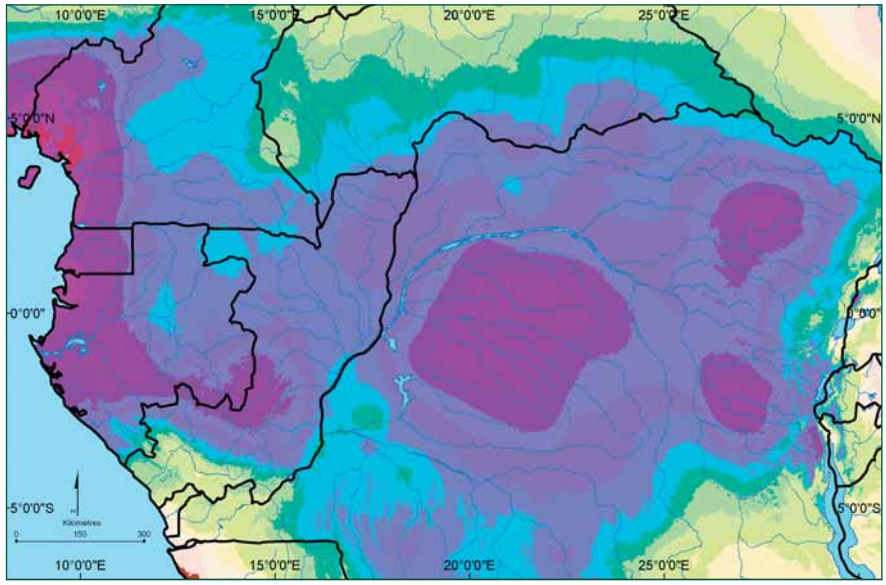


Figure 1.3. Precipitation in Cenral Africa (Sources : ESRI, Worldclim data, University of California, Berkeley, USA).

[1] The forest relics of western Uganda and Kenya are also part of the Guinea-Congo forest structure.

[2] The State of Africa 2006 suggests a total area of 520 million hectares (Maury, 2006).

[3] With changes in climate, species in the Andean forests have shifted both in an altitudinal and north-south direction, while African species have only shifted in an altitudinal direction. Even the Albertine Rift is not extensive enough for significant latitudinal shifts to appear.

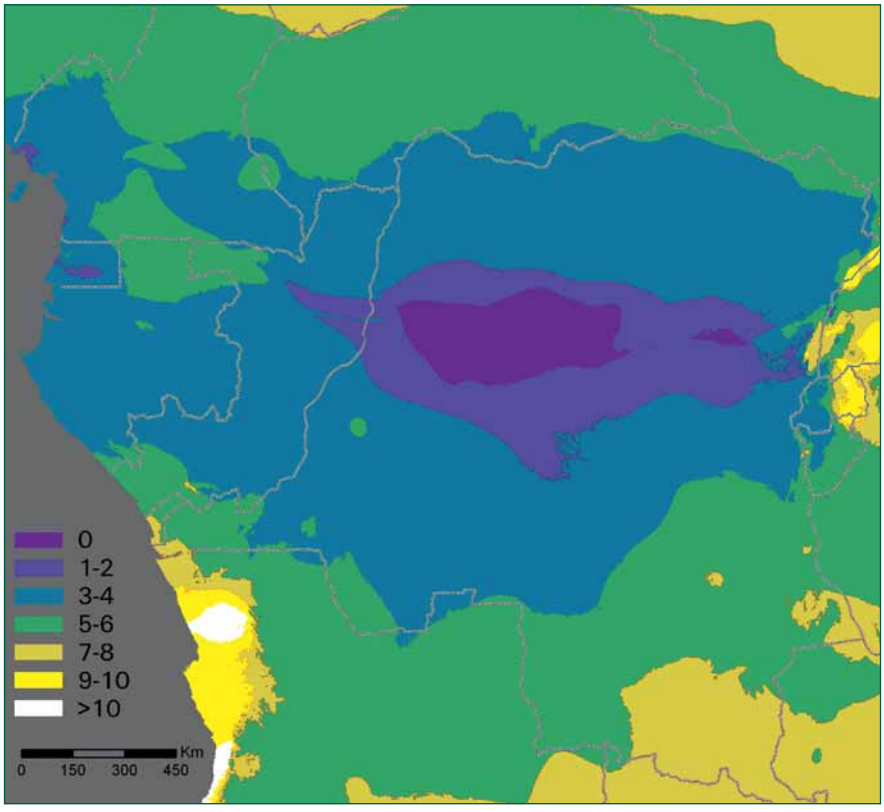


Figure 1.4. Number of dry months per year (Source: JRC)

The seasonal distribution of precipitation is bimodal in areas close to the equator but becomes unimodal further north or south. At the same time, the length of the dry season increases with latitude: it lasts one to two months on the equator but as much as three to four months at the northern and southern edges of the forest block (Figure 1.4). In Equatorial Guinea, most of Gabon, southeastern Cameroon and southwestern Republic of Congo, the effects of these rainfall gradients are tempered by the Atlantic influence, which considerably reduces the solar radiation, lowers the temperature by 2-3°C between July and September and reduces evaporation. Consequently, although they have a dry season of three months, these regions are covered with evergreen forests.

Fauna and flora

Vegetation

Along the Atlantic coast there is an irregular strip of evergreen forests including clumps of hyperhumid forests, in northeastern Gabon and western Cameroon, which receive more than 3,000-3,500 mm of precipitation annually. Approximately 100-200 km from the coast, on the mountain ranges (Monte Alén, Monts de Cristal, Monts Doudou, etc.), there is also an irregular strip of forests that are rich in Caesalpinids and, above an altitude of 650 m, have submontane characteristics. Towards the north, this strip mixes with the submontane and montane forests of Mount Cameroon and the highlands of western Cameroon. Further to the east, most of the terra firma forests of the Congo Basin consist of a mosaic of evergreen and semi-evergreen formations, which are generally less rich in species. Among these formations are monodominant forests, of which the best known and most extensive are the *Gilbertiodendron dewevrei* forests. In the center of the Congo Basin there are 220,000 km^2 of swamp forests or floodplain forests that exhibit less diversity, but a fairly substantial degree of plant endemism. In eastern Gabon and northern Republic of Congo, there are also vast open-canopy Marantaceae forests. In the east of the Congo Basin, the land rises to the mountains of the Albertine Rift with submontane forests between 1,000 and 1,650 m and montane forests between 1,650 and 3,000-3,400 m. The northern and southern fringes of the forest block consist of semi-deciduous forests that give way to a mosaic of savannahs and gallery forests, less rich from a botanical point of view, but supporting high populations of large mammals.

History

The size and the continuity of the forests of Central Africa have varied considerably over time. During the last two million years, these forests have periodically been reduced and fragmented by world climate variations, largely linked to cyclical variations in the Earth's orbit. For the past 800,000 years, these cycles have lasted approximately 100,000 years with three phases of very unequal durations: for about 80,000 years, the climate was variable but on average a little drier and cooler than at present; for 10,000 years it was much cooler and drier—these are the glacial periods—and for the remaining 10,000 years it was warmer and wetter.

During the last glacial period, which peaked 15,000 to 18,000 years ago, rainfall in equatorial Africa was very low, the Atlantic Ocean had dropped by 120 m, the continental plateau received little water and most of the present forests were turned into a landscape of savannahs and gallery forests. The dense forests were limited to refuges, mainly situated along the low mountains near to the Atlantic coast, on the eastern edge of the Congo Basin and on the high mountains in the east. Substantial refuges, albeit probably very fragmented, would also have existed in the center of the Congo Basin[4]. Today, these refuge areas

[4] Until 10-20 years ago, it was thought that during the glacial periods the Guinea-Congo forests were reduced to a small number of refuges, one in the east of the Congo Basin and one in Lower Guinea. We now know that these refuges were more numerous, fragmented and partially linked by a network of gallery forests that also contributed to the survival of many species.

still have a higher degree of endemism and greater diversity of species relative to other areas of the Congo Basin forests.

Climatic fluctuations are not limited to these great glaciation cycles. More localized variations, of the El Niño-La Niña type, appear depending on the distribution of the surface temperatures of the oceanic waters. The most recent natural recession of the forest formations dates back only 2,000 to 2,500 years. At that time, the forests underwent extreme fragmentation due to the spread of grasslands and even now they are still in the process of recolonizing areas where forests were lost. Due to this process, a large portion of the forests of Gabon are pioneer okoume (*Aucoumea klaineana*) forests in various stages of evolution. Okoume, a very important commercial timber species in Gabon, is one of the main species that colonizes savannahs, but it has difficulty regenerating in mature forests and is therefore eventually replaced by other species. In many other regions of Central Africa (Cameroon, Republic of Congo), rapid reforestation of the savannahs can also be observed.

This continual succession of expansion and regression of the forest, combined with the changes brought about by man, mean that the overall picture of the forests in the Congo Basin is very complex. Unfortunately, the implications of these processes for forest management and the conservation of biodiversity are still poorly understood.

Species richness and endemism

Overall, the forests of Central Africa have fewer species than those of America or Asia. This can be partially explained by their smaller size and the extreme contractions that they have undergone during the cold, dry spells of the Tertiary and, most significantly, the Quaternary periods. Nevertheless, the biodiversity of these forests is of worldwide importance because the fauna and flora in the forests of the Congo Basin do not exist anywhere else on earth. This uniqueness is found at the species and genus levels, as well as, to a lesser extent, the family level.

The flora in the low-altitude forests is comprised of over 10,000 species of higher plants, of which 3,000 are endemic. Some families are sparse or almost absent, particularly Dipterocarpaceae, Cactaceae, Bromeliaceae and Humiriaceae, but others, such as Euphorbiaceae, Leguminaceae, Meliaceae, Sapotaceae and Moraceae, are highly diversified. Nine families are endemic: Dioncophyllaceae, Huaceae, Hoplestigmataceae, Lepidobotryaceae, Medusandraceae, Octoknemaceae, Pandaceae, Pentadiplandraceae and Scytopetalaceae (Figure 1.5). The flora of the Afromontane forests is comprised of only 4,000 species, but at least 70% of them are endemic. There are two endemic families—Barbeyaceae and Oliniaceae—and also conifer species of the Podocarpus genus.

With respect to fauna, these forests house forest forms of the African elephant and the buffalo, together with endemic species such as the okapi, the bongo (Figure 1.6), the bonobo and the gorilla. The Anomaluridae, most of the Cephalophinae and Colobinae and many Cercopithecidae are confined to these forests. Their avifauna includes the Congo peacock and several families endemic to Africa, notably the guineafowl (Numididae), the turacos (Musophagidae) (Figure 1.7), the puffback and wattle-eyed flycatchers (Platysteiridae), the bush-shrikes (Malaconotidae) and the helmet-shrikes (Prionopidae).

Distribution and biogeography

The flora and fauna of the Congo Basin are very unequally distributed over the forests as a whole. Thus, the specific richness, as well as the composition of the associations and communities, varies enormously from one region to another.

Overall two areas with particularly high species richness can be identified: (1) the forests of Lower Guinea in the west (Cameroon, Equatorial Guinea, Gabon) and (2) those on the piedmont of the Albertine Rift in eastern DRC. These areas are separated by a vast, less rich area that covers the entire central region of the Congo Basin. The Guinea-Congo forests comprise three biogeographical entities of which two are in Central Africa: (1) the forests of Lower Guinea, which stretch from Nigeria to the eastern border of Gabon—this coincides with the separation of the Congo and Ogooué basins; (2) the Congolese forests, which are confined to the hydrographical basin of the Congo; and (3) the forests of Upper Guinea, which run from Ghana to Guinea and are separated from the other entities by the Togo and Benin savannah strip. Although the Lower Guinea and the Congolese forests are now contiguous, in the past they were often separated by a corridor of open countryside and swamp or floodplain forests.

Recognizing that care must be taken when assessing the richness of species—it all depends on the scale on which one is working[5]—it would appear that the forests of Lower Guinea are the richest on the continent (Thomas, 2004). As for the relatively lower species richness of the Central

Figure 1.5. Scytopetalum klaineanum.

Figure 1.6. The bongo Tragelaphus euryceros.

Figure 1.7. The giant turaco Corythaeola cristata.

[5] The number of species in a given zone is proportional to its area. The larger the area, the greater the potential for a more diverse set of habitats. One can therefore only compare zones with the same surface area.

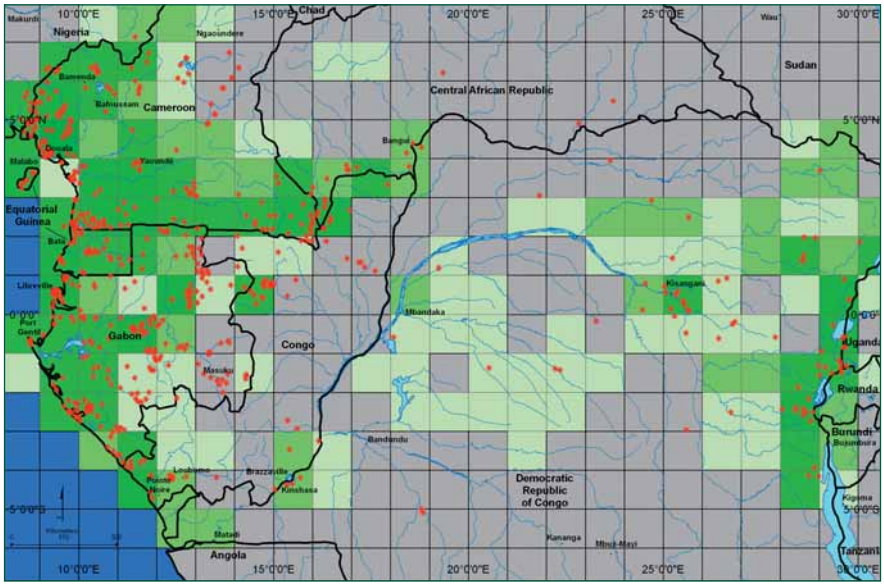


Figure 1.8. State of knowledge (Sources : ESRI, WWF-US).

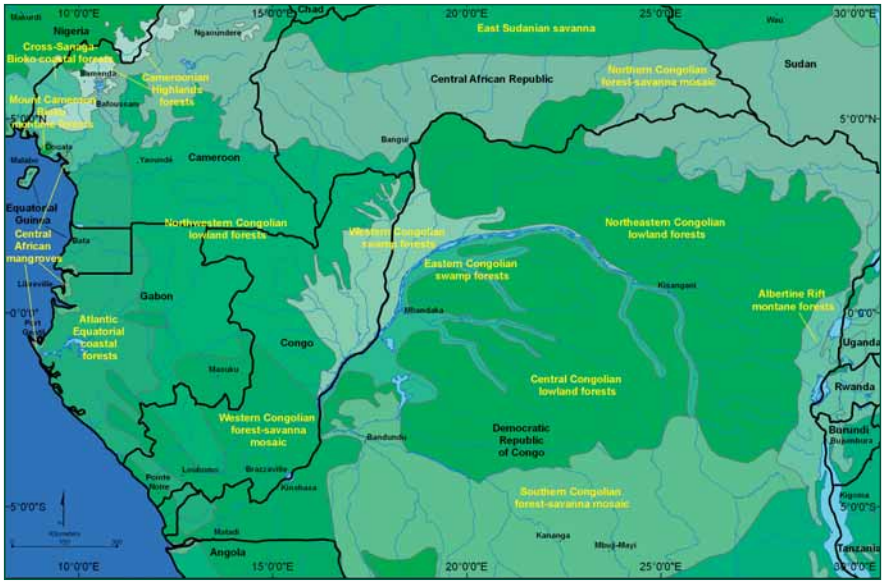


Figure 1.9. The 14 terrestrial ecoregions (Sources : ESRI, WWF-US).

Basin, it is possible that this is partly the result of insufficient knowledge (Figure 1.8).

Going beyond these two main biogeographical entities, the distribution of species is much more complex and northeast and eastern distribution patterns vary from one taxonomic group to another. In the case of birds, over 90% of the species exist throughout the forest block. With mammals, on the other hand, the distribution of species is highly compartmentalized because large watercourses have proven to be insurmountable obstacles to dispersion[6]. In the case of plants, some species are very widely distributed while others are highly localized[7]. Furthermore, the relative abundance of species varies greatly from one place to another. Despite the very flat relief, the forests of the Congo Basin are divided up into a fine mosaic of formations based on their dominant species. Some formations contain a large number of species while others are dominated by a single species, generally a Leguminacea from the subfamily Caesalpinioidea. The best known are the *Gilbertiodendron dewevrei* forests which occur from Cameroon to eastern DRC, and which also cover very large areas on the edges of the Central Basin.

The biogeography of the forests of Central Africa is extremely complex. It reflects not only the ecological requirements of the various groups of organisms and their responses to environmental parameters, but also the history of the region over the last few million years.

Terrestrial ecoregions

Efforts for the conservation and sustainable logging of the forests of Central Africa face a major problem: on the one hand, knowledge is still incomplete and for many groups of organisms we do not know exact distributions. On the other hand, the knowledge that we do have shows that the biogeography of this region is very complex. In order to simplify the situation, primarily for practical purposes, the whole area has been subdivided into 14 ecoregions[8] (Figure 1.9). This concept is widely used by conservation NGOs, especially WWF. However, for certain scientists this classification system is unsatisfactory because the boundaries between some of the ecoregions do not correspond to the reality on the ground[9]. In truth, ecoregions are more of a tool for planning than research.

Aquatic ecoregions

In Central Africa, the aquatic ecosystems and forest ecosystems are intimately linked, not only from the point of view of the fauna and flora but also through human activities and the economy. It is important to remember that the entire center of the Central Basin of the Congo River is taken up by the second largest marsh in the world, covered by various types of swamp or floodplain forests. From the hydrological point of view, the forests of Central Africa are drained by the Congo River

[6] This phenomenon has been clearly demonstrated for species and subspecies of primates, particularly through the work of Colyn (1987, 1991).

[7] The work of Sosef (1994) showed that for begonias of the subgenera Loasibegonia and Scutobegonia, 21 centers of endemism are evident in Central Africa: 5 in the Congo region, 17 in Lower Guinea.

[8] An ecoregion is a relatively large area of land that contains an assemblage of habitats and species that is distinct from those of neighboring ecoregions.

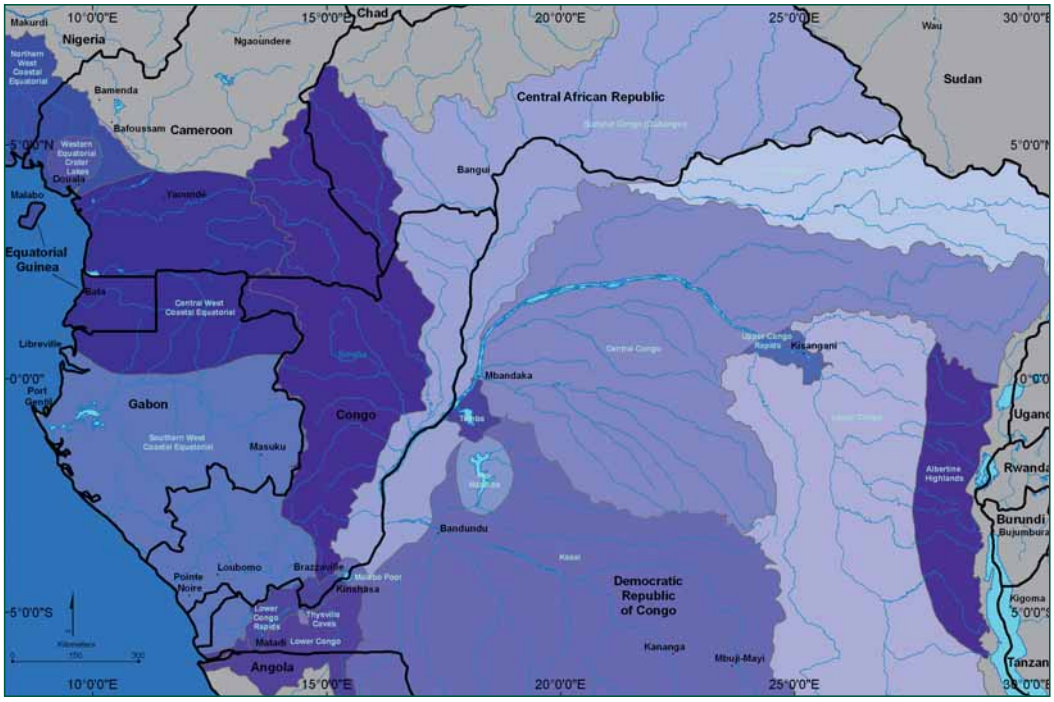


Figure 1.10. The 16 aquatic ecoregions (Sources : ESRI, WWF-US).

Basin and a series of coastal rivers which empty into the Gulf of Guinea. The largest of these rivers are the Sanaga, Ntem, Ogooué, Nyanga, Niari and Kouilou. The basin of the Congo River covers an area of 3.4 to 4.1 million km^2 — estimates vary — and can be subdivided into several sub-basins according to the quality of the water, the surrounding vegetation, the particular characteristics of the fauna and the seasonal flooding and receding of the waters. As is the case with the terrestrial environments, insufficient information is available on the aquatic ecoregions and vast portions of the Congo Basin have been barely explored. This is particularly regrettable in light of the fact that aquatic resources play an important role in the lives of the region's inhabitants. Similar to the terrestrial ecoregions it is possible to distinguish a number of different aquatic ecoregions, 16 of which lie within the forest block (Figure 1.10).

Ecological services

In addition to its species richness and endemic species, the Congo Basin also represents one of the last regions in the world where vast interconnected expanses of tropical rainforest permit biological processes to continue undisturbed. It is a rare example of a place where an animal the size of the forest elephant can still act freely on its ecosystem, like an 'engineer' transforming the landscape by influencing the distribution of species and maintaining natural ecological systems. Furthermore, because of their size, the forests of the Congo Basin constitute a carbon reserve of global significance for regulating the primary greenhouse gas, carbon dioxide. Finally, these forests also help to regulate the regional and local climates. In particular, they ensure that water is recycled as over 50% of the rainfall on the Congo Basin comes from local evaporation and evapotranspiration.

[9] The Gabonese forests change very gradually and evenly from west to east. At the very most one could possibly identify a separating line between the forests of the coastal sedimentary basin and those of the inland plateaus and mountains (and this only to the north of the Ogooué), but the current dividing line between the ecoregion of the equatorial forests on the Atlantic coast and the ecoregion of the Congolese forests in the northwest is totally arbitrary. It would perhaps have been wiser to draw two or three demarcation lines: the first at the edge of the coastal basin; the second (optional) at the junction of the mountain chains and the central plateau; and the third more or less at the watershed between the Congo and the Ogooué basins. On the other hand, the ecoregion of the montane forests of Itombwe only represents a subregion of the Albertine Rift region. Its flora and fauna are slightly richer, but overall very similar to other forests of this ecoregion. In particular, it shares several endemic species with the Nyungwe forest of Rwanda.

Figure 2.1. Pygmy hunter in Gabon.

Figure 2.2. Pygmy woman from the northeast of the Democratic Republic of Congo.

2. Human Populations in the Forest

Origin of populations

Approximately 30 million people, from over 150 ethnic groups, currently live in the forests of Central Africa. Their presence in these forests can be dated back to different periods. Traces of human occupation from several hundreds of thousands of years ago have been found in multiple places within the forests[1]. However, it is probable that for a very long time these populations lived in patches of savannah, at the edge of dense forests or along major watercourses. It remains very difficult to determine exactly when humans began to live in the heart of the forests. We do know that the Pygmies, who represent populations particularly well adapted to the forest environment, have existed for 20,000 to 25,000 years. The originally Neolithic and later metallurgist Bantu populations penetrated the forest from the northwest. In approximately 4,000 BP, they crossed the Sanaga and by 2,500 BP they occupied almost all of Lower Guinea. By around 1,000 BP, the whole forest block was colonized. In the north and the east, Ubangi and Sudanic populations intermixed with the Bantu migrations and influenced local cultures. Unlike the situation in Amazonia, the majority of the human populations still living in the Congo Basin forests are indigenous (Box 2.1).

[1] Near Lopé National Park in Gabon, sharpened stone tools dated at least 480,000 years have been found (Oslisly, 1994, 1998 and 2001).

2.1. Indigenous populations

In Amazonia, the indigenous Amerindian population represents less than 1% of forest dwellers. The remaining 99% originated from Europe, Africa or Asia. This situation led to the development of socio-political and environmental movements which for several decades have been working to protect these native populations. Similar movements also developed in certain parts of southeast Asia and in Africa. However in Central Africa the situation is different: populations originating outside Africa represent only a tiny fraction of the total population. All forest dwellers have been living in the forest and its immediate surroundings for more than 1000 years. Despite this, the term 'indigenous population' is used to describe nomadic (or semi-nomadic) hunter-gatherers in Central Africa. The term includes certain groups of Pygmies (Figures 2.1 and 2.2) even though some Pygmies have abandoned their hunter-gatherer livelihoods and become sedentary. Some Pygmies groups are also now mixed with Bantus, and certain Bantu groups have integrated Pygmies.

Interrelations

For 15,000 years, the Pygmies likely represented the only human populations living in the Congo forests. With the arrival of Bantu farmers, complex relations developed between the hunter-gatherers and farmers. The former were more familiar with the forest, but suffered from a scarcity of carbohydrates. They started to exchange labor and forest products such as meat, fish or honey for items rich in carbohydrates and, more recently, for manufactured products. The widely dispersed groups found today are distinguished by their degree of nomadism and their dependence on farmers.

Traditional agriculture in African forests was based on a cycle of forest clearance, cultivation, fallow periods and secondary reforestation followed once again by forest clearance. In the Neolithic age, the oil palm Elaeis and yams Dioscorea sp. played an essential agricultural role. Between 2,000 and 2,500 years ago, a banana from Asia was introduced and between 400 and 500 years ago plants of American origin, mainly manioc, beans, peanuts, maize and sweet potatoes, began to be cultivated.

This diversification altered the agricultural landscape, transformed habits and led to an overall increase in human population. The poor fertility of the soils found in the dense rainforests in Africa and the overall low productivity of tropical forests meant that the majority of the forest-dwelling populations in the Congo Basin continued to depend on the forests' natural resources. Furthermore the traditional lifestyle of hunter-gatherers and farmers is sustainable only in situations characterized by low human population density — probably less than 4 inhabitants/km^2 — and where the sole use of natural resources is local consumption. It was only in the high altitude regions of Cameroon and eastern DRC that more productive agriculture, often complimented by stock farming, was able to expand, resulting in higher human population densities.

Distribution

Human populations in the Congo Basin forests are very unevenly distributed (Figure 2.3). In the low-altitude regions, the largest human populations are found along the forests' edges in close proximity to adjoining savannahs. Additional populations are concentrated along the major

navigable watercourses, such as the Congo River, from Kinshasa to Kisangani, and the Ubangi River. These watercourses have always been important routes for communication, trade and transport, providing the local populations with food and various goods (Figure 2.4).

As all the rivers flowing into the Atlantic Ocean have rapids and waterfalls near their estuaries, access to the interior of the Congo Basin is difficult. Consequently, European influence on the interior of Central Africa was insignificant until the middle of the 19th century. Since that time, the distribution of human populations has been strongly influenced by the construction of railways and road networks for the extraction and removal of natural resources. This pattern, where villages re-locate near roadways, has been especially noticeable since 1930 in French Equatorial Africa and has resulted in vast expanses of forest with no human populations.

Today, roads still influence the rural complex (Figure 2.5). The construction of villages along roads creates halos, sometimes convergent, of human encroachment in the forest. At the same time, vast forest areas with no roads or navigable watercourses remain intact. This pattern of settlement, which is often driven by external economic forces and the aspirations of these populations to take advantage of development or health and educational infrastructure, leads to increasingly localized and unsustainable extraction of forest resources. Furthermore, the convergence of halos generates long strips of deforestation and degradation and results in the fragmentation of the remaining forested areas. These phenomena are exacerbated when local populations begin to export forest products to markets in large urban centers. Unfortunately, it is the same populations who subsequently suffer from the damaging effects of this process.

Apart from the ecological implications, the change in the distribution of human populations also has significant and complex cultural and socioeconomic implications. These implications

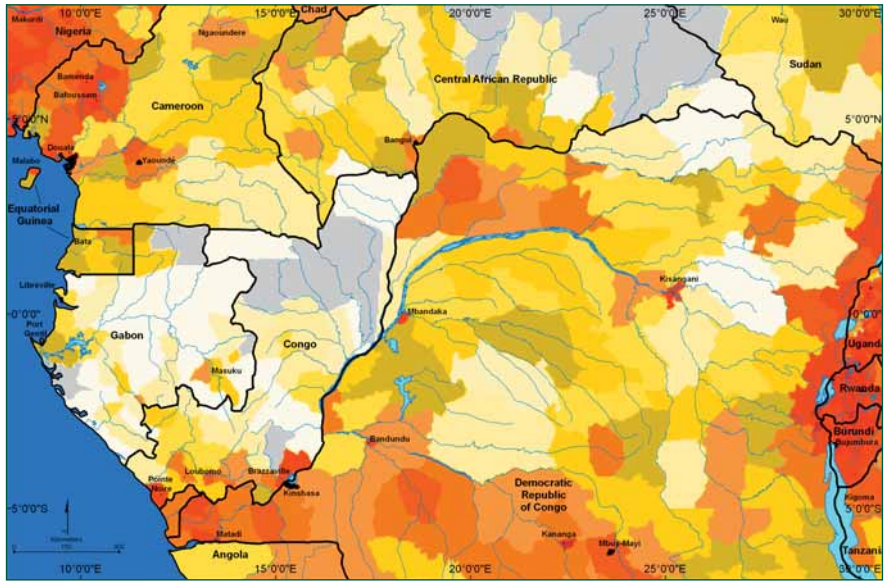


Figure 2.3. The human population density is variable from one region to another in Central Africa. In most of Gabon and the Republic of Congo it is below 2 inhabitants/km², while the high altitude regions of Cameroon and eastern DRC harbor over 150 or even 250 people/km² (Sources: ESRI, Gridd population of the worlds (GPWv3), CIESIN, Columbia University, City of New York).

are demanding growing attention and include: changes in the way in which resources are used; the introduction of new harvesting and hunting techniques; transformations in the local economy and traditional power structures (Figure 2.6); and varying mechanisms which determine whether or not the local populations benefit from the utilization of resources. To these concerns must be added the contradictions and ambiguities associated with land tenure (pages 63-69).

In eastern DRC, highland populations do not live in villages, but are more or less dispersed throughout the countryside where they practice intensive agriculture marked by short fallow periods (Figure 2.7). This lifestyle has created a pattern of high population density with local areas of overpopulation. Since the 1970s and 80s, this situation has prompted large-scale migration towards lower altitudes. This migration has resulted

Figure 2.4. A village along the Congo River.

Figure 2.5. A typical village in the forest.

Figure 2.6. A village chief in the Democratic Republic of Congo.

Figure 2.7. The high mountains of the Albertine Rift, where forests have been replaced by intensive permanent agriculture, are a demographic time bomb that day after day sends people into the lowland forests to the west.

in conflicts between resident populations and immigrants, mainly due to the fact that the social habits and agricultural methods of the latter are different from those of the resident populations and may be poorly suited to the new conditions.

Current Situation

Traditional cultures in Central Africa have been significantly impacted by historical developments associated with the rise of the Atlantic slave trade in the 16th century, the growth of the Arab slave trade in the 19th century, and the colonial period (Vansina, 1990). Diverse ethnic groups have been impacted in different ways, but overall there has been a collapse of many social and political structures. While many urban populations continue to rely on forest resources, an ever widening gap has developed between the forest and town dwelling populations. This gap is not only apparent when comparing material aspects of the two populations; it is formalized by existing legislation, which was largely inherited from the colonial era and is often in direct contradiction to forest traditions (pages 63-69).

In Central Africa today, industrial harvesting of timber, the production of palm oil, immigration, natural population growth, commercial hunting, road construction and growing access to distant markets have driven traditional systems of natural resource management to the breaking point. Very few populations retain control over the resources on which they traditionally depend. These same resources are being rapidly depleted.

In a world of growing wealth and consumption, one of the main challenges for natural resource management in the Congo Basin is the re-establishment of systems where local populations retain control over land use on an ethical self-regulating basis. Such systems make it possible to preserve the resources on which local populations depend and prevent the unregulated commercial offtake of these resources. In several areas, experiments on local management of the forests' natural resources are being conducted, however, refraining from marketing forest products raises an additional problem: how are local populations going to generate the necessary financial means to meet their basic needs, for example healthcare and education? Only increased production from agriculture and/or local stock farming can provide a solution. This solution still requires that products be taken away and marketed: a fact that necessitates development beyond the scope of local communities.

Another important factor affecting populations in the Congo Basin is the persistence or recurrence of conflicts in the Republic of Congo and, most notably, DRC. Since 1994, with the wars in the Great Lakes region, these conflicts have taken on an international dimension. They have driven human populations away from the roads and into interior forests and protected areas where they are less likely to encounter soldiers and armed gangs. Agriculture has been largely abandoned for a new style of gathering. These conflict generated movements have profound ecological and social effects. The mass movements of refugees, such as those seen since 1994 in eastern DRC, pose a major challenge. Despite aid from the United Nations, the environmental and social impact of such situations is extremely serious and in some cases irreversible.

3. Conservation

Conservation began in Central Africa towards the end of the 19th century. The first elephant reserve was established in 1889 and the mountain gorilla has been fully protected since 1912. National parks began being established as of 1925, but until the 1970s they remained centered around savannahs and their mega fauna[1]. Forest protected areas were only established from 1970 onwards, beginning with the creation of Salonga National Park in the DRC. Their number increased during the 1980s, at the same time as industrial logging activities, which until then had been limited to the coastal regions and along the major watercourses, started to spread across the whole of the interior of the continent. Currently, approximately 18.5 million hectares of forest are found within national parks or other protected areas (Table 3.1, Annex D).

Shifting approaches

Taking ecosystems into account

Conservation based solely on large charismatic species and the creation of national parks has proved inadequate in forest environments. On the one hand, the experience acquired shows that most national parks, except for the largest and most well protected, are too small to conserve over the long term their full range of species and ecological processes[2]. Maintaining the function, structure and viability of ecosystems means thinking and acting on the scale of entire ecosystems. On the other hand, it has been realized that the large dense forests, including the most remote and the most intact, are all inhabited by human populations to whom they provide essential subsistence resources. Successful conservation requires both sustainability at the ecological level and acceptance at the social level. Strategies must incorporate very diverse objectives related to protection, commercial exploitation, subsistence, agriculture, industry and urban development across a complex matrix of land and resource use. Focusing on charismatic species (Figure 3.1) has therefore given way to a more global vision of ecosystems: human populations have to be taken into account and conservation has to be envisaged on a scale going well beyond that of protected areas, no matter how large they may be.

The development of regional programs

This process required a pooling of efforts that only a regional vision could guarantee. Thus regional programs appeared, encompassing conservation, protected areas, extraction zones, production areas and development. In 1992, the ECOFAC program was launched under the financing of the European Development Fund (EDF). Initially, it intervened in six countries and in 2007 it will enter its fourth stage, incorporating the DRC. In 1995 USAID launched a planned 20 year initiative, the Central African Regional Program for the Environment (CARPE).

Figure 3.1. The Western Lowland gorilla Gorilla gorilla.

Table 3.1. The protected areas of Central Africa.

Country	Area of protected forests		Area under IUCN category I-II		Area under IUCN category V		Area of protected forests in Landscapes		Area of conservation series[3]
	1000 ha	%[1]	1000 ha	%[1]	1000 ha	%[1]	1000 ha	%[2]	1000 ha
Cameroon	2,346	11.9	1,538	7.8	808	4.1	1,257	53	245
Eq. Guinea	515	27.1	354	18.6	161	8.5	382	74	0
Gabon	> 2,919	13.2	2,919	13.2	?	?	2 ,778	95	115
CAR	476	7.6	122	1.9	354	5.7	458	96	0
Republic of Congo	3,265	14.7	2,143	9.6	1,123	5.0	3,211	98	0
DRC	8,989	8.3	6,189	7.3	2,799	2.9	7,562	84	0
Central Africa	**18,510**	**10.2**	**13,263**	**7.3**	**5,245**	**2.9**	**15,648**	**84**	**360**

1) Relative to country's total forest area

2) Relative to country's total protected forest area

3) Zones set aside for conservation within exploitation concessions

[1] Even the national parks that used to contain vast expanses of forest, such as Lopé-Okanda in Gabon, Odzala in the Republic of Congo or Virunga in the DRC, were created around their nuclei of savannah.

[2] Studies in the United States (Soulé, 1987) have shown that to have a good chance of survival in the long term animal populations must comprise a sufficient number of individuals, generally in the thousands. The density of many species in tropical forests is very low, which means that vast areas must be conserved in order to maintain sufficiently large populations.

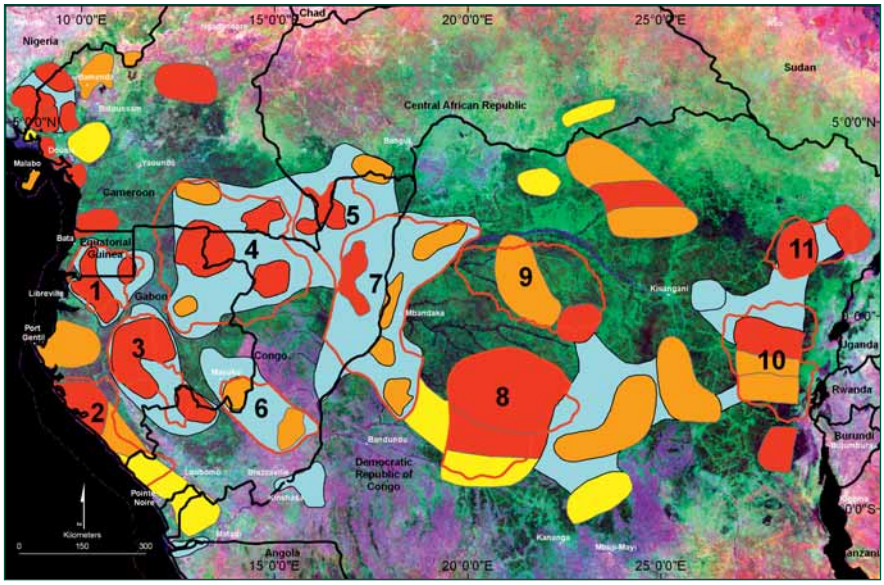


Figure 3.2. Priority areas for conservation and the Landscapes (Sources: ESRI, WWF-US, MODIS, UMD/SDSU).

Simultaneously, the States of Central Africa have been intensifying their regional coordination efforts with a view to ensuring the conservation of biodiversity and the sustainable management of forests throughout the Congo Basin. This desire for cooperation resulted in the signing of the Yaoundé Declaration of 1999 by the Heads of State of six forest countries in the region, the creation of the Central Africa Forest Commission (COMIFAC), the formulation of the 'Plan de Convergence' (Joint Plan) and the launch of the Congo Basin Forest Partnership (CBFP). The desire for cooperation was confirmed at the second meeting of the Heads of State held in Brazzaville in February 2005 (Box 3.1).

Box 3.1. The Congo Basin Forest Partnership (CBFP)

The CBFP is a Type II partnership. As such, it represents a voluntary and free association of multiple stakeholders working to accomplish common objectives. Evidence of its success is apparent in the following achievements:

- In February 2005, it organized the Second Central African Heads of State Summit in Brazzaville.
- It has successfully obtained the involvement of the private sector in conservation.
- It has catalyzed a real collaboration between Central Africa, Europe, and North America.
- It provides support for the majority of national parks.
- It has established real transnational collaboration.

Defining priorities

In practice, the lessons learned from the ECOFAC program, CARPE activities and the initiatives of some major NGOs involved in conservation and sustainable management of forests in Central Africa quickly revealed that it was necessary to define conservation priorities. The Congo Basin forests are too vast and the available funds too limited. Urbanization, as well as the natural loss and degradation of habitats, has also created vast areas where ecosystems no longer function or function very poorly and where the fauna has disappeared or the biodiversity has been impoverished. Moreover, with population growth at around 3% in the Congo Basin, and with timber and mineral reserves among the richest in the world, the Central African nations are obliged to reconcile the integrity of ecosystems with human use. Unfortunately, the forest block is very complex and too poorly known for the priority conservation areas to be easily identified. In order to address this problem WWF organized a workshop in Libreville in March-April 2000 in which over 160 national and international experts in natural and human sciences participated (Kamdem Toham *et al.*, 2006). This gathering of formal and informal knowledge made it possible to identify and map the most important sites for biodiversity conservation in Central Africa (Figure 3.2). Some priority sites cover or harbor existing protected areas; others are located entirely outside of the protected area network.

The Landscape concept

On the initiative of the CARPE program, the priority sites were grouped into large relatively intact areas, termed 'Landscapes', based on their representativeness, the viability of their populations, the sustainability of their ecological processes, their integrity and the resilience of their ecosystems (Figure 3.3). The CARPE program chose 11 of the Landscapes to serve as their basic units for conservation planning and implementation. These Landscapes form a vast network, often crossing national borders. COMIFAC has since adopted this strategy in its 'Plan de Convergence'.

The Libreville meeting focused on low-altitude forest ecoregions, while the region of the Albertine Rift with its Afromontane forests was addressed within the framework of the ARCOS initiative, whose conclusions were not taken into consideration in the choice of the Landscapes. However, it is well known that this mountain region, situated at the transition between Central

Africa and East Africa, contains environments of great conservation interest. Various partners of the CBFP are active in this Landscape, notably the European Union and multiple NGOs. For these reasons, a twelfth Landscape was added to the original 11: the Virunga Landscape, centered around Virunga National Park in DRC.

West Cameroon, probably the richest region of Central Africa[3], with Mount Cameroon, Korup and Campo-Ma'an national parks and numerous forest reserves of great biological interest (Takamanda, Ejagham, etc.) has also not been included in the Landscape network. Whatever the reasons for its non-inclusion in the current network of Landscapes, it is likely that in the future these regions will also have to be included in the SoF process, especially as several CBFP partners are active in West Cameroon.

Similarly, in DRC it will one day be necessary to address the region with the richest mountain forests of the Albertine Rift: Itombwe, southwest of Bukavu (Figure 3.4).

Overall, the CBFP Landscapes cover about 685,400 km^2, covering approximately 38% of the forests in the Congo Basin, and contain around 30 important protected areas (national parks and wildlife reserves). The Landscape network is therefore approaching the threshold of 50% 'protected' land considered necessary to stop extinctions due to human actions. Every Landscape is centered on one or more core zones—generally protected areas—where biodiversity conservation takes priority over other forms of land use. If possible, these zones are linked by corridors so as to combat fragmentation, which is considered to be one of the main threats to biodiversity in tropical forests. Around the core zones, most Landscapes include industrial extraction areas—forest concessions and/or oil concessions—and rural areas with community forests.

With an average area of 62,314 km^2 (ranging from 26,746 to 141,096 km^2), these Landscapes are sufficiently large to cover the territories used by species such as the forest elephant, large hornbills or the giant tigerfish and to conserve viable populations of rare species or species needing large spaces. In effect, each Landscape corresponds to a vast 'ecosystem' consisting of intact core zones, comprised of priority areas for conservation, with extraction and human impact zones increasing towards the edge. The threats to the core zones, which mainly come from the peripheral areas around the Landscapes, can be systematically identified and mitigative measures can be planned. A good understanding of the biological and human components of the Landscapes, obtained through discussions with governments and local populations, as well as research and on the ground experience, can help stakeholders develop and negotiate land use plans that incorporate both zones used for subsistence and zones for commercial exploitation, all the while protecting renewable natural resources.

The value of the Landscape concept is not only the fact that it incorporates protected areas into a wider context, but also and above all that it involves the communities that act in these protected areas, directly or indirectly, in conservation processes (Figure 3.5). In an increasingly democratic world, successful conservation relies on the creation of strong human relations among the main players within the Landscape. These relations

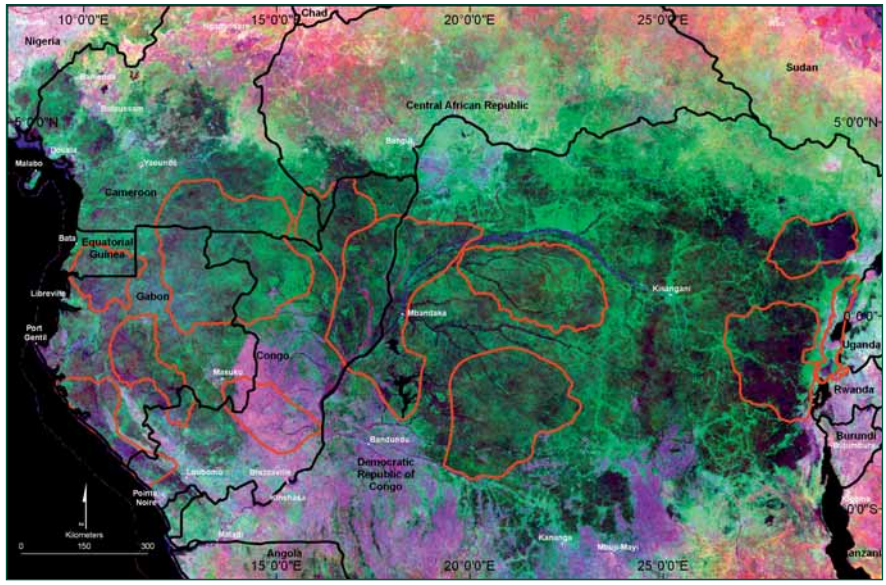


Figure 3.3. The 12 CBFP Landscapes (Sources: ESRI, WWF-US, MODIS, UMD/SDSU).

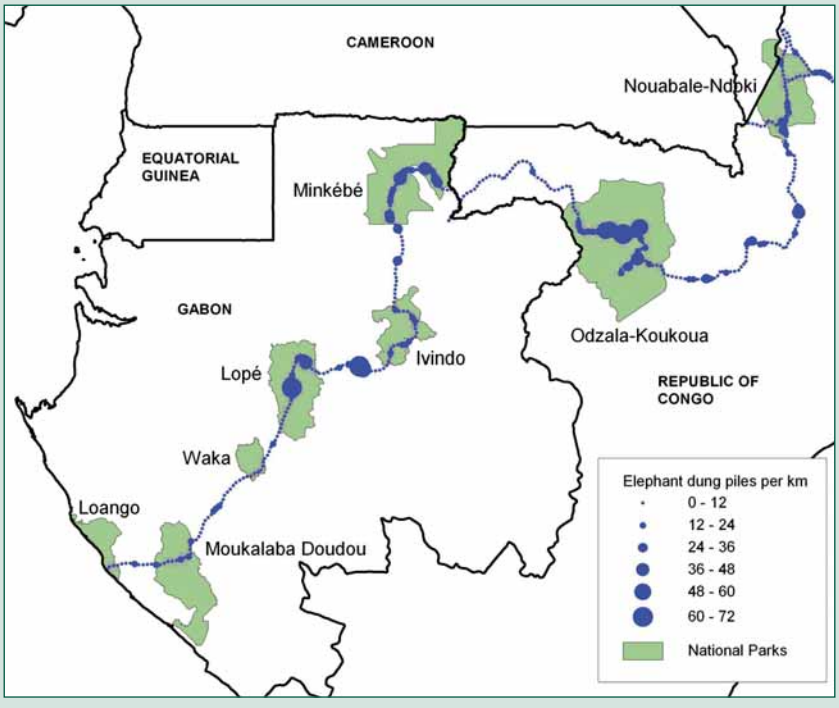
Figure 3.4. The Itombwe mountains have the richest forests of the Albertine Rift region.

[3] The region between the Cross and Sanaga rivers harbors many endemic species, including several endangered primates: : Cross River gorilla *Gorilla gorilla diehli*, Preuss's monkey *Cercopithecus preussi*, the red-eared monkey *Cercopithecus erythrotis*, the drill *Mandrillus leucophaeus*, the northern needle-clawed galago *Euoticus pallidus* and the Calabar antigwabo *Arctocebus calabarensis*.

Figure 3.5. An NGO agent organizing a meeting with the local community around Salonga National Park in DRC.

Box 3.2. Lessons from the Megatransect (1999-2000)

The Megatransect covered a 2000 km swathe of forest from northern Republic of Congo to the Gabonese coast, passing through protected areas and non-protected forest alike. The figure shows clearly the highly significant difference of over two-fold between elephant density inside versus outside protected areas ($Z = 3.24$, $P < 0.0001$). Furthermore, the size of protected areas and distance from the nearest road was strongly correlated with mean elephant abundance.



must be based on mutual respect, trust and common interests. Inside well-defined Landscapes, all stakeholders can be identified and involved. They can participate in negotiations as primary creators and implementers of land management plans designed around a sustainable common future in both ecological and social terms. This approach aims to gain not only acceptance of conservation, but also to promote the appropriation of conservation principles by local communities.

Unfortunately, within the CBFP, some voices are advocating transferring the focus of conservation efforts away from the management of national parks and other protected areas to management of the Landscapes in their entirety. This trend ignores the basic need for the Landscape approach, which aims to improve the preservation of the biodiversity inside of protected areas by incorporating these core zones in a matrix where threats decrease gradually as the boundaries of core zones are approached. The first step towards sound management at the Landscape level remains the establishment of adequate management for its core zones: national parks or other protected areas. Support for this management should include:

- establishing good relations with local populations, local and regional authorities, as well as the private sector, including logging companies
- improving the understanding of the context of conservation activities, including major threats and opportunities at different spatial and temporal scales

- putting in place management systems capable of coping with the increasing demand of Landscape level management
- developing activities that are realistic and feasible about the context in which activities are being implemented

Protected areas remain the only areas where relatively intact ecosystems survive amid an ocean of more or less modified habitats; national parks remain the only areas where conservation is the top priority. Their importance is clearly illustrated in the case of the forest elephant, a species which reflect a reality of conservation because of its extreme sensitivity to human threats. Two studies at the regional scale illustrate this case (Boxes 3.2 and 16.1). These studies demonstrate that wherever forest elephants still exist in Central Africa this species is being pushed into the most isolated forests and systematically eliminated from areas where environmental regulations are not respected. For this species and many others national parks represent their last stronghold and, as such, must remain the focus of conservation. When national parks are truly secure, have sufficient funding and when strong ties have been established between all stakeholders in the Landscapes–NGOs, populations, the private sector and local and national authorities–then it will be possible and necessary to address the many threats and opportunities associated with assuring that development is sustainable from both an ecological and socio-economic perspective over the long term.

The Landscape concept remains a strategic approach to conservation and not an end in itself. The conservation of protected areas, chosen for their biological value and their representativity, remains the priority objective, even if succeeding requires undertaking activities in the peripheral zones. The financial resources available for conservation in Central Africa, as substantial as they may be, are insufficient and can not replace the resources that should be made available for development in general. From this point of view, the immense size of some Landscapes is a challenge in itself and raises the question as to whether it would not be more realistic, in some cases, to reduce these areas to a more realistic size.

Sustainable management of the Landscapes

Planning

The ambitious conservation objectives and the enormous area covered by the Landscapes, combined with the lack of technical or financial means, the isolation of the sites and weak human capacity, constitute a challenge whose scale and implications have not yet been fully appreciated. In each Landscape there are a host of players whose actions are not always coordinated and are sometimes even conflicting (pages 48-62). In this complex human context, effective management to optimize the use of available funds requires rigorous planning based on: (1) the identification of specific objectives, (2) the identification of priorities, (3) the definition of strategies and actions and (4) the establishment of permanent or periodic monitoring.

The conceptual model

All of these management stages must be approached at multiple levels, ranging from the individual management unit to the Landscape and the region. They constitute a logical series of fundamental processes that must result in the introduction of sustainable management, as well as the preparation of the State of the Forest report. There are few systems more complex than the interrelations between humans and their environment or the implementation of sustainable natural resource management. All management planning must therefore include the development of a clear conceptual model of what we wish to achieve and how we want to achieve it. This exercise must be carried out in a transparent manner and involve a representative selection of interested parties from the management team, local partners, other stakeholders and funding agencies. The construction of a conceptual model also improves team spirit and motivation because everyone's experiences and points of view are represented.

The construction of conceptual models is the best way in which to begin planning and identifying the priorities of a new program; unfortunately this technique has not always been applied in the Congo Basin forests[4]. These models can however be introduced at any time, even in long standing programs. Within the CBFP framework, the management history of the Landscapes varies from 20 years of large-scale planning in the Sangha Tri-national to a few months in Landscapes such as Maringa-Lopori-Wamba. The CARPE

[4] An initiative pertaining to this subject that warrants special mention is the planning exercise carried out each year by CNPN to define in a collective manner the annual working plans for the national parks of Gabon.

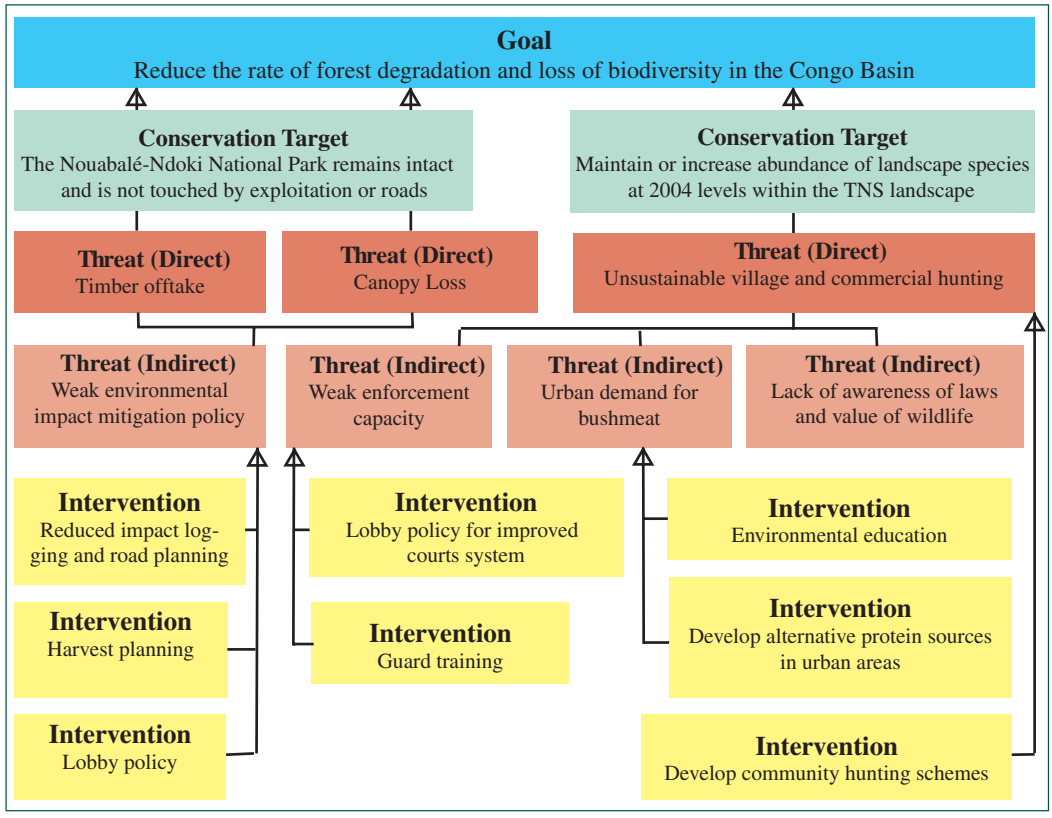


Figure 3.6. Within the context of the CBFP Landscape approach, conceptual models at the Landscape scale can be derived directly from the overall aim set out in the logical framework of the CARPE program. The example included here is based on a more comprehensive conceptual model developed for the Sangha Tri-national Landscape during the strategic planning stage of the CBFP. In this example, the managers decided that the overall aim of CARPE would be partly met once the conservation objectives, focused on habitats and key species, had been attained. In the first stage, the conservation objectives were defined. In the second stage, a meeting was held to bring together the project management team and certain key players to assess and identify priority threats to conservation objectives on the basis of imminence, degree of impact and reversibility. The latter factor took into account both the ability of managers to influence threats and the resilience of the systems involved. The threats over which the project could have no influence, such as global warming, were not included although they were raised in the discussions.

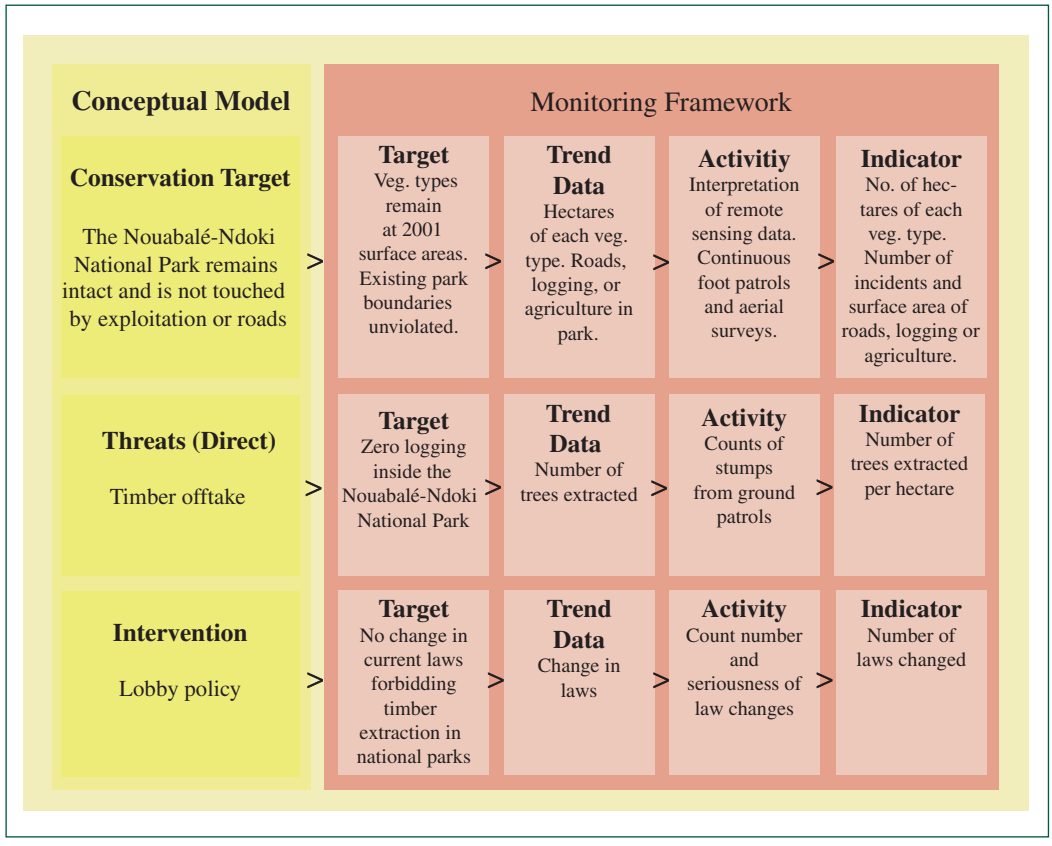


Figure 3.7. To each level of the conceptual model of the program (on the left) is attached a corresponding monitoring component (on the right). The monitoring component begins with a target (a quantitative description of the desired state and the necessary stages to demonstrate quantitatively if the targets are being met). It also includes the data required for the evaluation of trends, activities on the ground and indicators.

Operational Plan, which requires the production of periodic reports, is a starting point. The ultimate objective of CARPE and the CBFP partners is already clearly defined: reduce forest degradation and the loss of biodiversity through an enhanced capacity to manage natural resources at a local, national and regional level. This objective corresponds to one of the Agenda 21 objectives[5].

Whether it is simple or complex, a conceptual model must comprise four components levels:

- the overall aim
- the objectives of natural resources management (a clear description of the conditions desired)
- the threats (practices and policies directly or indirectly affecting attainment of these objectives)
- the interventions (direct actions aimed at stopping or reducing threats)

A conceptual model offers not only a logical and transparent basis for the management of a project, but it also serves as the basis for the development of a monitoring process (Figure 3.6). The construction of a conceptual model for planning, management and monitoring is therefore not an abstract theoretical exercise, but represents a pragmatic way of demonstrating the links between causes and effects in order to plan logically the activities to be undertaken and to test which interventions have positive effects, which do not and why. Management strategies and actions can then be adapted accordingly.

Inventories and monitoring

Given the fact that knowledge of biological and human components in the Congo Basin is still rudimentary, the development of realistic conceptual models requires two basic elements:

- an inventory of the biological and human systems, essential for establishing quantitative bases for evaluating factors considered to be a priority[6]
- monitoring the trends for a series of these factors or appropriate indicators

The durability of management rests on both the capacity to react to challenging circumstances and the capacity for self-evaluation. It is therefore imperative to closely monitor activities and results. To accomplish this task it is important to know:

- the rate of achievement of conservation targets and positive impacts (if they exist)
- management activities that work or do not work and why
- guidelines suitable for adaptive management to ensure that the positive impacts will be maintained and/or improved

The challenge posed by Landscape management, as reflected in the process of preparing the State of the Forest report, consists of determining how and where to invest time, money and effort to compile these inventories and monitoring programs over an area as vast as the Congo Basin, which is so important in terms of global biodiversity, while at the same time working within the constraints imposed by funding, human capacity, security and technical feasibility.

Inventories and monitoring programs have to be based on a rigorous scientific approach and quantitative data. However, the collection and interpretation of appropriate scientific data for monitoring purposes is a major challenge for three reasons:

- Natural systems are dynamic at very different temporal and spatial levels, which makes it impossible to differentiate between abnormal changes and normal fluctuations.
- Human political, social and economic systems are also dynamic at both spatial and temporal levels.
- Interactions between human and biological systems are complex and unpredictable and therefore hide causal relationships.

In Central Africa, these difficulties are exacerbated for the following reasons:

- the size of the forest
- the ecological, cultural and socioeconomic complexity of the region
- war, conflicts and insecurity
- the lack of financial means and capacity
- the conflicts and competition among players, which generate inefficiency rather than synergy

At present, there is no common strategy for carrying out conservation inventories and monitoring in the Congo Basin and one of the objectives of this first State of the Forest report is to begin to lay the foundations for this strategy. For the purposes of this first report, a very broad approach was followed in order to try to compile and understand the extent and depth of the existing information as a first step towards the development of a monitoring strategy. A large number of indicators were selected from existing lists (Annex A-C). They include legislative and socioeconomic indicators as well as indicators for industrial exploitation, land use and biodiversity. The infor-

[5] The Agenda 21 is an action program for the 21st Century aiming at supporting sustainable development. It was adopted by the countries that signed the Rio Convention in June 1992. Its primary objectives are: fighting poverty and social exclusion, the sustainable production of goods and services, and the protection of the environment.

[6] The identification of quantitative bases is a delicate problem; too often there is a tendency to dismiss old data and restart with new criteria. This constant or periodic 'resetting of baselines' serves to mask the real amplitude of processes, notably the degradation of the forests.

mation selected comprises very different spatial scales, ranging for example from that of the entire Congo Basin for assessment of the forest cover to that of the Landscapes, segments of Landscapes or individual management units. A variety of sources were used, including government archives, the archives of private companies, the public domain, such as the Internet, the scientific community and other organizations or institutions involved in natural resource management in the Congo Basin. The information also includes sound quantitative data obtained through remote sensing or field programs, qualitative assessments and, in the absence of anything better, estimates.

Implementation of this State of the Forest process has revealed, for the first time, the enormity of the task ahead for developing a coordinated monitoring process for the whole of the forests of the Congo Basin. Not only has this task proved to be enormous and the resources available limited, but also it has become clear that the results are of critical importance in view of the expectations of the numerous partners and other players. In the future, the planning and rigorous implementation of inventories and monitoring will therefore be of utmost importance. An appropriate framework for the development of these inventories and monitoring programs cannot be determined in a logical manner if the specific objectives of the programs, the threats, the actions and the targets are not clearly defined. CARPE offers a useful framework that has already defined strategic objectives, anticipated results, major actions and critical indicators, as well as requiring the identification and definition of threats. Ideally, monitoring should take three aspects into consideration: (1) management, (2) threats and (3) achievement of conservation targets.

Indicators

As it is unthinkable to monitor in detail the entire conservation process, defining a system for monitoring at multiple levels requires the careful definition of appropriate indicators, as well as collection and analysis methods that are statistically valid, while also taking into account budgetary constraints. In general, the easiest and least expensive is the monitoring of conservation actions. This is followed by the monitoring of threats. Finally, the most demanding is the monitoring of the level of achievement of the conservation targets. Likewise, the monitoring of actions produces results very quickly, whereas monitoring the level of achievement of targets takes a great deal of time. However, confidence limits are highest when the conservation targets are measured directly and lowest when monitoring interventions. For example, it is very easy to count the number of anti-poaching patrols in a national park (an action), but this does not reveal anything about the state of elephant conservation (an objective).

Measuring indicators inevitably requires sampling because complete measurements in socioeconomic or biological systems are rarely possible. Three qualities are vital in the use of management indicators: high precision, low bias and the existence of a causal relationship.

(1) Precision

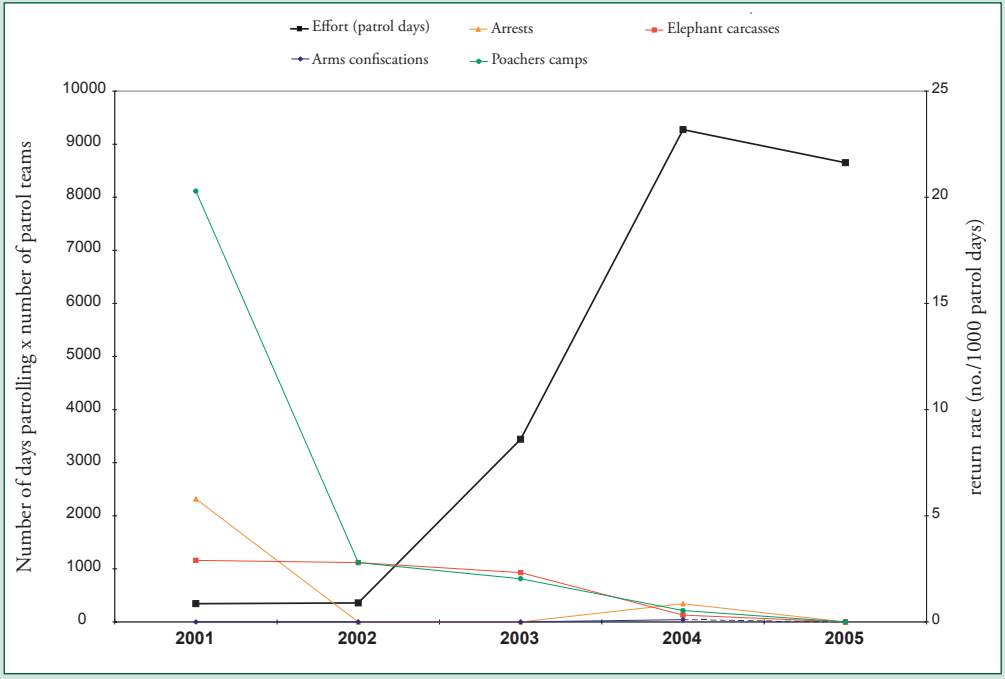
This represents the degree of reliability of an estimate. This is an important issue in monitoring because of the variability in ecological and human systems. It signifies, for instance, that two samples taken from the same population can produce different estimates of the size of this population, even if the two samples were taken at exactly the same time, using the same methodology and on the basis of the same sampling effort. The difference between the two estimates will depend on the size of the samples: the larger they are, the more precise the estimates will be. Thus, a monitoring system must use efficient indicators and methodologies, that is to say those which produce the largest possible sample for a given level of effort. Adequate detection of trends on a temporal scale requires a high degree of precision. If, in a series of household surveys, the estimate of protein consumption has a margin of error of 50%, it will probably not be feasible to detect anything more than a catastrophic decline in protein consumption over a 5-year period, making it impossible to alert managers and the government about a downward trend before the trend has negative effects on public health.

(2) Bias

Results are considered biased when they are not representative of the study population. This problem generally results from poorly designed monitoring. Ideally, monitoring indicators should not be biased and the change in the value of the indicator should be directly proportional to the change in the true value of the factor evaluated. The exact relationship between the two variables must be known.

Box 3.3. Monitoring law enforcement in Nouabalé-Ndoki National Park

In Nouabalé-Ndoki National Park (PNNN) in the Republic of Congo, managers are monitoring both anti-poaching patrol efforts (interventions) and the number of registered infractions (representing the level of threat for target species). The anti-poaching effort indicator is calculated as the product of the number of patrols and the number of teams patrolling. Threat indicators include arrest rates, numbers of elephant carcasses, numbers of seized guns, and the number of hunting camps discovered per 1000 patrol days. Since August 2003, patrolling effort has increased dramatically in reaction to growing evidence of elephant poaching. From 2003 to 2005, threat indicators (number of seized guns and number of arrests) were negatively correlated with patrolling effort. The objective indicator (number of carcasses) was also negatively correlated with patrolling effort, however not significantly. These results do not necessarily mean that a causal relationship exists between anti-poaching efforts and threat reduction or that progress is being made towards conservation objectives. Additional factors could explain these observations. For instance, patrol teams could have lost their motivation and consciously avoided known poaching zones or ammunition supplies for hunting guns could have become more difficult to procure. Nevertheless, it is probable that patrolling efforts are at least partially responsible for the decrease in poaching. Monitoring of law enforcement in PNNN provides a good example of conservation monitoring, but it also demonstrates some of the complexities associated with developing a technically strong monitoring program, even in what appear to be relatively simple cases. In all cases, it is necessary to monitor and include in the analyses as many factors that could be influencing responses to interventions as possible.



(3) Causal relationships

This is essential to understand why a trend in an indicator can change and how to adapt management in an appropriate manner. In reality, a monitoring program is not based on experimental manipulation, but on sampling and the deduction of conclusions is based on correlations rather than recognized causal relationships. Generally a high correlation is often sufficient for management requirements (Box 3.3). Once the requirements of unbiased sampling and the sampling effort itself have been satisfied, cause and effect conclusions with respect to biodiversity can generally be deduced from a spatial analysis. A high and well-documented correlation between the density of elephants and the distance from roads is a good indication that roads represent a threat for this species (because hunting starts from roads).

Apart from having these three essential qualities, an indicator must also:

- reflect changes at both a spatial and temporal level that are useful for management
- be simple to measure and respect the constraints imposed by human and financial resources
- be suitable for the collection, analysis and production of regular reports

Many of the indicators selected for this first report (Annex A-C) do not meet these criteria. Furthermore, there are too many of them[7] and collection of all the necessary data would require resources that are not available. Much work remains to be accomplished in order to define an adequate assortment of indicators that will be recognized by the majority of actors.

Problems of scale

The objectives pursued in conservation, by CARPE for example, are on a regional scale. Yet interventions are made at a local, Landscape or national level.

This diversity of scales leads to several complications. First, it is obvious that not all the indicators are valid at all levels, and thus the choice is bound to be limited. Second, the way in which data from different sites (faced with different threats and different levels of threats) are incorporated into a global system for analysis is of crucial importance if real trends at the regional scale are to be identified.

To incorporate the data in this way, there are three main options:

- The first involves allowing projects to collect quantitative or qualitative data at different sites using methods which are different but which are considered to be the most appropriate. When these data are centralized and analyzed together, a multivariate analysis can pinpoint trends for interventions, threats and conservation objectives. The advances made in analysis processes, particularly Bayesian and spatial modeling, allow valid comparisons on the basis of apparently disparate information.
- The second option consists of designing and implementing a monitoring program on the scale of the entire Congo Basin. This may seem surprising, but economies of scale favor such an approach in many cases, as illustrated by the monitoring of elephants, apes and human activities (Box 3.4). The data are collected, managed and analyzed in a program designed to meet the specific monitoring requirements.
- The third option consists of a combination of the first two, because there will always be specific monitoring requirements for sites and problems that will have to be tackled on a regional scale. The conservation partners will have to coordinate their efforts to find a happy medium between these different options and any coordinated monitoring effort will need appropriate technical personnel.

Data quality

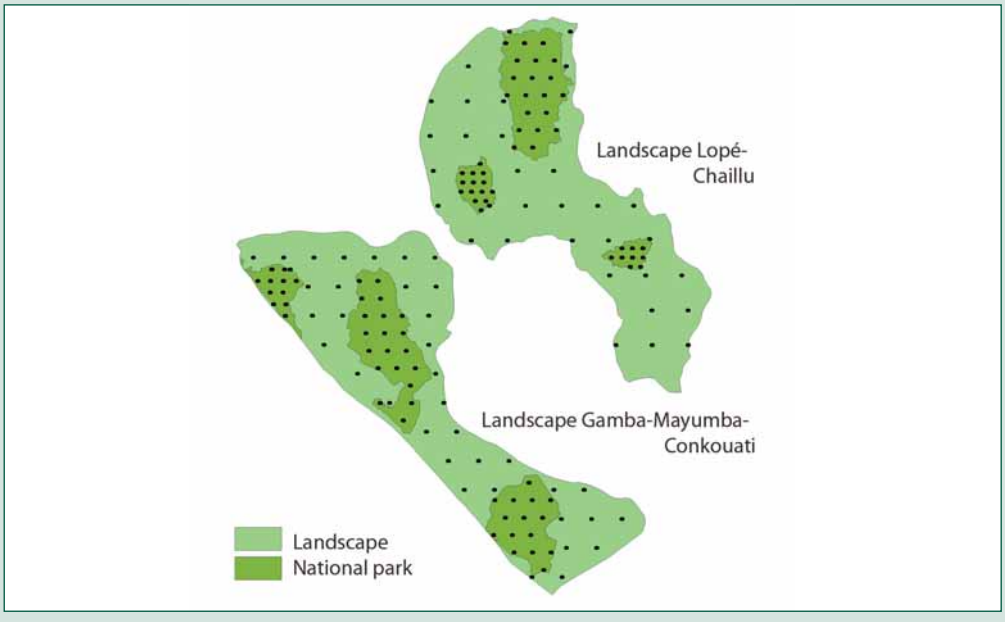
A monitoring program can be no better than the data collected. Quality depends in particular on the design of the monitoring plan, the methodology used for collecting data and the competence of the personnel involved in collection, analysis and interpretation. For instance, different remote-sensing methods used to calculate the area of forest cover are technically valid and justifiable, but can produce different estimates. Choosing the best and most consistent method is not easy. Another problem that is rarely talked about is the fact that the funding agencies, the partners and the pride of some of those involved often put considerable pressure on individuals, projects and organizations to obtain positive conservation results. Consequently, there is a great temptation to manipulate the monitoring data or to interpret them 'erroneously' when they indicate that the targets have not been reached, especially as verification of the quality of data is rarely carried out and is difficult to apply. Overcoming these problems of quality will require considerable investments in training and unbiased independent audits on monitoring practices.

[7] The preliminary list of indicators proposed at the Kinshasa meeting in November 2005 should have been reduced to a small number of essential indicators. Instead, the participants made it longer. In addition, for a good many indicators the data should be easily accessible and the fact that they could not be obtained illustrates the extent to which government archives are badly kept or otherwise rendered inaccessible.

Box 3.4. The cost of monitoring elephant populations in the Congo Basin

The objective of the CITES Monitoring of the Illegal Killing of Elephants (MIKE) program is to provide information to all the States where elephants exist in order to help them make appropriate decisions as concerns management, law enforcement and institutional capacity building for the long term management of their elephant populations. In 2003-2004, MIKE surveyed elephant populations in 6 Central African sites that were distributed over 5 countries and 3 landscapes. The surveys were based on dung counts along linear transects.

Based on these surveys, it is possible to estimate the total cost and effort required to carry out an elephant and great apes monitoring program across the Congo Basin. A reasonable objective for the SoF would include being able to detect a 10% change in population over a 10-year period with an 80% probability of detecting change and a 10% probability of not detecting change even if change exists. To achieve this degree of certainty, the TRENDS program calculates that the variation coefficient of each population estimate should not exceed 0.3. Given dung frequency (0-15/km), 833 transects would be necessary with a stratification of effort in correlation with the expected density. During the MIKE surveys, the mean cost of a transect was US $500. Logistical improvements and greater efficiency could bring the cost down to approximately US $350. Excluding training, equipment and a means of centralized coordination, the total cost of the proposed program would be US $1,200,000. This could be a wise investment given the fact that these types of surveys do not only produce information on living elephants, but also on the illegal killing of elephants, the distribution of legal and illegal human activities, the abundance of great apes, forest structure and composition, and land use and land cover. In addition, such surveys would provide a means to 'ground truth' remotely sensed data. It should be noted, however, that that type of program would be able to detect change across the entire region, but not inside management units or within separate landscapes. Survey efforts carried out in each individual site would be insufficient to detect change at that scale, especially in sites where elephant density is low. Therefore, it remains important that the SoF process establish links with other on-going programs, like MIKE, in order to optimize budget resources and reinforce the political implications and the power of analysis in key conservation zones.



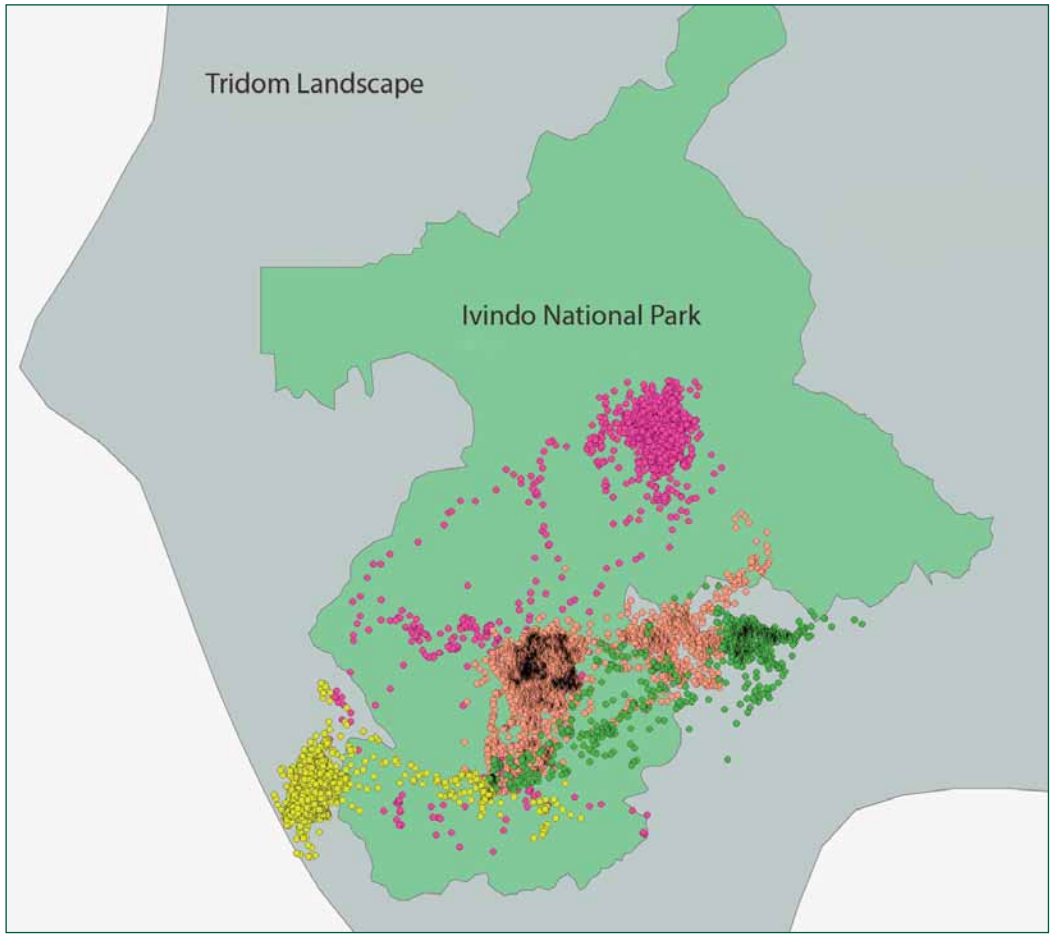


Figure 3.8. The movements of four elephants as watched by radio-tracking in Ivindo National Park in Gabon (scale: 1 cm = 7.8 km).

Data processing and analysis

Data are only useful when they have been suitably processed and analyzed. At the level of projects and programs, this activity is the responsibility of the project (Figure 3.8). However, data that are expensive to obtain and store, in terms of both time and financial resources, should be available for analysis on a regional scale. This would increase the value of the data sets. It is also, above all, a prerequisite for understanding regional plans and processes. The size of the task, in terms of personnel and technical capacity, represented by the collection, collating, organization, analysis, checking and publication of data is considerable and will require suitable personnel with an appropriate mandate. Testing the links of causality between interventions, threats and conservation targets in a system as complex as the Congo Basin is a real challenge on a statistical level. It is therefore essential that the development of monitoring programs should be overseen by statisticians as well as biologists, socioeconomists and managers.

4. Industrial Logging: Current Status and Trends

Industrial logging began during the second half of the 19th century, but it was not until after World War II, with the appearance of bulldozers, front loaders and logging trucks that it really took hold. Initially it was localized in the coastal regions and along the major watercourses, but today it reaches most of the forests of Central Africa, of which about 60% of the total area is considered to be industrially exploitable. Logging thus represents a very important economic sector for the countries concerned: it accounts for between 0.7% (DRC) to 10-13% (CAR) of gross national product and accounts for approximately 20% of jobs, second to mining and/or oil extraction (pages 235-237). Industrial logging also generates a large number of indirect jobs and economic activities in both urban centers and rural areas, particularly in connection with various forms of transport, equipment maintenance, services and small scale agricultural or pastoral projects. Finally, the forest sector largely contributes towards socio-economic development through the construction and upkeep of roads and the creation of health and education infrastructure directly associated with forest concessions. Looking beyond the figures, which highlight its overall development, the industrial sector is undergoing profound changes, not only in terms of its image and people's overall conception of the sector, but also with respect to its management practices.

Surface area, production and export

The area allocated to logging has increased significantly over the last few decades. For the region as a whole, it amounted to 49,400,000 ha in 2004, equivalent to 36% of the total area of production forests and 27% of the total area of dense rainforests. In Equatorial Guinea, Gabon, CAR and the Republic of Congo, 77-93% of the production forests have been allocated (Table 4.1). In DRC, allocations only cover 18% of the production forests due to the fact that many logging permits were cancelled in 2003. At the same time, production has also risen considerably: it reached 8.5 million m^3 for the region as a whole in 2004. In terms of production, Gabon has the highest, followed by Cameroon and the Republic of Congo. In DRC, production remains proportionately very low.

On average, 35% of production is exported as logs. In Equatorial Guinea this proportion rises to 85%, but in Cameroon it is only 6% following the severe legal restrictions on export logs. In terms of absolute volume, Gabon remains the main exporter of logs. On average, 19% of production is exported after undergoing first-stage processing. This percentage is lowest in Equatorial Guinea (5%) and highest in Cameroon (32%).

Table 4.1. Statistics on industrial logging in Central Africa (for further details, see pages 91-105). Total surface areas are derived from MODIS and GLC2000 maps (page 82).

Country	Total area of forests	Area of production forests		Areas allocated in 2004		Production	Log exports		Transborder exports	
	ha	ha	%	ha	%	m^3	m^3	%	m^3	%
Cameroon	19,639,000	12,000,000	61	5,400,000	45	2,375,000	141,000	6	758,000	32
Eq. Guinea	1,900,000	1,500,000	79	1,400,000	93	513,000	438,293	85	27,000	5
Gabon	22,069,999	17,000,000	77	13,800,000	80	3,700,000	1,517,000	41	515,000	14
CAR	6,250,000	3,500,000	56	3,000,000	86	570,000	194,000	34	57,000	10
Republic of Congo	22,263,000	13,000,000	58	10,000,000	77	1,300,000	659,000	50	284,000	22
DRC	108,339,000	90,000,000	83	16,000,000	18	90,000	58,000	64	15,000	17
Central Africa	**180,460,999**	**137,000,000**	**76**	**49,400,000**	**36**	**8,548,000**	**3,007,293**	**35**	**1,656,000**	**19**

The evolution of forestry concepts and the image of the forestry sector

Until 10-20 years ago, the forest was regarded solely as timber-producing capital and a source of revenue and foreign exchange. Meanwhile, within the global context of a growing awareness of environmental problems, the forest is now seen as a complex and multifunctional environment whose ecological, economic, social and cultural functions must be conserved by maintaining its overall equilibrium, avoiding irreversible measures and applying the precautionary principle.

At the same time, the image of the sector has also changed. Until recently, industrial logging had a very negative image: it was the source of the destruction of forests and the disappearance of fauna. It has certainly always had a number of negative impacts on the environment (pages 108-111), but more and more of its potentially positive aspects are also being acknowledged. Not only can it make a lasting contribution towards socioeconomic development, but it can also become a powerful ally of conservation. Examples in the Republic of Congo (CIB), Gabon (CEB) and Cameroon (Pallisco) show that well managed logging is a vital complement to the creation of protected areas, especially as forestry companies generally have more technical and financial resources than the national parks in the region and the latter will never cover much more than 10% of the forest block.

The evolution of management practices

The evolution of forestry concepts has led to the adoption of certain measures aimed at better ensuring the sustainability of the sector.

Management

Over the last decade, the industrial forestry sector has oriented itself more and more towards planning and management, replacing the 'mining' approach to exploitation. The forestry laws in force in the six forest countries of Central Africa also explicitly provide for the formulation and implementation of management plans. This requires a great deal of time and requires the mobilization of substantial human and financial resources. Furthermore, the areas under approved management remain proportionally small: 15 million hectares in 2003 (pages 235-237). The significant improvement in the management abilities of several large companies is nevertheless a positive step towards more rational and ecologically sound exploitation of the forests.

Recognizing the rights of local populations

In recent years, the right of access to natural resources for local populations has received more and more attention in the forest sector. The forestry laws include measures to increase participation by local populations in the planning and implementation of logging activities. They also provide for the sharing of profits generated. Although much effort is still needed to achieve greater equity in this sector, clear progress is being made: several management plans explicitly recognize the right of local populations to use the forests' natural resources and tax redistribution systems have been introduced for the benefit of these populations. In Cameroon, Equatorial Guinea, Gabon and DRC, the forestry laws also provide for the creation of areas managed and logged by village communities —community forests—but so far these have only been implemented in Cameroon and Equatorial Guinea (pages 235-237).

Low-impact logging (LIL)

Approximately ten years ago, a number of techniques and measures, well known for many years but rarely applied, were put forward as a means of considerably improving the sustainability of logging. At the same time, it was also recognized that these measures were insufficient and did not in themselves guarantee sustainability. Large-scale studies show, however, that rational logging practices can increase productivity per hectare while reducing damage to the forest (page 111).

Certification

Many companies are trying to obtain certification, another important step towards improving the sustainability of logging. Several systems exist but the certification process remains complex and slow—taking an average of 4-5 years. A number of major companies, grouped together within the IFIA association and in partnership with the WRI's GFW program, governments and civil society, have initiated the creation of an independent and voluntary monitoring system; FORCOMS. Nevertheless, certification remains a market instrument, directed towards a sector of the American and European markets. It therefore

concerns only a small part of tropical timber consumption and has no effect on the growing Asian market.

The evolution of legislation

Transparency

Improved transparency in the allocation of logging permits is another positive development in Cameroon (Box 4.1), where closed negotiations have given way to public invitations to tender. In other countries, contrary to the law in force, lack of transparency persists. This is clearly apparent in DRC where new concessions have been allocated despite a moratorium (Box 4.2).

Forest taxation

Tax burdens have increased, while few if any incentives have been introduced to encourage the legal obligation of sustainable logging (pages 70-72).

Small-scale logging

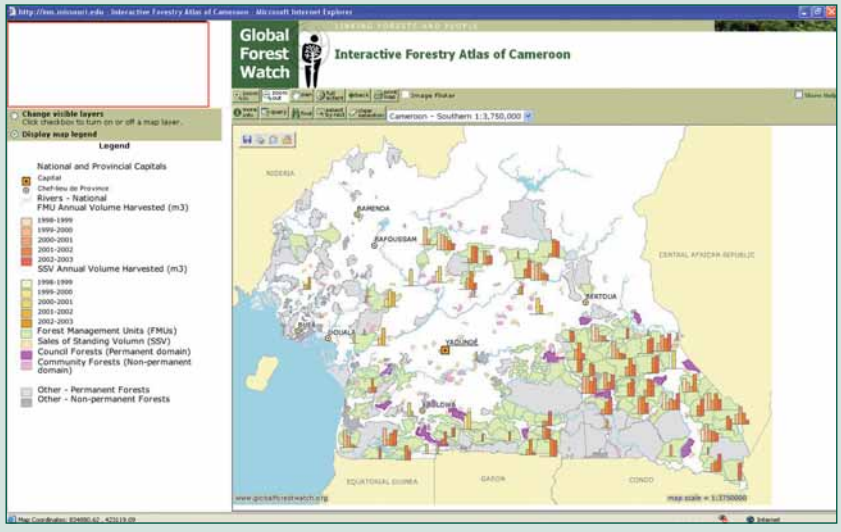
The legislation still does not provide a clear and secure structure for establishing small-scale logging and processing, even though these meet real needs that cannot be satisfied by industrial companies (page 75).

Application of the laws

Governments can be extremely overly fastidious in the application of certain regulations that have little influence on the sustainability of logging. Meanwhile, they sometimes appear to be very lax when it comes to compliance with laws as fundamental as those making sustainable management compulsory, but which could have major political implications (page 76).

Box 4.1. Interactive atlas of forests in Cameroon: the creation of a decision-making tool for the forest sector through partnerships

Within the context of a number of efforts aimed at improving the monitoring of forests, the Ministry of Forests and the Environment in Cameroon (MINEF) and the Global Forest Watch (GFW) initiative of the World Resources Institute (WRI) formalized a partnership to create an interactive forest atlas of Cameroon (Version 1.0). This MINEF-GFW collaboration is aimed at enhancing decision-making by improving the quality and accessibility of geographical information related to the forestry sector. This atlas contains the most recent verified information on the forest sector, including the limits of concessions and useful data on concessions, such as the state of progress on management plans, the year of allocation and annual timber production. A digital map of roads has been specially developed for this atlas through satellite images. The atlas is accessible on the Internet at the addresses http://www.globalforestwatch.org and http://www.minef.com, and in the form of a CD-ROM.



Box 4.2. Moratorium on the forestry sector in the Democratic Republic of Congo

In 1999, as part of an effort to clean up the forest sector, an inter-ministerial commission recommended the cancellation of all logging contracts that had not been inventoried or were not being actively pursued. Following this recommendation the contracts for 25 of the 41 million hectares allocated were cancelled in 2002. At the same time, a national moratorium was imposed on the allocation of new logging contracts. Despite these restrictions, 3 million hectares were allocated, bringing the total area allocated up to 19 million hectares in September 2005. In 2005, however, all existing logging contracts were due to be reviewed with a view to turning them into forestry concessions. This exercise would have led to further cancellations, reducing the total surface area allocated to about 10 million hectares.

Future trends

Improving processing

Not only is it necessary to increase the rate of processing and raise the output of first-stage processing units, but the quality of processed products must also be improved (pages 90-91).

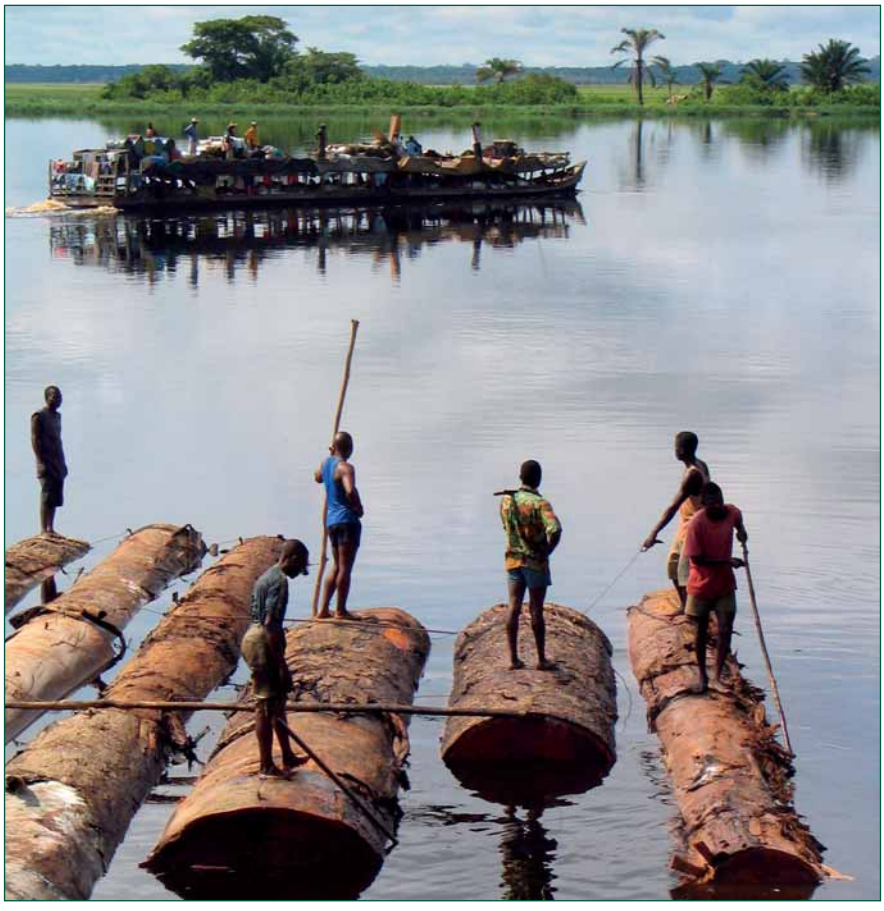
Diversification of species

Within the context of sustainable logging, more species must be promoted (pages 90-91).

Improved economic and fiscal conditions

To achieve sustainability in logging, companies must have a secure framework in which to operate (pages 77-78).

Figure 4.1. Logging in the central parts of the Congo Basin is limited by transportation problems, and is only possible in the vicinity of rivers.



Giving greater consideration to biodiversity

Although a great deal of progress has been made, much remains to be done in this field:

- Low-impact techniques are still based too heavily on purely technical considerations.
- Knowledge of the behavior of species must be improved and integrated.
- Minimum felling diameters must be reviewed.
- Opening up of the canopy must be optimized to ensure that floristic diversity is maintained.
- Sustainability of hunting associated with logging must be taken into account in a more realistic and pragmatic manner.

Taking artisanal logging into account

Only legal recognition of these activities can make them sustainable.

Harmonization of legislation

In the COMIFAC 'Plan de Convergence', harmonization of forestry legislation is seen as desirable, but this should not lead to 'blind' standardization. The different countries have widely differing situations which must be taken into account, particularly with respect to land status (pages 76-77). Harmonization of policies or the 'compatibility' of standards is still ambiguous in so far as the meaning of these terms has not been politically and technically explained. As concerns tax redistribution mechanisms, convergence is running up against institutional differences which go beyond the framework of the forest sector. To these differences must be added specific local political agendas and different types of governance. As far as taxation is concerned, the beginnings of convergence can be seen in the direction reforms introduced over the last ten years in this field have taken, often under the influence of the World Bank. However, important differences remain and the question of taxation remains a sensitive issue in the national political debate. As regards policies on exports and imports of forest products, these too have moved closer together, but the methods differ. Harmonization of legislation should be an opportunity for simplification of the laws and regulations, accenting key rules from the point of view of sustainable management of forest resources and the associated social aspects.

5. Threats or the Vectors of Change

The next ten years will be critical for conservation and development in Central Africa. Population growth, immigration, the aspiration for higher standards of living and increasing demand at the global level, particularly with the rapid development that China is experiencing, will inevitably increase the pressures on natural resources. At the same time, efforts to strengthen capacities, develop monitoring, and improve governance will offer new opportunities to the inhabitants of Central Africa in their search for solutions. In many cases, the threats to the biodiversity and resources of the forests of the Congo Basin are closely linked to the region's economic development. With a comprehensive understanding of these threats and the forces underlying these threats, as well as greater attention to the development of mitigation strategies and compensation systems, a sustainable future for the forests of the Congo Basin could become a reality.

In practice, the loss of resources and biodiversity in the forests of Central Africa is due to three processes, which are not necessarily linked but whose effects often accumulate:

(1) A reduction in the area of the forest, or **deforestation**, can by itself lead to the disappearance of certain species based on the concept that the total number of species in an ecosystem or region is proportional to the area of that ecosystem or region. Of course, there are many other factors that influence the number of species, but it is true that any major reduction in area is generally accompanied by a loss of species.

(2) **Fragmentation** of the forests can also cause a loss of species due to the fact that populations may be divided into unviable subpopulations. It also exacerbates edge effects and increases the vulnerability of forests.

(3) **Degradation** of the remaining forest formations.

The impact of a reduction in surface area and fragmentation is very variable and difficult to predict. Examples in East Africa (Rwanda, Uganda) suggest that these two processes alone must reach an advanced stage before they produce measurable effects[1]. Degradation of the forest formations is therefore the most harmful process that does not directly involve loss of biodiversity, but it is much harder to evaluate and monitor than a reduction in surface area and fragmentation because it is less visible and more difficult to quantify.

Whatever the nature of their real impact, these three processes are themselves the result of various vectors of change that constitute immediate or remote direct and indirect threats. Some of these vectors can simultaneously have direct and indirect effects and certain vectors can produce both harmful and positive effects. Therefore, the overall impact of specific threats partly depends on the context and the presence of other threats. The evaluation of threats remains a delicate exercise with many uncertainties.

Direct threats

Poaching and the trade in bushmeat

In all the Landscapes, with the exception of certain Landscapes in eastern DRC (Ituri), hunting for the bushmeat trade is considered to be the most immediate factor in the degradation of biodiversity (Table 5.1). It leads to the extreme rarefaction or even local disappearance of the hunted species. The bushmeat trade has taken on such dimensions that almost all species of large and medium-sized mammals and birds are threatened.

In many regions, animal populations have already been reduced to such an extent that they will probably not be able to recover and some have become economically uninteresting to hunters (Bennett & Robinson, 2000). In a large part of Central Africa, including certain Landscapes in the center and the east of DRC, the fauna has virtually disappeared from vast areas and only survives in 'pockets'. As many tree species are dispersed by animals (birds, primates, ungulates, rodents, etc.), the disappearance or rarefaction of this fauna can seriously disturb the re-growth of forest formations. However, given the slow reaction time of these formations, these disturbances are difficult to detect and have been little documented thus far. Unsustainable hunting is therefore a multifaceted threat not only to the fauna, but also to the forest and the livelihoods of traditional forest peoples[2].

[1] At present, Kibale National Park in Uganda covers only 700 km^2, but it still has a virtually intact fauna and the primate density in Kibale is far higher than those found in the parks of Central Africa. Kibale's forests are largely secondary forests which only developed after the cattle plague at the end of the 19th century. The Nyungwe forest in Rwanda currently covers 900 km^2 and has lost several large mammals over the last 25 years (elephant, buffalo, giant forest pig and panther), not because of the reduction in the size of the forest - by the beginning of the 20th century it only covered 1,200 km^2 - but because of intensive hunting by gold panners.

[2] By way of example, 15 years ago, and therefore well before the war, malnutrition affected a substantial proportion of children in the forest villages of Kivu and Maniema in DRC, a result of the fact that the fauna had been decimated and transported on a large scale to the urban centers of Kisangani, Goma and Bukavu since the beginning of the 1980s (Vande weghe, 2004). A similar situation was observed in Bandundu province (Steel, pers. com.).

Table 5.1. The most important threats to the forests of Central Africa.

	Alén-Cristal	Gamba	Lopé-Chaillu	Tridom	TNS	Batéké-Léfini	Télé-Tumba	Salonga	Maringa	Maiko	Ituri	Virunga
Direct threats												
Poaching	●	●	●	●	●	●	●	●	●	●	●	●
Ivory trade	●		●	●	●		●			●	●	
Live animal trade										●		
Shifting cultivation	●	●	●	●			●	●	●		●	●
Intensive agriculture										●	●	●
Industrial logging	●	●	●	●	●		●	●	●			
Informal logging										●	●	●
Industrial mining	●			●								
Artisanal mining	●	●	●	●	●					●	●	●
Oil drilling		●										
Pollution		●										
Illegal armed groups							●			●		●
Inland fishing		●			●		●	●			●	●
Fire			●			●	●					
Volcanoes												
Exotic invasive species			●	●	●							
Diseases			●	●	●							●
Collecting of turtle eggs		●										
Inderect threats												
Weak management capacity	●	●	●	●	●	●	●	●	●	●	●	●
Climate change							●					
Marine fishing		●										
Conflicts							●	●	●	●	●	●
Illegal trade of weapon								●				
Demographics	●	●	●	●	●	●	●	●	●	●	●	●
Human-wildlife conflicts				●								
Lack of information	●	●	●	●	●	●	●	●	●	●	●	●
Poor transborder cooperation	●	●										
Poor inter-ministerial cooperation	●		●									
Poor accessibility								●				

[3] The only national park under the MIKE program where the elephant population appears stable is that of Nouabalé-Ndoki in the Republic of Congo.

[4] In Bangui in CAR, elephant meat, especially smoked trunk, is highly appreciated and sells at 200,000 CFA a sack.

[5] The two main markets are China and Japan. In 2000, Japan bought 60% of all the ivory marketed; in 2005, China became the leading purchaser of ivory.

The effects of excessive hunting are especially difficult to assess objectively as observations in several Landscapes show that they represent a relatively recent phenomenon that have only emerged or started to spread over the last 20-25 years:

- Community techniques like the use of nets have given way to new, more effective and more individualistic techniques, including guns and wire snares (Figure 5.1 and 5.2).
- Hunters are going much further from their base to hunt and practically no forest remains out of their reach (especially in DRC).
- Neither laws nor traditions are respected.
- Modern means of transport allow the products of hunting to be more easily transported to market — including by bicycle if necessary. Many of the roads and track used were created by logging activities.

Moreover, what was once a subsistence activity has now become a commercial activity generating monetary income. This development emerged in parallel with the deterioration of the economic situation. In DRC, it began during the 1970s and reached catastrophic proportions with the instability and war in the 1990s. Even in Gabon (Gamba-Mayumba-Conkouati Landscape, Lopé-Chaillu-Louesse Landscape) and Cameroon (Tridom Landscape), many observations show that the development of hunting is linked to economic recession and urban unemployment. Hunting is therefore not only a traditional activity of forest peoples; for many, it has become a last resort.

The ivory trade

In many areas, the ivory trade (Figure 5.3) has already led to the local extinction of elephants. Recent CITES studies under the MIKE program reveal that most elephant populations in national parks are declining[3]. In vast regions of DRC, particularly in the Maiko-Tayna-Kahuzi-Biega and Salonga-Lukenie-Sankuru Landscapes, elephants have become very rare. Elephant hunters are increasingly using the meat of the animals that they kill[4]. These hunters are often specialists, armed and supplied with ammunition by a complex network of dealers and civil servants, the 'heads' of which are located in the urban centers. Elephant hunters supply markets outside of Central Africa, including in West Africa and Asia[5].

Figure 5.1. Only Pygmies still hunt with nets, an activity which requires the collaboration of the whole social unit.

Shifting cultivation or swidden agriculture

Shifting cultivation on burned land, as traditionally practiced in low-altitude forest regions in Central Africa, is not in itself a threat to the forests, even in a relatively populated country such as Cameroon (De Wachter, 2001). This practice has been part of the ecosystem for many centuries and contributes to its diversification and rejuvenation by maintaining a mosaic of crops and forests of different ages[6].

This form of agriculture only becomes a problem when the fallow period becomes shorter and shorter and more and more 'primary' forests are cleared. This generally occurs along main roads and on the outskirts of urban centers (Figure 5.4). Given the low human population density in the forests of the Congo Basin, the overall impact of this predictable and legitimate development is not yet perceived as a major threat, but strips of deforestation are starting to occur along the main roads, particularly in DRC, Cameroon and Equatorial Guinea. In these areas, fragmentation of the forest is visible on satellite images (Figure 1.1). In Gabon, deforestation is still limited to the extreme north (province of Woleu-Ntem) and to the southwest in the Republic of Congo (Mayombe).

Figure 5.3. Confiscated ivory in eastern DRC.

Permanent or intensive agriculture

In the densely populated mountainous regions and high plateaus of western Cameroon and the east of DRC, a form of virtually permanent agriculture is developing with very short (1-2 years) or even non-existent fallow periods. In these same regions, there is also local stock farming (particularly cattle), which exacerbates the impact of agriculture on the forest formations: abandoned fields are turned into pasture and any secondary reforestation is prevented. The inhabitants of these regions make very little use of the natural resources from the forest and often only regard the forest as land awaiting 'development'. The paradox of this situation is that the remaining forests are often in a fairly good state with relatively abundant fauna, due to the fact that hunting plays only a marginal role. Given the high population densities in these regions, deforestation nevertheless reaches dramatic levels: about 0.3% per year in the Maiko-Tayna-Kahuzi-Biega Landscape (page 86). These mountainous areas are considered 'hot spots' of biodiversity, in particular the high altitude forests of western Cameroon and those of the Albertine Rift, not so much for their species richness, but because they contain many endemic species.

Unsustainable industrial logging

Industrial logging in the forests of the Congo Basin currently affects about half of the forest block (pages 241-252). It is generally of low intensity, the number of trees being felled for sale being around 0.5 to 3 per hectare, with a maximum of 4 per hectare. However this process is very selective, with the degree of selectivity being much higher inland (DRC, northern Republic of Congo) than in the coastal regions (Gabon, Cameroon) because companies can only harvest species whose commercial value exceeds the cost of transport to the ocean. In many regions, this exploitation is still of the 'mining' type, in which only the very highest value specimens are taken (écrémage – literally creaming off the best specimens), and is not ecologically sustainable. Despite laws and regulations, this practice continues because of current political and social uncertainties and fluctuations on the international market.

From a social point of view, many believe that timber exploitation results in the inequitable redistribution of profits to local populations and national governments. However, this is a very complex problem, because ultimately it is the international timber market that determines what is feasible and what is not. Recently a number of

Figure 5.2. A blue duiker in a trap.

[6] In most of the Congo Basin, farmers burning forests clear a small plot every year (0.5 to 1.5 ha), usually at the expense of secondary forests aged between 15 and 20 years. Few primary forests are cleared due to the fact that it requires considerably more effort.

Figure 5.4. When population density increases, cleared areas increase and fallow periods become shorter. Primary forests give way to secondary forests and, finally, to scrub land.

companies, some of them leaders in sustainable management, have tried to pull out because of increased tax pressure.

From the environmental point of view, industrial logging has both inevitable direct impacts (Figure 5.6), including damage to the remaining forests (5-20% of the surface area) and various kinds of other disturbances (noise), and avoidable direct impacts, including soil erosion, water pollution, reduction in regenerative capacity and loss of genetic diversity (pages 108-111). Logging also increases human populations in the forest, removes nutrients and escalates forest fragmentation. However, many of the indirect impacts of logging can be avoided, including: increasing access to forests, hunting, deforestation, fires and the introduction of exotic species.

In practice, the use of low felling rates reduces the relative threat posed by the direct impacts of logging and makes increased hunting the most immediate threat posed by industrial logging. The threat posed by hunting is the result of increased access to forests, a growth in human populations and better means of transporting the meat to markets. Using their wages, the employees of logging companies can buy arms and ammunition or wire for snares. They can also hire the services of members of their families or outsiders to hunt on their behalf. In some places industrial logging of the forest also facilitates the installation of agriculture.

The departure of companies can also present a problem: a portion of the personnel emigrate in search of work elsewhere, but a portion also remain on site and rely on forest resources while waiting for another logging activity to start up. This scenario has been witnessed in Conkouati in the Republic of Congo and Bayanga in CAR.

However, it would be a mistake to assume that the dramatic increase in hunting is only the consequence of industrial logging. In eastern DRC, there is little or no industrial logging, but hunting is nevertheless highly developed—in areas where there is still some wildlife left—and hunters will travel 100 or 200 km from their village of origin to hunt.

Informal logging

Outside the industrial sector there are informal, or artisanal, forms of logging. These forms supply local markets with construction timber and firewood. Surveys carried out in Cameroon suggest that these forms of logging involve larger volumes of timber than those from industrial logging. They have been little studied and statistics are scarce. Their impact could be more serious than that of industrial logging, especially as they are not subject any kind of regulation. In the Kinshasa region, the destruction of forest galleries on the Batéké plateau, up to 150 km away from the city, has reached alarming proportions. In estern DRC, substantial but unknown volumes of hand sawn timber are exported to East Africa and the Arab Emirates. In Cameroon, charcoal from *terra firma* forests and mangroves is exported to Chad and Nigeria. It is therefore urgent to pay more attention to this sector, especially as it plays a fundamental socioeconomic role.

Mining

A large part of gold and diamond mining is conducted by small scale artisanal operators in small rivers and streams. In recent years the mining of coltan (a vital mineral for manufacturing cell phones and other electronic appliances) has increased significantly and has attracted international attention due to the severe environmental degradation caused by current practices. Working in small watercourses destroys these fragile ecosystems. Direct impacts, *in situ*, are generally fairly localized, but sedimentation and pollution can spread a long way from the mining sites. The indirect impacts are also considerable: agricultural activities tend to be abandoned and poaching tends to increase. Diamond mining is the main economic activity in CAR and some regions of DRC. Open-cast mining is rare. However, one of the largest iron ore deposits in the world is in Gabon, around Monts Minkébé and Monts Bélinga in the Tridom Landscape, and the mining of these deposits is now being considered. Mineral pros-

pecting also started in Monts de Cristal National Park (Monte Alén-Monts de Cristal Landscape) in 2005. Failure to apply better practices for appropriate attenuation of environmental impacts and a lack of compensatory measures are clearly a threat to forests and biodiversity in the Congo Basin.

Apart from direct threats, small-scale mining also has significant indirect consequences. In the mining regions, men give up agriculture, but as they obtain monetary resources they create markets for forest products (including bushmeat) from neighboring regions. In the south of the Salonga-Lukenie-Sankuru Landscape, bushmeat and fish are transported to the diamond-bearing regions of Kasai (page 187).

Oil extraction

The oil industry is important in the Gulf of Guinea and in the forests of the coastal sedimentary basin. The economies of Equatorial Guinea, Gabon and the Republic of Congo are heavily dependent on this industry. In the Gamba-Mayumba-Conkouati Landscape (page 130), this industry is a vital player and, despite the efforts of the big companies to mitigate them, substantial negative impacts on the environment have been observed. Pollution and the effects of seismic surveys remain worrying problems[7]. A major cause of damage seems to be or to have been the inappropriate abandonment of boreholes and pipelines. The oil industry also has indirect impacts, in particular an increase in local poaching as a result of the increased access to forests, despite mitigation efforts at the social level. In the long term, major problems are also to be expected when reserves are exhausted and the populations settled there by the oil industry, including within some protected areas, are abandoned and left to their own devices. Some populations will probably emigrate, but others will again turn to the natural resources at hand. Overall, the impact of oil companies varies considerably from one company to another and it would be unfair not to mention the enormous financial support offered by some large oil companies for conservation (Shell Gabon, Total Gabon).

Inland fishing

In the Congo Basin, aquatic environments and forest environments are intimately linked: more than 7% of forests are temporarily or permanently flooded. Although in both DRC and the Republic of Congo war has caused an overall reduction in fishing, what fishing remains has become concentrated in safe areas, where it has become unsustainable due to the excessive concentration of fishermen and the use of destructive techniques (nets with a smaller and smaller mesh, poison and explosives).

Figure 5.5. Fishing has been a primary activity for a long time, but during periods of conflicts, such as in DRC for the last 10 years, many people abandon other activities to concentrate on fishing.

Elsewhere in Central Africa, fishing effort has increased in recent years and fishing remains the primary source of protein for a considerable proportion of the populations throughout the region (Figure 5.5). Very few impact studies have been carried out. However, and the suggestion that a slow degradation of the aquatic resource may aggravate the already precarious food security situation of the populations involved remains a cause for concern. It appears that several species of fish have already disappeared from Lake Tumba in DRC (page 181) and another species from the Nkomi Lagoon in Gabon (page 132). In a large part of the Ogooué Basin, fishermen complain of a serious reduction in their catch and the existence of territorial conflicts among groups of fishermen, especially in Cameroon, clearly shows that there are problems with access to fish resources. Only close cooperation among fishermen, scientific partners and administrations responsible for fisheries or conservation can ensure the sustainable management of fishing and aquatic resources. With the exception of the attempts made in the Lake Télé- Lake Tumba Landscape, there are virtually no known examples of such cooperation.

Finally, the introduction of exotic fish also constitutes a threat, not only for biodiversity but also for production. Fisheries in the center of Cameroon, for instance, are suffering from the introduction of Nile perch *Lates niloticus*.

[7] Pollution is concerned not only with major visible forms of pollution – black tides – but also constant pollution in small doses which could have more insidious effects that are more difficult to control, particularly on cetaceans. As for seismic surveys, they have the potential to disturb cetaceans during the reproductive season (mating, birth, suckling of calves) (Rosenbaum & Collins, 2006).

Diseases

Animal health, human health and biodiversity are closely linked. The best examples of this relationship are provided by malaria, HIV/AIDS and Ebola, all of which are having devastating effects on local human capacity in forest management, conservation and the environment. In addition to its occasional effects on humans, the Ebola virus has been exterminating great apes and other species of fauna in great swathes of forest for thirty years. The Landscape most affected is Tridom (page 153). The Sangha Tri-national Landscape could follow. These two Landscapes contain or used to contain the largest populations of Western gorillas -*Gorilla gorilla*- in the world. Insufficient knowledge of the links between human health and animal health, combined with a lack of infrastructure capable of minimizing the effects of epidemics, constitute major threats to sustainability in the region. Diseases could also have impacts even when they are not present. The halt on imports of poultry into Gabon, because of a fear of the bird flu epidemic spreading, could have unexpected effects on the bushmeat market.

Invasive species

In many places, invasion by exotic species, plant or animal, is an important factor in degradation and the loss of biodiversity. In tropical humid forests this phenomenon is generally not very prevalent and is rarely taken into consideration, with the exception perhaps of the plant *Chromolaena odorata* (page 111) and the ant *Wassmannia auropunctata*. As it has been such a long time since an invasive species has caused real problems, nobody is really paying attention to the issue, so it is likely that when a problem does surface it will be too late to take effectual measures. The case of the water hyacinth *Eichhornia crassipes* on the Congo River is a good example.

Indirect threats

Population growth

In most Landscapes, hunting is identified as the most immediate threat, but in the Landscapes of eastern DRC—Ituri, Maiko-Tayna-Kahuzi-Biega and Virunga—the most urgent problems are related to demography. These Landscapes are seeing an influx of people from the densely populated regions of the Albertine Rift. This is not a new phenomenon[8], but it has accelerated substantially over the last few decades and could become totally uncontrollable in the years to come with the return of security and the rehabilitation of roads.

Throughout Central Africa the human population is expected to grow from 76 million in 2005 to over 185 million in 2050 (Table 5.2). In the least populated countries, this may not cause any fundamental problems, but in Cameroon, Equatorial Guinea and DRC demographic pressures will become very intense. This is significant since human pressure is at the root of many of the above-mentioned threats.

In the least populated regions, particularly Gabon, an increase in immigration from West Africa will be virtually inevitable. This will exacerbate the pressure on natural resources, especially as immigrant populations are unfamiliar with the environments that they colonize and are generally more 'destructive' than the original resident populations[9]. This immigration could well give rise to social tensions.

Road construction

Roads are absolutely essential for development, but they fragment the forests, favor the advance of agriculture and facilitate hunting and trade in bushmeat (Figure 5.6). The damage that they cause is usually the result of a lack of planning and non-compliance with the laws in force. In certain cases, roads have positive effects and attract populations away from the forests, sometimes even out of protected areas. In effect, they allow these populations to develop activities other than hunting and gathering[10]. The construction or rehabilitation of roads is therefore a very ambiguous problem that, more than any other problem, requires an objective, rational and multidisciplinary approach (Wilkie *et al.*, 2000).

Lack of development of national parks

Other regions of Africa that tourism in national parks constitutes not only a way of developing parks, but also an important means of attenuating conflicts between conservation and local populations. However, tourism in the national parks of Central Africa is very poorly developed (or non-existent) at present and for many local populations the reasons for protected areas are poorly understood. In several countries in the region, the lack of development of national parks is due to unfavorable political and/or economic situations, but in other countries tourism could be developed.

[8] Already by the end of the colonial era, Rwandan populations were emigrating to regions immediately to the west of the Rift, particularly Walikale. In the 1970s and 1980s, Shi from the Bukavu region emigrated to the low regions west of the Rift, and in the 1990s Rwandans moved to the Walunga region and further west in the direction of Shabunda. The wide cultural differences between the immigrants and the resident populations, from both the social point of view and from the point of view of agricultural practices, generated permanent conflicts.

[9] For example, Nigerian populations who are moving into the mangroves of Gabon have begun to cut down mangroves for firewood, including within national parks.

[10] In eastern DRC, the reconstruction of the Bukavu-Walikale road at the beginning of the 1990s attracted populations away from Kahuzi-Biega National Park.

Climate change

Although our knowledge of the effects of climate change in the Congo Basin is very limited, various studies suggest that in the long term they could be severe. Many localized endemic species could succumb to even slight changes in the climate. Montane species will see their habitat shrink and perhaps even disappear. An increase in seasonal and inter-annual variations and the more frequent occurrence of extreme climatic events could affect the forest formations, especially fragmented formations. In turn this could increase the pressures on human communities whose livelihoods depend on these resources.

Pollution

At present, soil pollution does not appear to constitute a major problem in the region. It remains localized and linked to urban areas and industrial activities. However, capacities for monitoring and protecting the environment from pollution are extremely low in the region and could be masking the true extent of the problem. For instance, mining and the growing urbanization and industrialization of certain regions considerably increase the risk of negative impacts. The storage of chemical residues by foreign companies has been noted as a worrying problem. In addition, pollution from the mining industry, which has become totally anarchic in DRC (Kasai, Katanga, etc.), could be even more serious and constitute a major threat for portions of aquatic ecosystems. Pollution of the oceans, independent of that caused by hydrocarbons, should not be underestimated either: the beaches of Gabon, particularly in the Gamba-Mayumba-Conkouati Landscape, are covered with waste from the Pointe-Noire region, Kinshasa, Brazzaville and Angola (page 133).

Marine fishing

The marine environments are far removed from the forest ecosystems, but industrial fishing could have consequences for terrestrial biodiversity. Industrial fishing started to develop after World War II and has increased considerably along the coasts of the Gulf of Guinea over the last few decades. In many cases, current regulations are ignored. Monitoring capacities are also minimal or non-existent. The agreements on coastal fishing are often not very transparent and are disadvantageous for the national governments. Finally, some parts of the Atlantic coast of Central Africa are being invaded by fishermen from West Africa. Certain communities have even moved into protected areas and fish intensively in spawning grounds and nurseries[11].

Artisanal fishing and industrial fishing have complementary effects and together are leading to the overexploitation of fishery resources. Even in inland areas, sea fish, often salted, represent an important source of proteins for local populations, supplementing fish from the rivers, lakes and lagoons[12]. In the long term, the reduction in maritime production will inevitably step up the pressures on other resources, mainly those in the forest ecosystems.

Table 5.2. Human population in Central Africa: state in 2005 and predictions for 2050 according to the UNFPA.

Country	2005	2050
Cameroon	15,456,000	37,290,000
Equatorial Guinea	465,756	1,122,000
Gabon	1,225,853	2,682,000
CAR	3,562,367	7,689,000
Republic of Congo	2,716,814	8,597,000
Democratic Republic of Congo	53,277,195	(131,475,000)
Total	**76,701,000**	**188,000,000**

Figure 5.6. Road construction.

[11] In Akanda National Park in Gabon, there are approximately 500 Nigerians and other West Africans who live essentially on fishing. The men fish far away from the coasts using longlines, while the women comb the banks in the national park, which serve as nurseries for 'shrimp' fishing (Vande weghe, 2005).

[12] In Makokou in eastern Gabon, about 400 km from the sea as the crow flies, small restaurants serve as much or more sea fish than freshwater fish, depending on the season.

Urbanization

In general, human populations in Central Africa are highly urbanized (up to 80% in Gabon). This urbanization has led to an exodus from the forests to the urban centers, reducing the rural populations and their impacts on the forests. However, urban populations continue to depend on available forest resources. All towns and cities have large game markets and consume enormous quantities of firewood.

In addition, waste treatment, sewage and pollution have become major problems. Urban services are unable to keep up with the dramatic growth rate and the environmental problems that urbanization generates. Finally, urbanization also draws the most skilled labor and the 'brains' to the towns and cities, leaving the rural world to fend for itself[13].

Displaced populations and conflicts

Some countries in the region (CAR, Republic of Congo, DRC) or neighboring regions (Angola, Uganda, Rwanda, Burundi) have been ravaged by wars and/or civil disturbances that have led to large numbers of refugees and displaced persons. Despite United Nations assistance, these populations have been forced to depend on the country's natural resources and live in places where their impact has been very severe, both on natural ecosystems and on local populations. This problem is particularly acute in eastern DRC, in the Virunga Landscape and the Maiko-Tayna-Kahuzi-Biega Landscape. Furthermore, the conflicts have been financed to a large degree by logging, the ivory trade or diamond, gold and coltan mining.

World energy requirements

The problems of the post-petroleum period are manifest within the Landscapes, as is the case with the Gamba-Mayumba-Conkouati Landscape where oil extraction currently occurs. In the long term, they also risk affecting the whole forest block. The production of bio-fuels (plant-based fuels), a technology that could assume a scale of unknown proportions in the future, could affect enormous areas in the tropical regions.

The underlying causes

Corruption and the lack of good governance

These two problems are undermining progress towards conservation and sustainable management of forest resources in Central Africa. Corruption and bad business practices are causing or maintaining a lack of transparency and good governance in the awarding of forest concessions, often in contravention of the laws and regulations in force. This situation, along with growing tax pressure on companies, is perhaps discouraging long term investments vital to improving the sustainability of the forestry sector. Poor governance also diverts part of the profits from the exploitation of natural resources and reduces equitable distribution among the populations in the region.

Lack of institutional capacity

The limited allocation of government budgets to conservation means that many departments responsible for forests and fauna are understaffed and suffer from poor morale. This leaves these departments extremely weak. Knowledge and technical know-how to monitor the state of biodiversity are lacking and local populations are incapable of effectively safeguarding the natural resources on which they largely depend. In some countries, however, a growing national commitment to conservation is resulting in an increase in support from funding agencies for these departments, enabling more training and career opportunities. Despite insufficient funds and weak capacities, the commitment to conservation is considerable in some regions. In DRC, for example, the national park guards remained on duty during the war, endangering their own lives.

Insufficient long term funding

Conservation is a long term objective that requires long term investments. However, the principal funding agencies currently operate on short term planning cycles, generating the cyclical appearance and disappearance of projects. For the whole of Central Africa, 19 protected areas have short term financing, 11 medium term financing and only 4 long term financing (Annex C). Many newly created protected areas, or protected areas that have been neglected for many years, only exist on paper. Turning them into functional entities requires a sustained commitment, lasting decades and supported by substantial funding and capac-

[13] For many university graduates, or holders of higher technical diplomas, assignment to a post far from town is too often regarded as a sort of administrative punishment.

ity building. The financing of conservation must be both long lasting and continuous. Too many programs suffer periods of interruption during which the personnel become less effective and poachers redouble their activities.

Lack of understanding of problems of scale

The understanding of the fundamentals of conservation must be strengthened in the Congo Basin at all levels. Many people living in or outside the region think that the forest is infinite and its resources inexhaustible. Even if the political commitment in the region is strong, efforts must be made to ensure that the value and vulnerability of these forests are understood by both the general public and government agents, so that the latter can make decisions more soundly based in conservation and the sustainable management of natural resources.

Lack of capacity among NGOs and community based organizations

Community based organizations must be strengthened and given the power to make a real contribution to the sustainable management of natural resources, but in most of the forest regions of Central Africa traditions in this direction are poorly developed. Societies are of an acephalous nature and the traditional decision-making processes at the level of the villages or communities are very complex. In addition, decisions taken at local level often conflict with those taken at the national level. The knowledge, traditional values and know-how of the local populations can contribute to the sustainable management of certain natural resources, but not all of them. For instance, there is no traditional knowledge of logging, an activity introduced by foreigners. In addition, community management runs up against a number of serious socio-cultural problems: traditional management of community forests does not correspond to traditional political practices and community forests risk becoming a political issue (Delvingt, 2002).

Lack of data, monitoring and evaluation

Lack of knowledge about the distribution and state of biodiversity is a major obstacle for conservation and sustainable development in the Congo Basin. Not only are the exact distribution and current size of the populations of most species unknown, but also very few reliable historical data exist. Furthermore, the few existing historical data are often either ignored or called into question. It is therefore virtually impossible to set realistic baselines for monitoring and evaluation. Yet the rapid decline of animal populations in the forests of Central Africa is a process that began a long time ago. Management at the Landscape level, however, is a new concept in Africa and the creation of baseline datasets is only just beginning. Improving tools and capacity is therefore essential so that decision-makers can have permanent access to the information in order to make the best possible decisions. The lack of available data is also partly a result of the slow-down in research since the end of the 1970s. This is largely due to the reduction in funding allocated to research and insecurity in certain regions. To some extent it is also a result of the administrative difficulties created by some actors in the region.

6. Priority Actions

The ultimate objective of CARPE and the CBFP is to reduce the rate at which biodiversity is being lost in the forests of Central Africa. As we have seen (page 33), this loss is due to deforestation, fragmentation and degradation. Reducing biodiversity loss comes down to combating these three processes. However, simply reducing the rate of loss would only postpone the problem and in the long term the end result may be the same. Consequently, we should go further and, wherever possible, 'totally' stop the loss of biodiversity at a time and a level that are considered acceptable. It is with this objective in mind, that the concept of 'priority actions' should be considered.

This is a very ambitious objective and clearly it can only be attained—if it ever really can be—in the long term. Therefore, action to combat deforestation, fragmentation and degradation must comprise multiple strategies:

- short term actions aimed at combating the most pressing threats so as to preserve the existing resource pool by preventing irreversible damage
- long term actions aimed at stabilizing a situation, which otherwise could deteriorate irreversibly

In addition, the planning and implementation of conservation measures must remain focused on protected areas. The Landscape approach only makes sense within this context and the objective of Landscape management should remain the conservation of priority areas for biodiversity, which most likely means focusing on protected areas.

Actions in the short term

Management of hunting

In all the Landscapes, with the exception of the Ituri and Maiko-Tayna-Kahuzi-Biega Landscapes, hunting is the primary or most visible threat. In many regions of Central Africa hunting has already caused serious and perhaps irreversible damage. Species that are particularly vulnerable are in real danger. In DRC, the elephant and several primates, particularly red colobus monkeys *Piliocolobus sp.*, have become rare, highly localized and some isolated populations are probably no longer viable in the long term. In Cameroon, several species of primates with a limited distribution, notably the drill *Mandrillus leucophaeus* and the Preuss's guenon *Cercopithecus preussi*, are species of concern in conservation. The primary reason for this situation is the fact that over the past 25 years, in parallel with economic collapse or recession, hunting has become a highly commercial activity. Whatever the causes of this development, it is important to curb it, at least in key areas (protected areas and large concessions) where there are still sufficiently large animal populations and where there is a reasonable possibility of successful intervention. Action must be undertaken at two levels.

(1) Actions to combat poaching

Actions to combat poaching must be stepped up both in the protected areas and in select forestry concessions in order to preserve sufficiently large populations of target species. Both oil and forestry concessions play an important role due to the fact that they encompass very large areas, the extraction companies control access to their concessions and they often have more technical and financial resources than national parks. On the ground, this action must be based on the technical means available: mobile patrols, fixed posts, checks on roads, trains and national airlines and, above all, informants. Indeed, in several Landscapes, infiltration of villages by informants has shown itself to be one of the most effective methods of combating poaching. Within forestry concessions, controlled access or track closures, through passive or preventive methods, have been shown to be effective[1]. However, implementing such proven techniques requires long term financial support, trained personnel and political support at all levels.

(2) Monitoring and controlling trade

In urban and village markets, it is necessary to ensure that the existing laws concerning both bushmeat and ivory are applied. To accomplish this, the agents involved in this activity (police, gendarmerie, water and forests agents, customs officers, etc.) must be trained and made aware of the situation. In other regions of Africa, the laws governing hunting and the trade in wildlife are more respected and this should also be possible in Central Africa. Offenders should be prosecuted and, where applicable, sentences need to be enforced. This will require improved awareness among high level officials in administration and the courts. A few rare examples, particularly in the Gamba-Mayumba-Conkouati Landscape, demonstrate that the effective application of pen-

[1] It has also emerged that it is easier to prevent poaching from increasing than to stop it once it is well established and has garnered support in urban areas.

alties can reduce offences considerably. However, for this strategy to have lasting effects it may be necessary to review and adapt certain laws in order to bring them more into line with regional traditions. In forestry concessions in particular, the main bases and camps must be guarded, access to these areas must be controlled and marketing of wildlife outside the concessions must be prevented. Such measures are all part of low impact logging practices already being carried out in certain concessions; it is essential that these standards be extended.

Logging

The environmental impacts of logging are numerous and, in addition to controlling hunting and the marketing of bushmeat, it is imperative to apply low impact logging techniques and act against illicit logging by enforcing regulations and laws. To accomplish these tasks, it is essential to encourage management of concessions that incorporates biodiversity considerations and local populations in the following:

- providing legal protection to companies
- applying laws
- creating tax incentives
- developing partnerships between logging companies and conservation NGOs

Forest management objectives and actions undertaken need to be tailored to the type of forest and the nature of logging. For instance, the young okoume forests on the central plateau of Gabon, particularly in the Lopé-Chaillu-Louesse Landscape, are much less 'fragile' than the old forests of the Monte Alén-Monts de Cristal Landscape. Each partnership between a logging company and conservation NGO must also reflect these considerations. In particular, the conservation zones within logging concessions must be chosen according to their value for biodiversity and not their lack of value for logging. Going beyond conventional conservation actions, this type of partnership can help make logging and the appropriate manipulation of forests, a tool for the management of biodiversity.

In several countries, most notably Cameroon, Gabon and the Republic of Congo, there are already a number of partnerships with large companies. Effort must also be made to involve smaller companies; their impact is often more insidious, but also more detrimental, than large companies. In the Lopé-Chaillu-Louesse and Monte Alén-Monts de Cristal Landscapes in Gabon, numerous small companies play a preponderant role (page 117). Engaging small companies is a challenge that should not be underestimated as these companies often have limited technical and financial resources, a short term vision and are managed or owned by politically important persons who generally do not want anyone intervening in their business.

Specific or local actions

(1) Industrial mining

In several Landscapes there are potential but imminent threats from industrial mineral extraction. In such cases, it is important that the agencies in charge of conservation, both governments and NGOs, are involved from the beginning in conducting impact studies to minimize these threats by appropriately adjusting certain developments. It is also essential that these impact studies are not reduced to simple rituals for which there is no follow up. They must result in the introduction of monitoring systems.

(2) Oil extraction

In the Gamba-Mayumba-Conkouati Landscape, large oil companies (Shell Gabon, Total Gabon) have made a substantial contribution to conservation and research through partnerships with NGOs. These partnerships must be strengthened and extended to include smaller companies less concerned with environmental problems. In particular, it is necessary to introduce maritime pollution detection or monitoring systems as well as strict standards to ensure conservation of critical marine species and habitats during the exploration and extraction phases. At present, the necessary process for assessing environmental impacts is applied on a case-by-case basis with little or no independent scientific supervision (Rosenbaum & Collins, 2006).

(3) Nature tourism

The development of tourism in national parks should be supported because not only does it contribute to the national economy, but it also can improve the perception of these protected areas and attenuate certain conflicts with neighboring populations. This is currently the case in Gabon, where the establishment of tourism companies must be encouraged.

However, in the development process it is important to bear in mind that:

- Not all national parks have the same tourism development potential—biodiversity and tourist value are two very different things—

and during the start-up stage this industry should concentrate first and foremost on the parks with the highest tourism potential, so as to minimize the risks associated with investment in this field. All facilities must be planned to protect nature and investors alike.

- Although ecotourism—a form of tourism developed as much as possible with, and to the benefit of, local populations—should be promoted, it does not constitute an alternative to the development of conventional tourism and generally can only be successfully developed on a sustainable basis in conjunction with conventional tourism (King & Stewart, 1996).
- As in the case of logging, tourism must be developed by tourism professionals, preferably in association with the conservation movement, but not by the conservation movement alone[2].

(4) Public health problems

In certain regions of Central Africa, human health problems have emerged in conjunction with wildlife disease outbreaks, most notably the formidable Ebola virus. The risk of such outbreaks and their negative impacts will increase as forests are opened up. In the countries affected, it is important to launch national information campaigns to teach populations how to minimize the risks of animal-human transmission.

(5) Fishing

Both inland and at sea it is vital to enforce laws and regulations concerning fishing. These need to be applied at the industrial and small-scale to curb illegal fishing and the use of destructive fishing methods.

(6) Communications

It is essential to develop communications via the national media so as to obtain the support of the populations through national NGOs and civil society.

[2] Tourism is a complex economic activity that involves several types of professions and is subject to commercial rules and constraints that only professionals in the sector can handle. Too often, however, tourism development programs are initiated by conservation experts—and also these days by social scientists—without calling on tourism professionals.

[3] 'Montane' habitats in particular are well suited for this type of protected area: isolated mountain peaks and inselbergs, for example, often contain very important species even though these features have never covered vast areas.

Actions in the long term

Planning and zoning

It is inevitable that substantial areas of natural forests will be lost and/or fragmented in order to free land for agriculture, agro-forestry, industrial plantations, mining and the creation of infrastructure, such as roads. Neither deforestation, nor fragmentation, can be stopped, but it must be planned to preserve sufficiently intact areas of forest to be able to maintain biodiversity and forest resources. The intent of this report is not to decide what percentage of the forests should be conserved, but to stress the absolute necessity of identifying and respecting a permanent forest domain in each country and each Landscape, comprised of all the forests that are intended for conservation or sustainable logging.

In practice, zoning should include the identification of the following categories of zones: protection zones (protected areas); permanent forest domain zones, with production forests and their associated conservation areas; mining zones; important hydrological zones; urban zones; and rural development zones for village-scale hunting, agriculture, community forestry and forest or agro-industrial plantations. The preparation of zoning plans requires multiple stages of work or the implementation of numerous actions that are not necessarily linked, but are often complementary.

Zoning is also essential to protect investments, for example in the field of tourism. Zoning is particularly important in regions subject to high demographic pressures, such as the Ituri and Maiko-Tayna-Kahuzi-Biega Landscapes, which have seen an influx of populations from the Albertine Rift.

(1)Designing the network of protected areas

Central Africa already has a substantial network of protected areas, but some regions or ecosystems are either under or poorly represented. In each country, an evaluation of the protected areas system should be carried out and adapted if necessary so as to maximize the protection of biodiversity, the resilience to climate change and the tourism potential. This network should aim to cover 15% of the surface area of natural habitats and consist of a combination of large blocks capable of preserving all the functions of the ecosystems and species with large home ranges, and smaller blocks intended for the protection of species or habitats with a localized distribution[3]. In certain countries, the networks of protected areas are relatively new and were designed based on numerous

factors (Box 6.1). Elsewhere, protected area networks are more established, but through a lack of means or knowledge, some protected areas were demarcated in a somewhat opportunistic manner. In other cases, specific protected areas may be too large or poorly designed. In these countries, the networks need to be revised. In Cameroon and DRC, for example, several protected areas still exist on paper, but no longer exist on the ground. Finally, some habitats are still under represented in the existing protected areas

(2) Demarcation of Landscapes

As with many protected areas, the Landscapes, whose limits were drawn at the beginning of the present millennium, must be reassessed and possibly modified. Certain regions and protected areas where CBFP partners are active should be incorporated in new Landscapes in order to include currently under-represented ecosystems. For instance, the fact that the protected areas of western Cameroon have not been included in one or more Landscapes should be rectified. These montane or submontane forests have never covered very large areas and are now surrounded by large human populations, but this should not be a deterrent to conservation. After all, many of the national parks in East Africa are surrounded by more dense human populations and they are still successful. Conservation of smaller forests is probably more difficult, but it can also demonstrate that conservation 'by the people, for the people' is more than a slogan. Examples in Uganda and Rwanda suggest that this can become a reality.

Adaptation of laws

For zoning to be recognized and respected, it is essential to resolve the mismatches and contradictions that exist between the laws promulgated by States and land rights claimed by local populations. In particular, villagers' rights must be recognized, including for example, the right to prevent outsiders from hunting in their territories. Open access and the fact that game is common property are major obstacles to establishing the sustainable management of hunting[4].

Box 6.1. The national parks network in Gabon

In Gabon, the national parks network created in 2002 was the result of a national evaluation of priorities in the field of biodiversity, including the most recent knowledge of forest refuges, predictions in the rise in sea levels, resilience in the face of climate change, botanical diversity measured in real terms, the presence of substantial concentrations of large mammals, the diversity of birds, reptiles, amphibians and fish, potential for logging or mining activities and human activities (socioeconomic studies mapped the areas used by villagers around all the sites selected). A second phase, involving a new evaluation, is currently under way to identify sites of smaller surface area, particularly cultural sites, in order to increase the area of the network from 3 to 4 million hectares or from 11% to 17% of the area of the country. Marine reserves will also be created.

Establishment of genuinely sustainable logging

Even when applying low impact logging practices and following management plans, it is unlikely that logging will be able to satisfy the demands of our growing population. Numerous studies on different continents have shown that the natural regeneration of nature's renewable resources is rarely if ever sufficient to offset logging, except in marginal cases of little used resources. Revision of the forest codes, actions to combat illegal logging and various forms of support for management plans are important steps towards sustainability in the short term, however, these actions will be insufficient to guarantee long term sustainability[5]. For this, it is vital to develop a vision in which the planning process integrates silviculture techniques and biological knowledge of the forests, particularly forest dynamics and the ecological behavior of the species harvested.

Unfortunately, very little research has been carried out in this field over the past 40 years, despite the fact that basic scientific knowledge has developed considerably. Too many CBFP partners are preoccupied with short term emergencies and ignore the fact that decisions taken before logging begins influence everything that follows, including future timber production. As a result, industrial logging in Central Africa is in a vicious circle of repeated logging cycles in which every 20 to 30 years —if not less—the baseline data are reset to zero, masking the inexorable impoverishment and degradation of the production forests.

[4] In Europe too, there are countries where hunting rights are not linked to property law or land use. It is in these countries that protection of fauna poses the most problems.

[5] This is a complicated problem due to the confusion that exists between logging and forestry. The former is an industrial activity that consists of harvesting the naturally occurring forest resources and relies solely on natural regeneration. The latter is an applied science that relies on appropriate manipulation of the forest cover to guarantee sustained and lasting production; it is practiced by highly qualified professionals.

This future vision of forests and forestry must entail different approaches in different places. In areas immediately surrounding protected areas, the emphasis must be placed on the 'light' harvesting of natural forests that are subject to little manipulation; elsewhere, more 'aggressive', but also more productive forestry must be developed in order to meet the demand for timber.

Establishment of systematic monitoring

It is important for conservation to be based on activity and results monitoring, so as to be able to adapt management to each new set of circumstances. This requires increasing capacity and research.

Capacity building

In all fields, including protected area management and logging, it is necessary to train technicians at all levels to implement the actions envisaged[6].

In the field of protected areas:
- skilled personnel for management of national parks (Figure 6.1)
- personnel capable of carrying out biological monitoring
- good guides, a prerequisite for the development of tourism in the forest environment

In the field of logging:
- technicians at all levels, especially in DRC, provide the most effective means for on the ground implementation of the forest code

In the general field of the environment:
- experts capable of carrying out environmental impact studies

In addition to this, general environmental education should be promoted to assure sufficient support from civil society to pass on conservation and sustainable management concepts to more influential national and/or local NGOs.

Research

Although most funding agencies are not currently interested in financing research, it is clear that research is still essential. Indeed it is the key to all progress.

In the field of logging:
- Knowledge on the distribution of species must be improved, in order to be able to evaluate logging potential more precisely and formulate realistic management plans.
- The ecological niche and dynamics of commercial species must be much better understood so that appropriate silvicultural techniques can be developed.
- Known, but often neglected, silvicultural techniques must be adapted to regional and local conditions and opportunities.

In the field of biology:
- Knowledge on the distribution of plants and animals must be improved in order to evaluate more objectively the networks of protected areas[7], this research must be approached in terms of 'gaps' in knowledge both at the spatial level and at the level of the choice of species; in particular, it is necessary to go beyond the classic flagship species[8].
- Baseline data must be collected to develop essential biological monitoring systems for the evaluation of conservation activities and the impacts of logging.
- Poaching and the bushmeat trade must be the subject of socioeconomic studies so as to gain a better understanding of the unknowns that govern these illegal and widespread activities, which are constantly adapting to the constraints and opportunities that present themselves.
- Freshwater and marine ecosystems, so important for human populations, must be studied so as to be able to determine their sustainable utilization; in many regions, it is not even known what species are present and virtually nothing is known of their biology.
- It is necessary to study pollution from the large towns and cities in the region in order to identify means of control.

[6] In the DRC, no technician has emerged from the forestry colleges for over 15 years. This highlights the lack of trained staff available to formulate concession management plans.
[7] Certain biodiversity 'hotspots' are not included in protected areas merely because they are not sufficiently known.
[8] Flagship species often have a fairly vast distribution and are subject to substantial hunting pressure. It is necessary to add 'control' species that are not subject to pressure from hunting and can provide clearer information on the impacts of changes in the Landscapes.

Figure 6.1. In many regions of Central Africa, like here in Virunga National Park, training of rangers remains an essential component of conservation activities.

In the field of climatology:

- It is necessary to study at the regional level what are, or could be, the real consequences of climate change, what can be used to limit greenhouse gas emissions and what means exist to improve or preserve carbon storage.
- It is necessary to study how to preserve the resistance of the forests to expected changes—the problem of climate change must be included in planning and zoning.
- Initiatives should be based on the recognition of carbon storage in natural forests, via the Kyoto protocol, through the establishment of an *ad hoc* lobby.

To encourage research, it is not only necessary to have sufficient funding, but it also necessary for States in the region to facilitate the development of research. In addition, national institutions and researchers must take a real interest in field research, which is often difficult and seen as being of little benefit. It is important to ensure that the overall quality of research does not suffer in the process.

Development of sustainable funding

All the activities mentioned above will require substantial financial resources and it is essential to develop sustainable funding mechanisms in order to avoid initiatives with no long term future.

Figure 6.2. Very large old trees will only survive in national parks. Here an okoume or Gabon mahogany Aucoumea klaineana *in Ivindo National Park.*