OCCASIONAL PAPER

Deforestation and forest degradation in the Congo Basin

State of knowledge, current causes and perspectives

Bérenger Tchatchou
Denis J. Sonwa
Suspense Ifo
Anne Marie Tiani

CIFOR

OCCASIONAL PAPER 144

Deforestation and forest degradation in the Congo Basin

State of knowledge, current causes and perspectives

Bérenger Tchatchou
Denis J. Sonwa
Suspense Ifo
Anne Marie Tiani

Center for International Forestry Research (CIFOR)

Occasional Paper 144

ISBN 978-602-387-021-9
DOI: 10.17528/cifor/005894

Tchatchou B, Sonwa DJ, Ifo S and Tiani AM. 2015. *Deforestation and forest degradation in the Congo Basin: State of knowledge, current causes and perspectives*. Occasional Paper 144. Bogor, Indonesia: CIFOR.

Translation of: Tchatchou B, Sonwa DJ, Ifo S et Tiani AM. 2015. *Déforestation et dégradation des forêts dans le Bassin du Congo : État des lieux, causes actuelles et perspectives*. Papier occasionnel 120. Bogor, Indonesie : CIFOR.

Photo by Ollivier Girard/CIFOR
Between Kinshasa and Lukolela, view from the Congo river.

CIFOR
Jl. CIFOR, Situ Gede
Bogor Barat 16115
Indonesia

T +62 (251) 8622-622
F +62 (251) 8622-100
E cifor@cgiar.org

cifor.org

We would like to thank all funding partners who supported this research through their contributions to the CGIAR Fund. For a list of Fund donors please see: https://www.cgiarfund.org/FundDonors

Contents

List of figures and tables

Figures

Tables

Abbreviations

AFD	French Development Agency
AfDB	*Banque africaine de développement* (African Development Bank)
CAR	Central Africa Republic
CEMAC	Central African Economic and Monetary Community
CIFOR	Center for International Forestry Research
CO_2	Carbon dioxide
COBAM	Climate Change and Forests in the Congo Basin: Synergies between Adaptation and Mitigation
COMIFAC	Central Africa Forest Commission
COP	Conference of the Parties
DRC	Democratic Republic of Congo
DSCE	Document on Strategy for Growth and Employment
DSCRP	Document on Strategy for Growth, Employment and Poverty Reduction
DSRP	Document on Strategy for Poverty Reduction
ECCAS	Economic Community of Central Africa
EGEP	Gabonese Investigation on the Evaluation and Monitoring of Poverty
FAO	Food and Agriculture Organization of the United Nations
PFD	Permanent forest domain
NPFD	Nonpermanent forest domain
GDP	Gross Domestic Product
ICASEES	Central African Institute of Statistics and Social and Economic Studies
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
IUFRO	International Union of Forest Research Organizations
LSDV	Least squares dummy variable
MINAGRI	Ministry of Agriculture
NTFPs	Non-timber forest products
OFAC	Observatory for Central African Forests
ONFI	*Office national des forêts International* (ONF International)
PACEBCo	Congo Basin Ecosystems Conservation Support Program

REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation, sustainable management of forests, conservation of forest carbon stocks and enhancement of forest carbon stocks
RPP	Readiness Preparation Proposal
TREES	Tropical Ecosystem Environment Observations by Satellite
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change

Foreword

Recognizing the possible synergies between adaptation and mitigation, in 2010 CIFOR initiated the project Climate Change and Forests in the Congo Basin: Synergies between Adaptation and Mitigation (COBAM).

The general objective of COBAM is to provide policy makers, practitioners and local communities with the information, analysis and tools they need to implement policies and projects for adaptation to climate change and reduction of carbon emissions in the forests of the Congo Basin, with equitable impacts and co-benefits – including poverty reduction, enhancement of ecosystem services, and protection of local livelihoods and rights.

The present report analyzes the state of deforestation and degradation of the Congo Basin forests with a view to proposing to policy makers the means by which to reduce deforestation and the related emissions from deforestation and degradation.

We wish to thank our collaborators and partners for their contributions. Our gratitude goes to Youssoufa Bele for the translation of this document from French to English. Thanks are also due to Richard Sufo Kankeu for his hard work in editing figures and pictures, and to the whole COBAM project team for their assistance.

Last, we gratefully acknowledge COMIFAC, the African Development Bank (AfDB) and the Economic Community of Central African States (ECCAS) through their Congo Basin Ecosystems Conservation Support Program (PACEBCo).

Executive summary

The Congo Basin contains the second largest tropical forest after the Amazon. It extends over six countries: Cameroon, Congo, Gabon, Equatorial Guinea, Central Africa Republic (CAR) and Democratic Republic of Congo (DRC). The forest cover of the DRC is more than 166 million hectares and alone represents more than 62% of the Congo Basin forest, which is made up of 69% of dense forest and only a little more than 30% of other types of forest.

The rates of deforestation and forest degradation in the Congo Basin are low compared with other regions of the world. However, the net deforestation rate has increased from 0.09% between 1990 and 2000 to 0.17% between 2000 and 2005. This increase has been worsened by the DRC, where the rate has doubled between the two periods, from 0.11% between 1990 and 2000 to 0.22% between 2000 and 2005.

The contribution of the forestry sector to GDP and to the economies of the countries presents an overall downward trend. However, this trend is not the same for all countries: while the curve is decreasing in Cameroon, Equatorial Guinea and the DRC, it is stable in Congo and Gabon and in constant growth in CAR.

In the six countries of the Basin considered, several causes can explain deforestation: the direct causes, such as infrastructure development or agricultural expansion; and the underlying causes, such as economic development or population expansion. Nevertheless, agriculture constitutes the main cause – in particular the slash-and-burn agriculture practiced by the different populations.

The industrial wood production in Cameroon has evolved over time, with output changing from 2.3 million m^3 in 1991 to about 3.5 million m^3 in 1997, before falling to 2 million m^3 in 2000, and then rising to 3 million m^3 in 2005. Gabon is also one of the major producers of logs, with production varying between 2 and 3 million m^3.

Most of the study countries aspire to the Emergence at various stages. They have developed strategies based on the development of key sectors, such as infrastructure, agriculture, forestry or mining. An analysis of these strategies and their links with the future evolution of the forest cover has led to several assumptions.

1. The development of infrastructure. Gabon and Equatorial Guinea intend to develop their countries. As such, they are planning to open new road networks. However, this cannot be done without destroying portions of their forests. Cameroon, on the other hand, has no plans to open up new roads, but rather to improve the quality of the existing road network. However, Cameroon is planning to build more than 3000 km of railway, principally in the forest regions of the country. This construction represents 2330.5 km of additional lines to open. If a 10-meter-wide strip across the entire infrastructure is assumed, then the loss of forest cover would represent 2330.5 ha. Many hydroelectric dams are also in the planning stages and these would serve to reduce the energy deficit. For the single case of the Cameroon, more than 24 hydroelectric dams are projected to be installed, of which the most important are the dam/reservoir of Lom Pangar and the hydroelectric dam of Memve'le: these last two alone would cause respectively the destruction of more than 3220 and 2010 ha of forest.
2. The development of agriculture. Cameroon intends to increase its cultivated areas by 30% compared with 2005 levels, with a view to ensuring food security while also strengthening growth and employment in this sector. This will induce the deforestation of

more than 1025 million hectares. Gabon also plans to substantially increase its agricultural production by extending the use of arable land. However, it is not possible to estimate the resultant loss of forest cover due to the lack of data.

3. Forest exploitation. Each country intends to stabilize the production of logs and even to ensure their local processing with a view to increase the value added of the sector and to supply the domestic market.
4. Mining. The development of this sector could lead to the destruction of more than 943,725 ha of forest in Cameroon, considering the ambitious mining program of the country.
5. The underlying factors. The dynamics in the medium-term indicators such as demography, economy and others, show potential impacts on the forests if development strategies developed by the various States are applied. The population of the region will double by the year 2035 if the rate of population growth observed during the last 20 years is maintained. This implies that, according to the agricultural plan, production should be doubled, leading to a considerable increase in the cultivated areas at the expanse of the forest.

At the institutional level, each country of the region has a ministry in charge of forest and the environment. However, the strategies of development are not always consistent with the concerns of forest preservation.

Therefore, in the absence of decisions and vigorous actions, deforestation will increase substantially in the countries of the region because of large programs that are being put in place in view of their emergence. For instance, Cameroon, a country for which data are available, could lose more than two million hectares of forests by 2035.

1 General introduction

Deforestation and forest degradation are two phenomena which are at the basis of the implementation of a new instrument of economic incentives adopted at the 13th Conference of the Parties (COP-13) of the United Nations Framework Convention on Climate Change (UNFCCC), held in Bali in 2007 (UNFCCC 2007). This mechanism, initially restricted to just deforestation, has expanded to include forest degradation under the acronym of Reducing Emissions from Deforestation and Forest Degradation (REDD).

Understanding the causes of deforestation and forest degradation is the first step to overcoming the challenges that REDD+ will have to address. To date, the final architecture of the REDD+ mechanism is still being negotiated with a reference to the United Nations Framework Convention on Climate Change (UNFCCC) to finance the reduction of carbon emissions related to deforestation in emerging developing countries.

REDD+ is a strategy to mitigate climate change by limiting CO_2 emissions to the atmosphere, the gas that is widely acknowledged as being responsible for global warming. The share of CO_2 in the atmosphere due to deforestation and forest degradation varies from 12 to 18% of the total amount emitted per year to the atmosphere (IPCC 2007; Friedlingstein et al. 2010).

Deforestation is defined as the conversion of forest land to another land use or the long-term reduction of this parameter below a 10% threshold (Kanninen et al. 2007).

Reports on tropical deforestation indicate that deforestation happens in various places and that the underlying causes are not always easily identifiable (Rudel and Roper 1996). Geist and Lambin (2001) also stress that these causes vary, depending on the continents.

The development of agriculture, transport infrastructure, forest exploitation, charcoal production and mining are considered as the main factors that lead to forest destruction in the world. However the degree of impact of each factor varies from one continent to another and from one country to the next.

Several direct causes may explain the deforestation and forest degradation: slash-and-burn agriculture, collection of wood energy, mining, forest exploitation and infrastructure development.

There are also structural or underlying causes: population growth, macro-economic factors (consumer credit, GDP, industrial production, unemployment rate, imports), the deconstruction of traditional societies and the alteration of traditional practices (Geist and Lambin 2001).

The direct cause of deforestation or forest degradation is the one that has a direct action on the forest area (e.g. clearing for agriculture in all its forms or the development of basic infrastructure such as the construction of roads). In Africa, the causes are the same as those noted around the world, with the development of agriculture as the primary factor of deforestation (FAO 2010). As a matter of fact, slash-and-burn agriculture is responsible for 60% of the total deforestation, while permanent agriculture accounts for approximately 10% (Simula 2009).

The indirect or underlying causes, also called structural causes, are those that trigger or explain the direct causes. These include, for examples the social factors that influence the behavior of agents of deforestation, such as economic, ethnologic,

demographic, political, institutional or cultural factors. There are also social events that trigger deforestation such as armed conflicts responsible for the migration of populations.

The purpose of this study is to identify current and future causes of deforestation in the six countries of the Congo Basin (Cameroon, CAR, Congo, Gabon, Equatorial Guinea, DRC). Essentially bibliographic in nature, this study relies on scientific publications and on a rich gray literature made up of official documents, theses, and research and workshop reports.

This report is structured around four main sections. The first presents the methodology and the theoretical framework; the second presents the state of knowledge on deforestation and forest degradation in the Congo Basin; the third analyzes current causes of deforestation and forest degradation; and the last makes a prospective analysis in the light of different countries' visions of development.

1.1 Methodology and theoretical framework

The issues of deforestation and forest degradation in the Congo Basin are complex. This makes it necessary to define the scope of the study and to set an appropriate conceptual framework. In this section, we will attempt to first define key concepts related to deforestation and forest degradation, then propose the theoretical framework and finally justify the methodology adopted.

1.1.1 Definitions of key concepts

The definitions adopted in this report are based on those mentioned in the literature and are limited to forest, deforestation and the degradation of forests.

Forest

The definition of forest differs from one organization to another and even from one researcher to the next. All definitions stress the importance of trees in the system and include places where the amount of tree cover ranges from 5% to as high as 100%. The Food and Agriculture Organization of the United Nations (FAO) considers the forest as a parcel of land of at least 0.5 ha covered to at least 10% by trees whose height at maturity is at least 5 m (Simula 2009).

Table 1. Definitions of 'forest' adopted by the countries of the Congo Basin.

Country	Definition
Congo	Forest is a space represented by trees having a minimum height of 3 m over a minimum area of 0.50 ha with a crown cover rate of 30%
Cameroon	FAO definition
DRC	The forest is a space represented by trees having a minimum height of 3 m over a minimum area of 0.50 ha with a crown cover rate of 30%
Gabon	FAO definition
Equatorial Guinea	FAO definition

Source: RPP of the countries

The United Nations Environment Program (UNEP) uses the threshold of 40% of trees for 'closed forests' and 10–40% for 'open forest,' while the Tropical Ecosystem Environment Observations by Satellite (TREES) project (run by the European Commission's Joint Research Centre) classifies 'dense forest' as areas exceeding 70% of tree coverage and 'fragmented forests' as those with 40–70% of tree coverage.

In a botanical sense, a forest is best defined as an ecosystem or assemblage of ecosystems dominated by trees and other woody vegetation. Other features of the forest also include mosses, algae, fungi, insects, mammals, birds, reptiles, amphibians, and microorganisms living on the plants and animals and in the soil. These interact with one another and with the nonliving part of the environment – including the soil, water and minerals, to make up what we know as a forest.

From an ecological point of view, a forest is a complex and rich ecosystem providing habitats to numerous species of plant, animal, fungal and microbial populations, most of which have interdependent relationships.

In the framework of REDD+, each country is called upon to formulate its own definition of the concept 'forest' for the official inventories of the

sources of greenhouse gases. Some countries of the Congo Basin have adopted the FAO definition, while others have developed their own definitions (see Table 1).

In the context of this document, the FAO (2010) definition has been adopted. According to the FAO (2010), forest is a parcel of land of at least 0.5 ha covered to at least 10% by trees whose height at maturity is at least 5 m.

1.1.2 Deforestation and forest degradation in the Congo Basin

Deforestation

Deforestation is defined as a conversion of anthropogenic, long-term or permanent forest lands into non-forest land (definition 11/CP7). It is important to note that in the framework of the climate negotiations and REDD+, deforestation and the degradation of forests are considered only under the prism of carbon stocks, while biodiversity and other functions of the forest are ignored (de Wasseige et al. 2009).

Forest degradation

Compared with deforestation, forest degradation is an entirely different process. Several international agencies have proposed definitions (Table 2). According to FAO (2011), the International Tropical Timber Organization (ITTO) definition of forest degradation is the most comprehensive in comparison with that proposed by the Intergovernmental Panel on Climate Change (IPCC), which focuses on carbon.

However, for FAO (2011), forest degradation is the reduction of the capacity of the forest to provide goods and services. In the context of REDD+, it can be defined as the partial loss of biomass due to forest exploitation or to other causes (Kanninen et al. 2007).

Forest degradation, although temporal, has several consequences for forests. It may induce the opening of the canopy, biodiversity loss, and modification of the vertical structure of the forest or change in other attributes. Noss (1999) asserts that forest degradation reduces the forest area in quality and quantity and alters the spatial structure of landscapes through the process of fragmentation.

In this work, the ITTO definition has been adapted to stress the fact that forest degradation refers to a reduction in the capacity of a forest to produce goods and services.

1.2 Theoretical framework of the causes of deforestation and degradation of forests in the Congo Basin

The work of Geist and Lambin (2001) constitutes the theoretical framework used in this paper. They show that tropical deforestation stems from a combination of economic, institutional and political factors as well as remote causes. Figure 1 presents various causes of deforestation as identified by these authors and stresses their interactions.

The immediate causes of deforestation and forest degradation mentioned by Geist and Lambin (2001) are:

- the extension of the infrastructure for transport (roads, railways, etc.), markets, population growth, and public services, such as the development of the electricity and water networks
- the expansion of agriculture (permanent agriculture, itinerant agriculture, cattle ranching, colonization of land)
- the extraction of timber (commercial extraction, firewood, poles, production of charcoal
- other factors, such as the environmental predispositions, biophysical factors and social factors.

The underlying causes identified by these authors are based on economic, demographic, technological, political, institutional and cultural factors.

Kissinger et al. (2012) estimated the contribution of the main factors of deforestation and forest degradation in the loss of forest cover in three regions of the world. Their information is summarized in Figure 2.

It is clear from the graph proposed by Kissinger et al. (2012) that the factors of deforestation

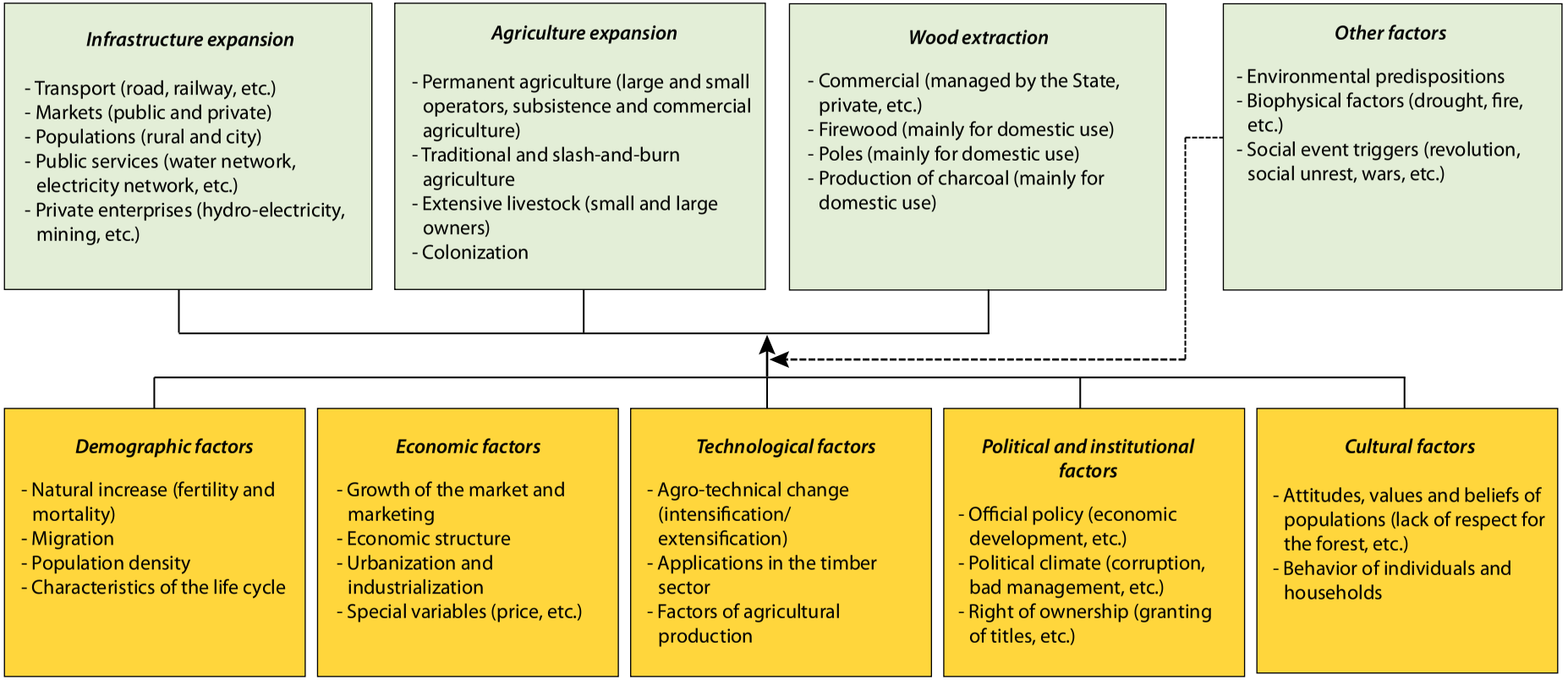

Figure 1. Causes of deforestation and forest degradation.
Source: Geist and Lambin (2001).

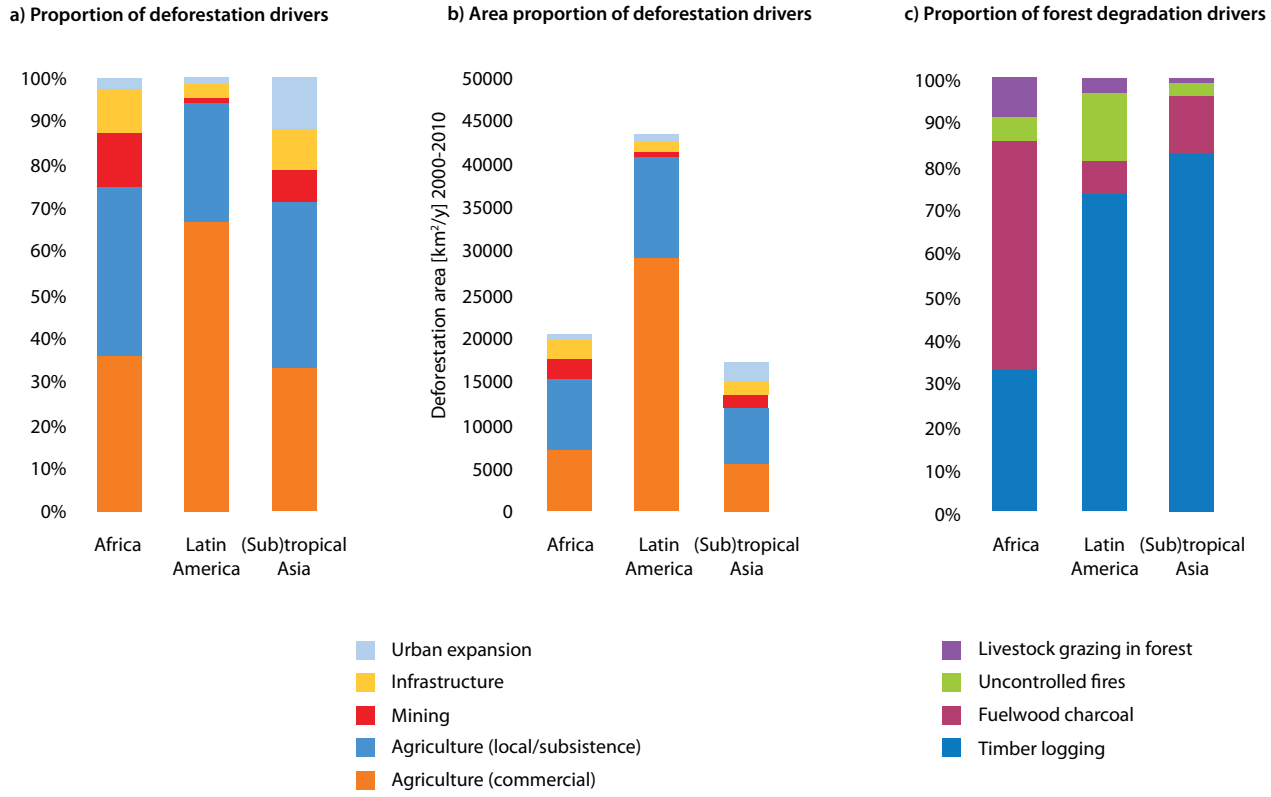

Figure 2. Distribution of the causes of deforestation and forest degradation in different regions of the planet.

Source: Extract from Kissinger et al. (2012).

and forest degradation do not have the same importance from one continent to another. In Latin America, commercial agriculture and logging are the main direct causes of deforestation and forest degradation, respectively, whereas in Africa, the main cause of the loss of forest cover is assigned to slash-and-burn agriculture and that of forest degradation to the exploitation of wood energy.

1.3 Methodological approach

1.3.1 Geographical delimitation and economic context of the study countries

Delimitation of the study area

The Congo Basin is located in central Africa and covers the following countries: Cameroon, Central Africa Republic, the Democratic Republic of Congo, the Republic of Congo, Equatorial Guinea and Gabon (Atyi et al. 2009). It includes 70% of the forest cover of Africa. Of the 530 million hectares of the Congo Basin, 300 million hectares are covered by forest. The forest area is composed of more than 99% of primary forests or naturally regenerated forest, as opposed to plantations, and of 46% of dense low-altitude forests (Megevand et al. 2012).

Economic context of Cameroon

Cameroon is located at the hinge of central Africa and West Africa. The country covers a surface area of 475,422 km² (Republic of Cameroon 2010). In 2012, Cameroon population was estimated at 19,406,100 inhabitants (BUCREP 2010) and represents nearly 50% of the population of the CEMAC, which is estimated at 36 million inhabitants (AfDB 2009).

In 2008, population growth rate was 2.7%. Projections for 2011 and 2012 were 3.8% and 5.3%, respectively and were essentially based on the strength of domestic demand, particularly private consumption. The rate of investment

Table 2. International definitions of forest degradation/degraded forests.

Organization	Definition
Second Meeting of Experts (FAO 2002b)	Reduction in the capacity of a forest to provide goods and services.
FAO (2001)	Changes within the forest which negatively affect the structure or function of the population or of the site and which, consequently, diminish its ability to provide products and/or services.
ITTO (2002, 2005)	Forest degradation refers to the reduction in the capacity of a forest to produce goods and services (ITTO 2002). The capacity includes the maintenance of the structure and functions of ecosystems (ITTO 2005). A degraded forest provides only a limited quantity of goods and services and maintains only a restricted biological diversity. Such a forest has lost the structure, function, species composition and/or productivity normally associated with the natural forest (ITTO 2002). The Explanatory Notes (ITTO 2002; 2005) distinguish, among the forests that have been altered beyond the normal effects of natural processes, the degraded primary forest, secondary forest and the degraded forest lands. (i) Degraded primary forest is a primary forest whose initial cover has been affected by the nonsustainable exploitation of timber and non-timber forest products (NTFPs) with consequences for the structure, processes, functions and dynamics of forest, to the point of jeopardizing the capacity for adaptation in the short or medium term of the ecosystem. (ii) Secondary forest comprises a woody vegetation reconstituted on lands of which the original forest cover has been largely cleared (at least 90%). In general, secondary forests develop naturally on abandoned land after it has been used for slash-and-burn agriculture, sedentary agriculture, pasture or after the failure of tree plantations. (iii) Degraded forest lands are former forest lands severely damaged by excessive exploitation of wood products or NTFPs, inappropriate management, repeated fires, grazing or other uses that have damaged the soil and vegetation to the point of preventing or greatly delaying regeneration of the forest after its abandonment.
CBD[a] (2005, 2001)	A degraded forest provides a reduced quantity of goods and services and its biological diversity is limited. It may have lost its structure, composition or the productivity of the species normally linked to a natural forest (UNEP/CBD/COP/6/INF/26). A degraded forest is a secondary forest which, as the result of human activities, has lost the structure, function, composition or the productivity of the species normally associated with a natural forest. For this reason, this type of forest offers a reduced supply of goods and services and has only a limited biological diversity. Its biological diversity includes many components of non-tree items that can dominate the under plant cover (UNEP/CBD/SBSTTA/7/INF/3). Degradation is any association of loss of soil fertility, lack of forest cover, lack of natural function, soil compaction and salinization that prevents or delays regeneration of the forest not assisted by secondary succession. The reduction of forest cover, forest degradation and fragmentation lead to a loss of forest biodiversity, by reducing the available habitat of forest-dependent species and indirectly cause the disruption of major ecological processes such as pollination, seed dispersal and gene flow. The fragmentation of forests can also compromise the ability of plant and/or animal species to adapt to global warming, and to the disappearance of the previously connected migration routes. In some forest types, the fragmentation is also likely to exacerbate the probability of forest fires, which may later affect biological diversity (UNEP/CBD/SBSTTA/11/INF/2)

Organization	Definition
IPCC (2003)	Forest degradation represents a direct loss, in the long term, due to human activities, persisting for X years or more, losing at least Y% of carbon stocks (forest and forest values), since a time T, and not qualifying as deforestation or activity under article 3.4 of the Kyoto Protocol.
IUFRO (2000)	Degradation is defined as damage to the chemical, biological and/or physical structure of a soil (soil degradation) and to the forest itself (forest degradation), as the result of a use or inappropriate management, which, if they are not improved, will reduce or destroy irreparably the production potential of a forest ecosystem.
	Explanatory Note: External factors, such as air pollution, can also contribute to forest degradation (Source: Nieuwenhuis 2000).

a CBD, Convention on Biological Diversity
Source: Simula (2009).

was also estimated to move from 18.5% to at least 25% of GDP, which constitute the minimum rate to ensure a sustainable economic growth and job creation (Republic of Cameroon 2010).

Economic context of the Republic of Congo

The Republic of Congo spans the equator and lies at the heart of the world's second-largest forest. It extends over an area of 342,000 km^2.

The population of Congo was estimated at 3.5 million inhabitants in 2008, which corresponds to an average density of 11.98 inhabitants per square kilometer. The average annual population growth rate is 3.2%. Although the five major cities contain almost 60% of the population of the country, most of the rest of the populace are dependent on forests for their vital needs (food, energy, medicines, etc.).

The economy of the Congo is mainly based on the exploitation of natural resources, particularly oil, which contributes to approximately 85% of GDP (Republic of Congo, 2010a), while agriculture occupies 40% of the active population, but contributes only 6% to GDP (Republic of Cameroon 2010).

In 1960, agriculture constituted the most important sector of the economy of the Congo and agricultural production was the main source of income for 80% of the population. But today, only 40% of the population derive their income from agriculture, whose contribution to the GDP has dropped by about two thirds, from nearly 20% in 1965 to 6.2% in 2005 (Republic of Congo 2010b).

Economic context of the Republic of Gabon

The Republic of Gabon extends over an area of 268,000 km^2. In 2012, the population was estimated at 1.3 million inhabitants with a population density of 4.8 inhabitants per square kilometer. The average growth rate of the Gabonese population is estimated at 1.48% each year (Republic of Gabon 2012).

The economy of Gabon depends to a large extent on nonrenewable resources, such as oil, manganese and uranium. The forestry sector was the cornerstone of the economy of the country until the oil boom of the 1970s. In 1998, the oil sector and forestry accounted for 36% and 2.5% of the gross national product of the country (BEAC 2013). The mining sector excluding oil represents 1.7% of GDP and 6.2% of the total exports of Gabon.

In 2012, oil reached 46% of GDP and 84% of export revenue. In total, oil, wood and manganese represent 96% of the exports of Gabon, making the economy vulnerable to international fluctuations and to the exchange rate differential between the euro and the US dollar (Republic of Gabon 2012).

Economic context of the Republic of Equatorial Guinea

Extending over an area of 28,052.46 km^2, Equatorial Guinea had a population of 693,000 inhabitants in 2010 according to the World Bank (2012).

In spite of the decline in its production, the economic growth of oil is sustained by strong international demand and by the construction of major infrastructure projects (Republic of Equatorial Guinea 2007). Oil exports contributed to 84.2% of GDP.

Economic context of the Central Africa Republic

Extending over an area of nearly 623,000 km^2, the population of CAR is estimated at 4.7 million inhabitants and is unevenly distributed throughout the national territory (Pison 2013).

The economy of CAR is based essentially on the primary sector, which contributes 55% to GDP and 90% of exports. It is composed mainly of subsistence agriculture (28% of GDP), livestock farming (13%), forestry (5.5%) and extractive industries (3%, most of which involves diamonds).

Forest exploitation affects approximately 2 million hectares. Wood is mainly sold to markets in Europe and North America, which, because of the global economic crisis, have reduced their demand since 2000. Timber production has dropped by 30% in volume and 50% in value. In 2010, however, the increased price of wood has led to a partial recovery of the sector (Pison 2013).

Economic context of the Democratic Republic of Congo

The Democratic Republic of Congo (DRC) covers an area of 2,345,000 km^2 and has an estimated population of 70 million inhabitants (World Bank 2012), which gives a density of 27 inhabitants per km^2. An estimated 70% of the population live mainly in rural areas and 30% in the cities (Democratic Republic of Congo 2010). The area of natural forests (145 million hectares) represents 10% of all tropical forests of the world and more than 47% of those of Africa. These forests are essential to the conservation of biodiversity (COMIFAC 2010). On the economic front, DRC is among the richest countries in the world in terms of natural resources, including mineral (diamond, cobalt, gold and coltan), hydrologic and forest. The main sectors of activity such as agriculture and the forests, industry and mines, and services provide, respectively, 40%, 28% and 32% of GDP.

In 2010, the contribution of the mining sector was 12% of GDP, 9% of the State budget and 50% of export earnings. The government intends to substantially increase the contribution of the mining sector to the State budget, from 9% in 2010 to 25% in 2016.

1.3.2 Methodology used for the collection of information

The purpose of this work is to make a synthesis of existing information on the causes of deforestation and forest degradation in the six countries listed previously, mainly based on a review of the literature. Information gathered from the various documents has allowed a proper treatment of the data and a thorough statistical analysis. These documents included scientific publications, official documents, newspaper clippings, and reports from workshops and scientific meetings.

2 State of the forests of the Congo Basin

This section presents a thorough description of the current status of the forest cover, the level of deforestation and degradation of forests, as well as the contribution of this sector to the economies of the countries of the Congo Basin.

2.1 The forest cover of the Congo Basin

2.1.1 State of the forest cover of the Congo Basin in 2010

The information related to the forest cover of the Congo Basin, in particular for 2010, comes from the series *State of the Forests* (de Wasseige et al. 2009, 2012) and is summarized in Table 3.

Table 3 shows that in 2010, the Congo Basin had a forest cover of more than 268 million hectares (de Wasseige et al. 2012), which represents the second largest tropical forest cover in the world after the Amazon (Tsayem and Fotsing 2004). It has more than 186 million hectares of humid dense forest and more than 81 million hectares of other types of forests. The distribution of forest cover by countries is represented in Figure 3.

Nearly two thirds of the forest cover of the Congo Basin is located in DRC, while Cameroon only has 10% and Congo 9.61%.

The distribution of forest cover varies according to country and forest type. Figure 4 gives the proportions of dense and open forests in the six countries of the Congo Basin.

Dense forest represents 69% of the forest cover in the Congo Basin compared with only 31% for non-dense forests, except in CAR, where the trend is reversed (69% and 31% of forests are non-dense and dense forests, respectively).

Cameroon's forests are divided into a permanent forest estate (PFE) and a nonpermanent forest estate (NPFE). With 12,788,026 ha, the PFE is made up of state forests and communal forests: the former fall within the private domain of the State and[1] the latter within the private domain of the relevant municipality. The category known as State Forests comprises protected areas for wildlife and the forest reserves, which consist in turn of many modes of use of forest land. On the other hand, the NPFE extends over 6,850,974 ha.

With a forest cover estimated at 22.5 million hectares, or approximately two thirds of this total area, Congo is heavily forested. The majority of the Congolese forests, or approximately 21,800,000 ha, are made up of dense rain forests and almost 37% (8,369,760 ha) are flooded almost permanently, which gives them a natural form of protection. More than 80% of the national forest area is part of the national forest estate, which makes the State the main forest owner (Republic of Congo, 2010b).[2]

In Gabon, forest covers 85% of the total land area (Republic of Gabon 2012). It includes six main vegetation types: (i) mangrove, (ii) flooded and marshy forest, (iii) the noninundated forest at the coast, (iv) mountain forest, (v) highland forest of the interior and highland forest without okoume in the northeast. From an administrative point of view, three types of forests are encountered in Gabon: production forests (12 million hectares), conservation forests (4 million hectares) and forests in rural areas (6 million hectares).

---

1 Article 25 of the new Act no. 94/01 of 20 January 1994 lays down regulations for forests, wildlife and fisheries, Ministry of Environment and Forests, Republic of Cameroon.

2 Proposal for the preparation of the REDD+ (RPP), Republic of Congo.

Table 3. State of the forest cover of the Congo Basin in 2010 (ha).

Type of forest	Cameroon	Congo	CAR[a]	DRC[b]	Gabon	Equatorial Guinea	Total
Humid dense forest of low altitude	18,640,192	17,116,583	6,915,231	101,822,027	22,324,871	2,063,850	168,882,754
Transition forest	194,638	-	8,364	3,273,671	-	24,262	3,500,935
Mountain forest	28,396	10	-	930,863	19	6,703	965,991
Edaphic forest	-	4,150,397	95	8,499,308	16,881	-	12,666,681
Mangrove	227,818	11,190	-	181	163,626	25,245	428,060
Total dense forest	**19,091,044**	**21,278,180**	**6,923,690**	**114,526,050**	**22,505,397**	**2,120,060**	**186,444,421**
Forest mosaic-savannah	2,537,713	517,068	11,180,042	6,960,040	51,092	-	21,245,955
Rural complex and econdary forest	3,934,142	3,664,609	713,892	21,425,449	1,405,318	507,281	31,650,691
Open dry forest and/ or dense dry forest	1,292,106	297,824	3,430,842	23,749,066	31,337	172	28,801,347
Total other forest	**7,763,961**	**4,479,501**	**15,324,776**	**52,134,555**	**1,487,747**	**507,453**	**81,697,993**
Total general	**26,855,005**	**25,757,681**	**22,248,466**	**166,660,605**	**23,993,144**	**2,627,513**	**268,142,414**

a Central Africa Republic; b Democratic Republic of Congo.
Source: de Wasseige et al. (2012).

Equatorial Guinea is covered by almost 2,200,000 ha of forests, including 400,000 ha in the course of exploitation, 500,000 ha already exploited, 600,000 ha still untapped and 700,000 ha retained in the form of forest reserve (Republic of Congo 2010b).

The forests of Equatorial Guinea are divided into two categories: conservation forests (protected areas) and production forests. Production forests are made up of forest patches (reduced areas of primary forest or secondary forests located inside concessions), community forests (granted on a permanent basis to local communities because of their traditional rights) and national forests, which belong to the State and are exploited in association with private companies. In fact, the largest share of 1.5 million hectares of production forests has been assigned in the form of concessions for industrial exploitation.

The dense forests of Central Africa Republic cover an area of 5,300,000 ha (0.85% of the national territory). A substantial share of these dense forests (3,320,923 ha representing 62.65%) has been leased to the 15 forest companies that are holders of a forest exploitation and management permit (Mahode and Mvale 2002). The forestry sector contributes 10–13% to the GDP of CAR, representing approximately 50% of the export

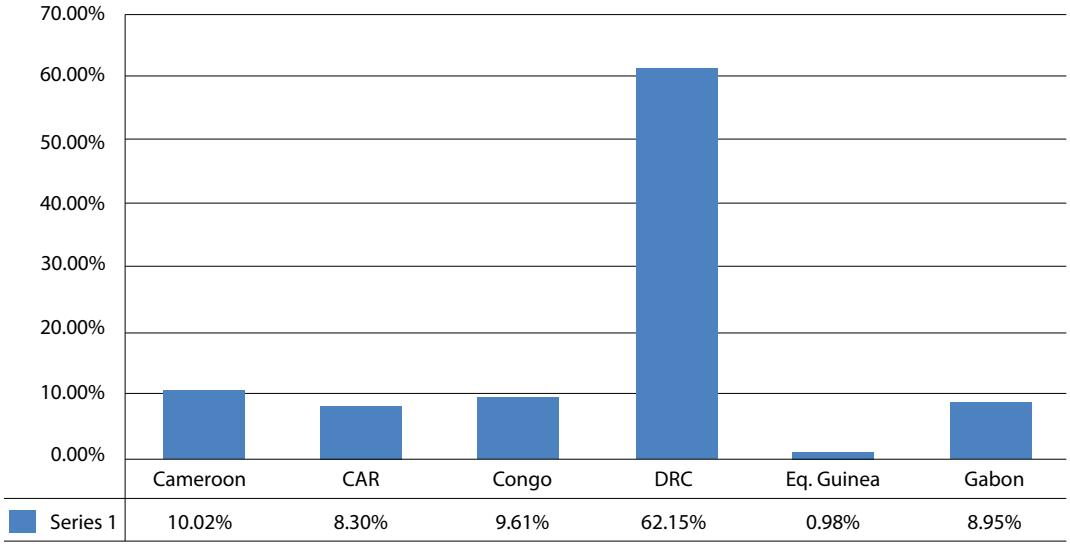

Figure 3. Distribution of the forest cover of the countries of the Congo Basin.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: de Wasseige et al. (2012).

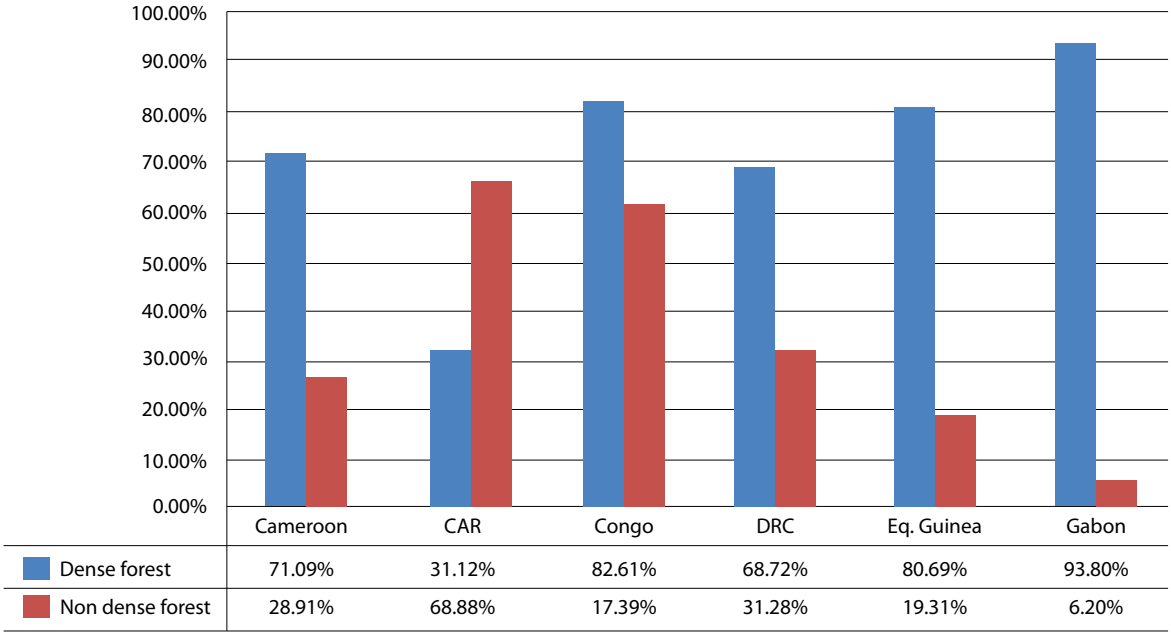

Figure 4. Distribution of the forest cover by forest type for the countries of the Congo Basin.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: de Wasseige et al. (2012).

value. Hevea has been exploited for its latex since the beginning of colonization. Currently, however, usage is more diversified: lower quality forest products are processed locally by a small plywood industry, while the more valuable products are exported in the form of logs.

DRC has 155 million hectares of forests (Democratic Republic of Congo 2011[3]). It is the fifth largest country in the world in terms of forest

3 *Interactive Atlas of DRC.*

Table 4. Evolution of the rate of deforestation in the Congo Basin.

	Rate of deforestation in the Congo Basin					
	1990–2000			2000–2005		
	Deforestation Gross (%)	Reforestation Gross (%)	Deforestation Net (%)	Deforestation Gross (%)	Reforestation Gross (%)	Deforestation Net (%)
Cameroon	0.10 ± 0.05	0.02 ± 0.01	0.08	0.17 ± 0.14	0.14 ± 0.19	0.03
CAR[a]	0.09 ± 0.05	0.02 ± 0.02	0.06	0.10 ± 0.06	0.04 ± 0.05	0.06
DRC[b]	0.15 ± 0.02	0.04 ± 0.01	0.11	0.32 ± 0.05	0.10 ± 0.03	0.22
Congo	0.08 ± 0.03	0.04 ± 0.02	0.03	0.16 ± 0.06	0.08 ± 0.05	0.07
Equatorial Guinea	0.13 ± 0.09	0.11 ± 0.18	0.02	-	-	-
Gabon	0.08 ± 0.03	0.03 ± 0.01	0.05	0.07 ± 0.05	0.07 ± 0.07	0.00
Congo Basin	0.13 ± 0.02	0.04 ± 0.01	0.09	0.26 ± 0.04	0.09 ± 0.02	0.17

a Central Africa Republic; b Democratic Republic of Congo.
Source: de Wasseige et al. (2012).

area and the largest in Africa. Forests cover 67% of the national territory (de Wasseige et al. 2009).

The moist forests occupy almost 99 million hectares, of which some 83 million hectares are found at low altitude. It is estimated that 60 million hectares of these forests would be suitable for timber production, which is roughly equivalent to the size of all the other forest countries of central Africa put together (Debroux et al. 2007).

2.1.2 State of deforestation of the Congo Basin

As already mentioned, deforestation is still defined as the anthropogenic conversion of direct forest lands to non-forest land (de Wasseige et al. 2009). Table 4 gives the evolution of the net rate of deforestation in the six countries considered and in the Congo Basin as a whole.

In the Congo Basin, the deforestation rate varies between countries. However, as a whole, the Congo Basin displayed a net deforestation rate of 0.09% between 1990 and 2000, compared with 0.17% between 2000 and 2005. This shows that, during these two periods, the rate of deforestation has increased. The Democratic Republic of Congo is the country with the highest rate of deforestation, with a net rate that has doubled between the two periods, from 0.11% during 1990–2000 to 0.22% during 2000–2005. In contrast, Gabon has the lowest deforestation rate. In fact, with 0.02% between 1990 and 2000, Gabon has reached a balance (with a net rate of deforestation of null) since 2000.

The authors agree that the forests of the Congo Basin are relatively well preserved with a deforestation rate of 0.17%. This rate is largely below that of the Amazon, which is 0.4% per year (Demaze 2007). As a matter of fact, only 5.4% of forest loss has been registered during 2000–2005 (Hansen et al. 2008).

However, compared with Asia, some effort is required in the Congo Basin. In fact, with a net forest loss of about 0.6 million hectares per year in the 1990s, Asia showed a net average gain of more than 2.2 million hectares per year between 2000 and 2010 (FAO 2010). This result is mainly attributable to the program of large-scale afforestation undertaken by China, whose forest area increased by 2 million hectares per year in 1990 and by an average of 3 million hectares per year since 2000; it is also due to the reduction of the rate of deforestation in some countries, including Indonesia (FAO 2010).

2.1.3 Status of forest degradation of the Congo Basin

Forest degradation is the conversion of dense forests into degraded forests (Atyi et al. 2009). Table 5 presents the evolution of the

Table 5. Evolution of the rate of forest degradation in the Congo Basin between 1990 and 2005.

	Rate of degradation of the forests of the Congo Basin					
	1990–2000			2000–2005		
	Degradation Gross (%)	Regeneration Gross (%)	Degradation Net (%)	Regeneration Gross (%)	Reforestation Gross (%)	Degradation Net (%)
Cameroon	**0.08 ± 0.06**	**0.02 ± 0.01**	**0.06**	**0.14 ± 0.12**	**0.07 ± 0.08**	**0.07**
CAR[a]	0.04 ± 0.02	0.01 ± 0.01	0.03	0.05 ± 0.03	0.02 ± 0.02	0.03
DRC[b]	0.07 ± 0.01	0.02 ± 0.00	0.06	0.16 ± 0.03	0.04 ± 0.02	0.12
Congo	0.04 ± 0.02	0.01 ± 0.01	0.03	0.08 ± 0.03	0.05 ± 0.03	0.03
Equatorial Guinea	0.05 ± 0.03	0.02 ± 0.02	0.03	-	-	
Gabon	0.05 ± 0.02	0.01 ± 0.01	0.04	0.04 ± 0.05	0.05 ± 0.08	–0.01
Congo Basin	0.07 ± 0.01	0.01 ± 0.00	0.01	0.14 ± 0.02	0.04 ± 0.01	0.09

a Central Africa Republic; b Democratic Republic of Congo.
Source: de Wasseige et al. (2012).

rate of degradation of the Congo Basin forests between 1990 and 2005.

Table 5 shows that the rate of forest degradation has increased sharply over time. While forest degradation was 0.01% between 1990 and 2000, this rate increased by a factor of 9 (that is 0.09%) between 2000 and 2005. In DRC, the rate of forest degradation has doubled between the two periods, from 0.06 between 1990 and 2000 to 0.12% between 2000 and 2005. In Cameroon, the rate also increased slightly, from 0.06% to 0.07% between these two periods. In Gabon and Congo, the rate of degradation is lower and has remained constant at 0.03% over the whole period considered.

2.2 Status of the carbon stocks in the Congo Basin

Carbon stocks vary according to different parts of the ecosystem (soil, ground biomass, dead wood, litter, undergrowth), but also between different forest types. The total carbon of the Congo Basin is estimated at about 46 billion tons. The details of the distribution of carbon stocks in the different land uses are presented in Table 6 and an assessment of stocks of carbon totals by country is in Table 7.

Table 6 shows that the dense rain forests contain more than 65% of the carbon stocks of the Congo Basin compared with 34.8% for other ecosystems. Moist forests at low altitude alone represent approximately 60% of this stock for only 35% of the area. Aboveground biomass and soil are the two largest reserves of carbon, with 199.3 $t.ha^{-1}$ and 57.8 $t.ha^{-1}$, respectively.

According to Table 7, the DRC contains more than 58% of the carbon in the whole of the Congo Basin, followed by CAR (11.7%) and Cameroon (10.8%). Equatorial Guinea contributes only 1%.

2.3 Forest contribution to the economies of the countries of the Congo Basin

The forestry sector contributes to the economy of a country in various ways (Figure 5): it allows the creation of direct and indirect jobs, brings and redistributes wealth across sectors, contributes taxes and affects the economy in many other ways. It also provides many ecosystem goods and services that contribute to the regularization of many vital functions for the entire planet. Unfortunately, most of these goods and services are little recognized. Forest exploitation, the collection of non-timber forest products and, to a lesser extent, the exploitation of wildlife products, are the activities most in view in this sector. If the ecosystem goods and services are economically, environmentally and socially important, it should be noted also that they suffer more pressure from the other

Table 6. Carbon stocks by vegetation type in the Congo Basin.

Carbon stocks by forest type and vegetation in the Congo Basin (in millions of tons)			
Land use type	**Area (km²)**	**Soil carbon (million tons)**	**% Total**
Dense forest of low altitude	1,421,834	27,299	59.3
Swamp forest	123,264	1,761	3.9
Dense forest of medium altitude (900–1500) m	63,100	770	1.7
Montane forest (>1500 m)	9,754	119	0.3
Total humid dense forest	**1,617,952**	**29,949**	**65.2**
Deciduous dense forest (Miombo)	304,808	2,791	6.1
Forest mosaic/culture	370,123	3,955	8.5
Savannah forest mosaic	588,011	3,403	7.4
Savannah woodland and deciduous shrub	630,890	4,149	9.0
Grassy savanna, scrub, scattered trees	392,414	1,770	3.8
Subregion Congo Basin	**4,048,470**	**46,016**	**100**

Sources: de Wasseige et al. (2009).

Table 7. Distribution of carbon stocks by country.

Country	Estimated total carbon stocks (millions of tons)	% In the subregion
Cameroon	5,043	10.8
Congo	4,219	9
Gabon	4,383	9.4
Equatorial Guinea	445	1
CAR[a]	5,460	11.7
DRC[b]	27,258	58.2

a Central Africa Republic; b Democratic Republic of Congo.
Source: de Wasseige et al. (2009).

sectors. Understanding the real contribution of the forest sector to the national economy can help us understand whether or not forest conservation is needed. It is also a first step toward the development of strategies for sustainable forest management and to fight against deforestation and forest degradation.

The GDP represents all the wealth created in a country in the course of a year. It can be evaluated at a constant price or at the current price. We have used the current price for this study.

In general, the contribution of the forestry sector to the GDP is stable, except in Equatorial Guinea which displays a significant decline. This result does not mean that the volume of the added value of the forest sector has necessarily declined; it could also be explained by an increase in the GDP rather than the added value of the forest sector, that is, a substantial increase in the contribution of other sectors to the GDP. In fact, the share of the forest sector to the GDP of Equatorial Guinea has experienced an upward trend between 1991 and 1994, rising from 8% to 16% before it suddenly dropped to less than 1% after 2000, which can be attributed to the expansion of the oil exploitation sector. Today, Equatorial Guinea is the third largest oil producer of the continent, behind Nigeria and Angola.

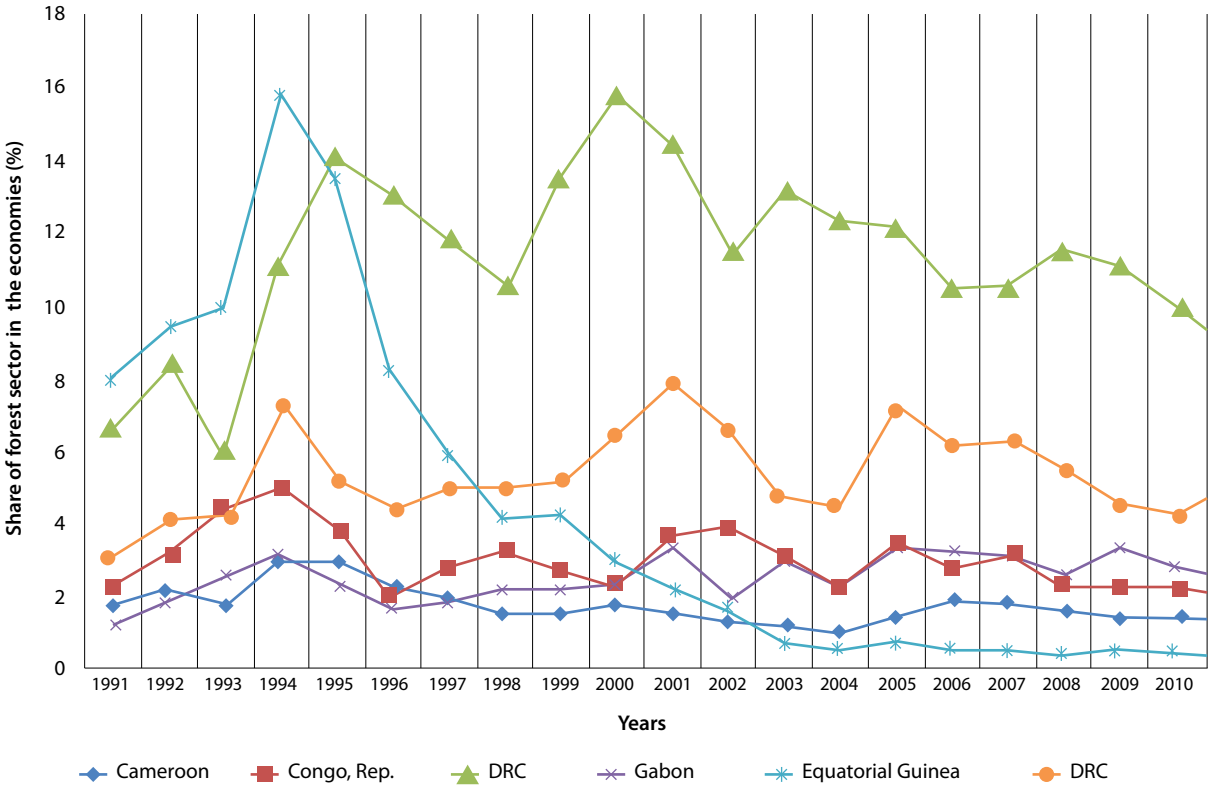

Figure 5. Share of the forest sector in the economies of the six countries considered between 1991 and 2010.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compiled from the World Bank database, consulted in 2013

The forest sector's contribution to DRC's GDP has evolved with time: it has varied between 7% in 1991 and 16% in 2000, the trend being at approximately 12% during the period.

This section has revealed that the Congo Basin is one of the main vegetation strongholds in the tropics and is covered to nearly 70% by dense forest. DRC alone holds nearly two-thirds of these forests. The forest sector contributes greatly to the economies of the countries studied, but the tendency of this contribution is either stable or declining. Deforestation in the Congo Basin, which is certainly low compared with other regions, is relatively important, varying from 0% in Gabon to 0.22% in DRC. As to forest degradation, the annual net rate varies from –0.01% in Gabon to 0.12% in the DRC.

Faced with these levels of deforestation and degradation of forests in the Congo Basin, it is extremely important to explore the causes. The next section will attempt to address this.

3 The current causes of deforestation and forest degradation in the Congo Basin

The Congo Basin displays a historical rate of deforestation that is relatively low in comparison with other areas of the planet. However, this rate is already increasing and requires control. If one considers the many pressures on the forest areas, such as increasing demands for agricultural land, mining and other sectors, it is important to determine the current causes of deforestation and degradation, in order to propose options and effective and realistic recommendations for better protection of the forest ecosystems without constituting an obstacle to the objectives of development.

3.1 The immediate causes of deforestation and forest degradation

Geist and Lambin (2001) have identified four major groups of factors that may be considered as the immediate causes of deforestation and forest degradation, i.e. the factors that act directly on them:

- extension of the infrastructure
- expansion of agriculture
- extraction of timber
- other factors.

3.1.1 Infrastructure extension and urban expansion

In terms of infrastructure, the most important are roads, railways, hydroelectric dams and power lines to carry the resultant electrical energy, etc. It is important to mention that the opening of a route has a double impact on forest cover. First, road opening entails forest destruction. On the other hand, the open road gives new opportunities to farmers, ranchers and hunters to access parts of the forest that were previously inaccessible. This is the case for the railways and other forms of infrastructure.

Urban expansion is motivated mainly by a population explosion in the large cities. For instance, RPP of Congo states that the population growth rate is 3.6%. The annual rate of urban growth has increased from 6.6% in the period from 1960 to 1974 to 6.8% in 1975–1984, an increase of nearly 3% (Tati 1987). However, our current knowledge is limited, because no current data are available to update this statistic.

The economic growth realized by Equatorial Guinea over more than a decade is at the origin of important modernization of the country. However, the impact of this modernization on the forest cover is less important. The construction of roads and modern infrastructure thus allows the opening up of areas that until very recently were separated from the rest of the major cities in this country (Republic of Equatorial Guinea 2007, as projected for 2020).

In CAR, the forest massif of Southwest is crossed by 2530 km of roads. If one assumes a road width of 10 m, 2530 km of road results in the destruction of approximately 2530 ha of forest.

3.1.2 Agricultural expansion

Kissinger et al. (2012) show that smallholder agriculture is the main cause of deforestation in tropical areas (Figure 2). It contributes to 35% of the destruction of the forests in Africa, 65% in Latin America and a little more than 30% in Southeast Asia. The idea that slash-and-burn agriculture is responsible for an irreversible deforestation and the disastrous degradation of forests and soils of tropical regions is increasingly challenged. In fact, studies conducted by ethnobotanists and anthropologists emphasize the benign character and nondisruptive effects, in the ecological sense, of the traditional agriculture as far as it is carried out by the indigenous populations

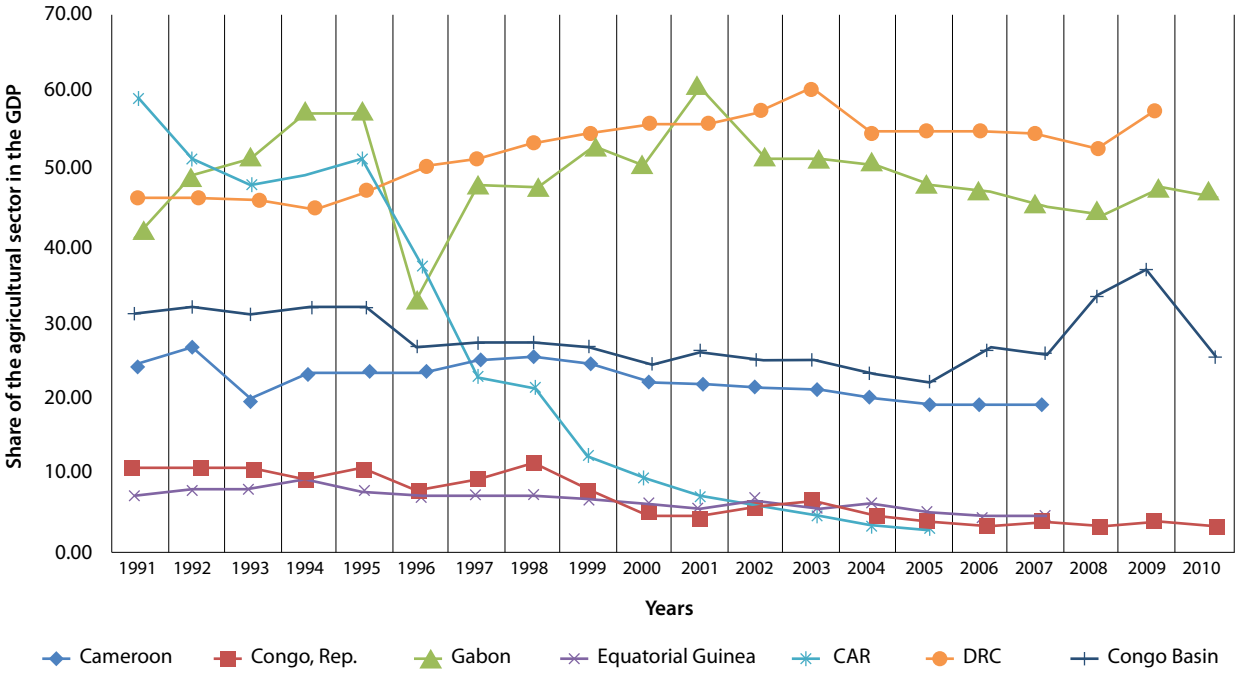

Figure 6. Evolution of the share of the agricultural sector in the GDP of the study countries.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

of the forested tropical regions (Rossi 1999; Dounias 2000).

Figure 6 presents the annual data for the period 1991–2012 and shows the trend of the share of the agricultural sector in the GDP of the six countries considered in the study.

Overall, the share of the agricultural sector in the GDP of the Congo Basin declined over the years, from 30% to 13% between 1991 and 2012. However, the overall figures mask enormous disparities between countries. For instance, in Equatorial Guinea, the oil boom has drastically reduced the contribution of the agricultural sector to GDP, which has dropped by 55% in 1991 to less than 2% in 2011.

In Congo and Gabon, the contribution of the agricultural sector to GDP has also experienced a slight decline, while the contribution of oil and wood exploitation is on the increase. DRC and CAR show a stable trend of around 50%. Cameroon also follows the same trend. As in the four previous countries, the contribution of agriculture to GDP has declined over the years, from over 25% in 1992 to a little over 13% in 2012. However, the reasons for decline vary from one country to another: Cameroon's agriculture centered on cash crops (coffee, cocoa). Here, the fall in prices on the world markets has resulted in the discouragement of producers and the abandonment or conversion of plantations. Despite the escalation of prices of these products, the country is struggling to improve production. In addition, the modernization of agriculture is very slow. Agriculture is the principal activity of most of the essentially rural population who continue to work with rudimentary tools (machetes, hoes, etc.). In parallel, the country is experiencing an increased exodus from rural areas.

Figure 7 gives the evolution by country of the added value per worker of the agricultural sector. It shows that the general trend is rising. This means that workers in the agricultural sector are creating more and more of wealth with time. It is expected that an improvement of individual performance may also lead to a reduction of deforestation.

Figure 8 shows the evolution of the index of agricultural production and shows the relative total volume of agricultural production of the six countries, for each year, compared with the reference period of 1991 to 2012.

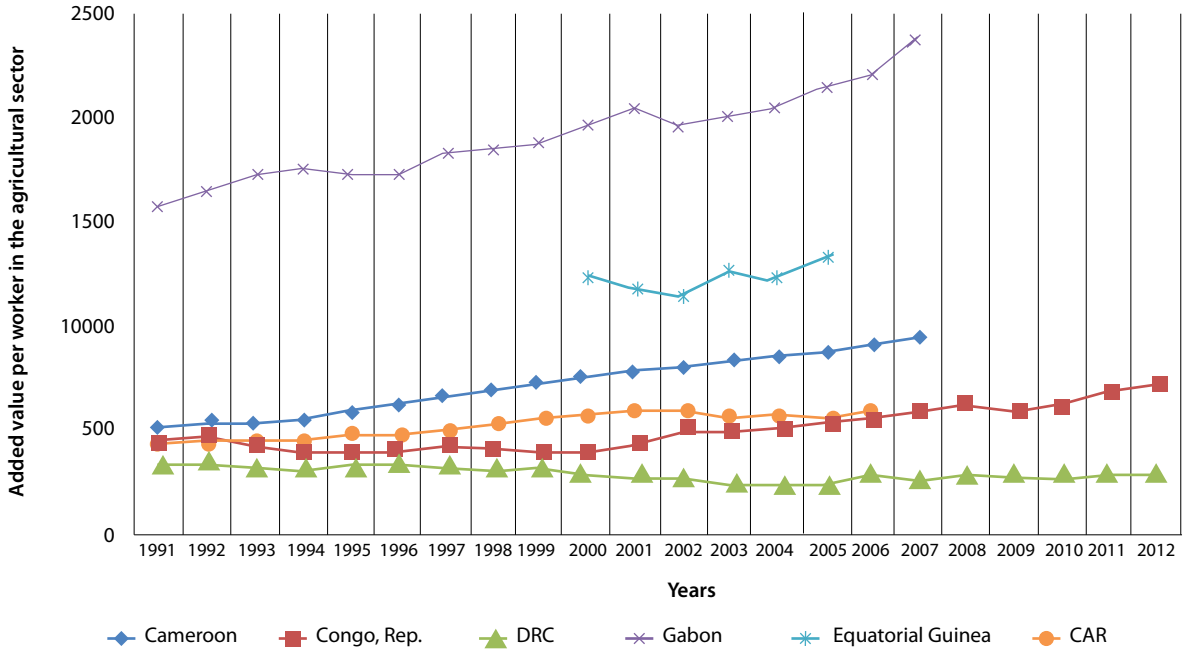

Figure 7. Evolution of the added value per worker in the agricultural sector.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

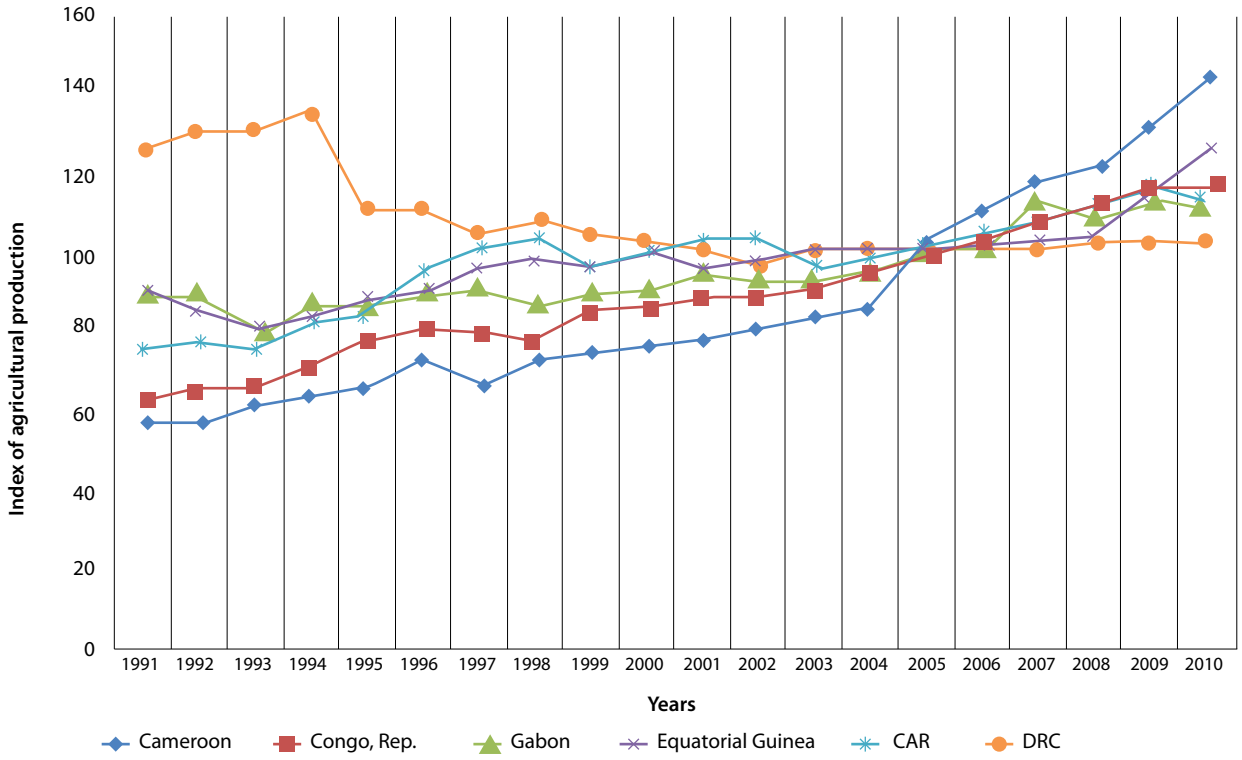

Figure 8. Evolution of the index of agricultural production.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

The index of agricultural production (base year 2006 = 100) is increasing constantly over the whole period considered, except in DRC which registered a decline followed by stagnation from 2001 onwards. The other countries show a rise in the index, the highest being registered in Cameroon with a little less than 60% in 1991 to more than 140% in 2010.

Agricultural expansion, including that of livestock, is a factor that affects deforestation. In particular, the index of animal production shows a relative total volume of animal production, for each year, compared with the reference period. Figure 9 gives the evolution of this index between 1991 and 2012.

In the six study countries, animal production increased constantly during the whole period of the study, with Congo having recorded the largest increase with a production index (base year of 2006 = 100) reaching 160% in 2010.

Agriculture, including livestock, has progressed significantly over the years in all the countries of the Congo Basin. In the absence of improved technology and production techniques, this increase of agricultural production can only be explained by an increase in the cultivated area and thus in deforestation and forest degradation.

The advance of agriculture at the expense of forests is not exclusive to the Congo Basin. The same trend is observed in the Amazon where farmers and ranchers are also among the main agents of deforestation. The raising of livestock occupies 80% of the deforested area, or 1.72 million hectares per year (Chomitz and Thomas 2001; Greenpeace 2008). In Brazil, the area cultivated with soybean has doubled between 1994 and 2004, and it has increased fivefold in Argentina leading to the conversion of approximately 1.3 million hectares of the Amazon forest (Campion et al. 2006).

3.1.3 Timber exploitation

Timber extraction seems to be the main cause of forest degradation in Southeast Asia, Latin America and Africa. Forest exploitation contributes more than 80% to forest degradation in Southeast Asia, more than 75% in Latin America, and about 32%

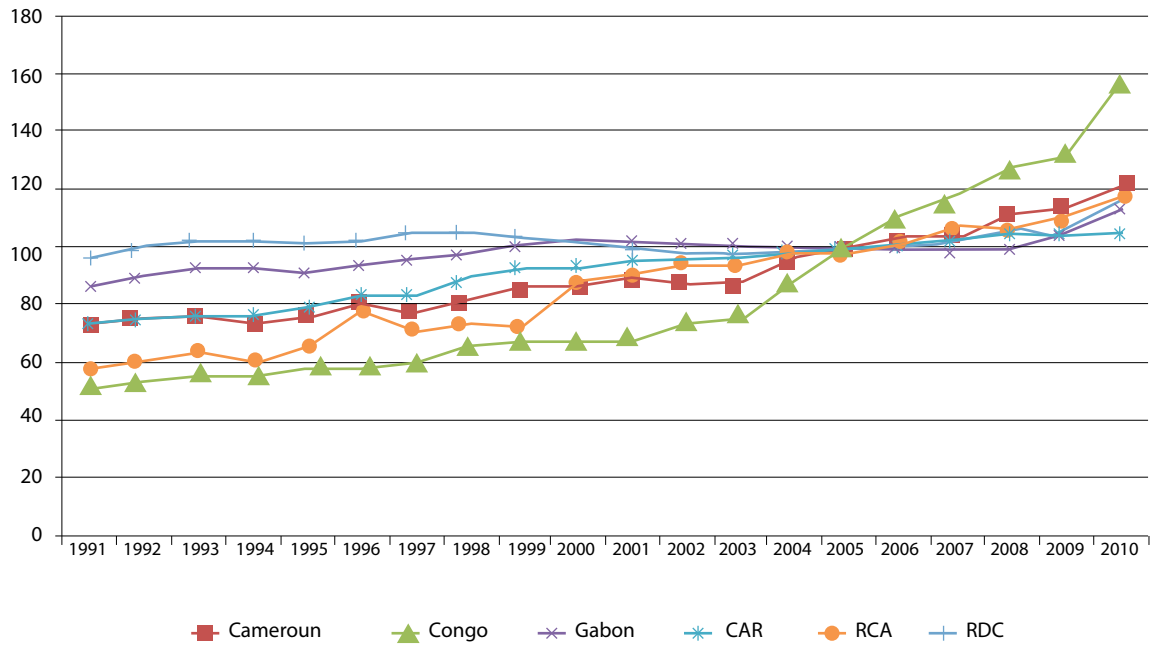

Figure 9. Evolution of the index of animal production.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

in Africa (Kissinger et al. 2012). Three types of timber exploitation are taken into account in the present report:

- industrial exploitation
- artisanal logging or small-scale timber exploitation
- charcoal and fuelwood exploitation.

Industrial forest exploitation

Data from industrial timber exploitation come from the State of Forests, edited by the Observatory of the Forests of Central Africa (OFAC), which cites ITTO as a primary source of information (de Wasseige et al. 2012). Figure 10 describes the evolution of the industrial timber exploitation in the six countries studied.

Between 1991 and 1997, timber production in Cameroon went from 2.3 million m^3 in 1991 to about 3.5 million m^3 in 1997, before falling to 2 million m^3 in 2000 and then increasing again to 3 million m^3 (de Wasseige et al. 2012). The trend is similar to that in Gabon, but the overall tendency is to increase. By contrast, other countries have a more or less stable production. DRC is one example. The forest sector is little developed, despite its forest wealth, which represents more than 62% of the forest cover of the Congo Basin. Armed conflicts and the country's landlocked status have contributed to preserving these forests. We can therefore understand that the industrial timber exploitation is not really an important factor in the deforestation and degradation of forests in the DRC, but could be in Cameroon, Gabon or in the Congo.

3.1.4 Artisanal logging or small-scale timber exploitation

Production of the subsector of artisanal logging

Artisanal logging, also called small-scale timber exploitation, is not yet sufficiently explored in

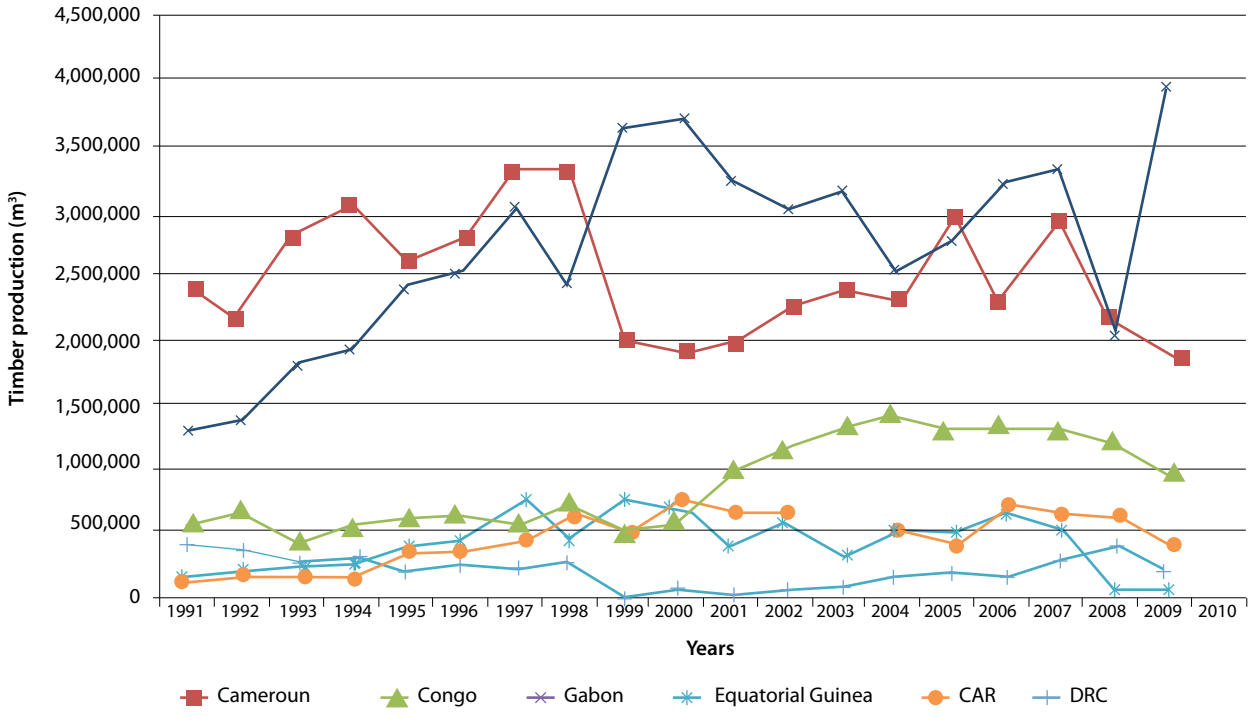

Figure 10. Evolution of timber production in the six countries of the Congo Basin between 1991 and 2009.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Data from de Wasseige (2012)

the six countries of the Congo Basin. However, detailed studies have been carried out for the cases of Cameroon and Congo.

In Cameroon, in 2001, more than 1000 artisanal loggers were accredited (Auzel et al. 2001). Cerutti and Lescuyer (2011), who have studied the industry in that country, have noted that it evolved primarily as an informal industry. Its intensity varied according to three criteria: accessibility to an urban market, availability of the resource, presence (past or present) of a forest company. In 2009, the annual production of informal sawnwood reached 715,000 m^3, against 360,000 m^3 for the industrial sector. In addition, those authors stated that if the volume of informal sawnwood in the domestic markets was taken into account by the national statistics, the total production would be approximately 4.3 million m^3 per year (in roundwood equivalents), i.e. almost double the official estimate of timber production in Cameroon.

According to Lescuyer et al. (2014), more than one million m^3 of sawnwood are artisanal products in the DRC, of which 85% are fuelling domestic demand. Equivalent roundwood production of artisanal logging, estimated at 3.4 million m^3 per year, is 13 times greater than all the formal production of wood products in cases where the official statistics were reliable.

Artisanal log volume by number of trees felled

A study conducted by Lescuyer et al. (2014) establishes the distances traveled by the loggers and the volume of logs produced per tree felled. The results are summarized in Table 8.

The result is that the artisans travel an average distance of 4.2 km in Congo and in CAR for artisanal logging, against 1.3 km and 1 km in Gabon and Cameroon, respectively.

3.1.5 Wood energy

In Cameroon, the annual consumption of wood-energy in urban areas is estimated at 2,203,496 tons for firewood and 356,530 tons for charcoal; all for a turnover estimated at 188.33 billion CFA francs per year. It is estimated that, in rural areas, the population consumes annually approximately 4 million tons of firewood that they collect directly from surrounding vegetation, representing an estimated value of 77.8 billion CFA. In terms of monetary value, this amount is, however, lower if one takes into account the various costs related to transportation and marketing. Charcoal plays a marginal role in the satisfaction of energy needs of the households (Atyi et al. 2013).

In Congo, commercialization of wood energy is not yet formal and is still considered as part of the subsistence economy. The forecasts indicate that only 55% of urban households and 25% of rural households will be able to have access to electricity by 2025 (Republic of Congo 2011a). The use of fuelwood and charcoal will continue to be essential in the next few decades, both in the cities and in rural areas.

In CAR, the Strategic Document for Growth and Poverty Reduction (Republic of Congo 2008–2010) states that, currently, wood represents nearly 87.7% of the energy consumption. In addition, the heavy concentration of population in the commune of Bangui (800,000 inhabitants, representing 20% of the total population) results in a steady increase of wood energy needs and food products, which in fact contributes to deforestation and forest degradation around the city.

Table 8. Distance traveled for artisanal logging and volume of logs produced per tree felled.

	Congo	CAR[a]	Gabon	Cameroon	DRC[b] (Orientale Province)
Distance from logging site (km)	4.2	4.2	1.4	1	3
Volume of logs per tree felled (m^3)	0.52	2.3	2.91	3.18	5.7

a Central Africa Republic; b Democratic Republic of Congo.
Source: Adapted from Lescuyer et al. (2014).

In DRC, less than 7% of the population has access to electricity. Fuelwood and/or charcoal remain the only sources of energy available. The consumption of wood energy in the city of Kinshasa is estimated at between 3 and 6 million tons of energy-wood equivalent per year (Peltier et al. 2010).

The consumption of wood energy in the urban centers in DRC increases with population growth and the absence of other sources of energy. Households depend heavily on fuelwood for their daily needs in energy for cooking (87% in Kinshasa and 95% in Kisangani) (Schure et al. 2011).

For just the cities of Kinshasa and Kisangani, the volume of the market for wood energy (4.9 million m^3) represents more than 12 times the volume of domestic production of official lumber valued at 400,000 m^3 (ITTO 2011). In Kinshasa, the capital of the country, which has nearly 6 million inhabitants, the total value of the market for charcoal is estimated at 143 million USD in 2010, 3.1 times the value of the national exports of timber of the country, that is, US$46 million in 2010 (FAO 2011; Schure et al. 2011).

3.1.6 Other factors

Other factors are those that do not include infrastructure development, agricultural expansion and timber exploitation. Those factors include mainly:

- environmental predispositions;
- biophysical factors;
- social upheaval brought about by events such as wars, revolutions, etc.

Since the civil wars that erupted in DRC in and after the 1990s, many forest exploitation permits have been granted, most of which did not comply with the standards defined in the Forestry Code of the country. In 2009, the government, after investigation, cancelled 91 of 156 forest concessions granted in the country. Most had been assigned during the 10 years of civil war, especially from 1992 to 2002. This revealed the negative impact that the armed conflict had and its influence on the process of development and reconstruction of the State; the effects could also be seen in the management of the forestry administration at the bottom of the scale.

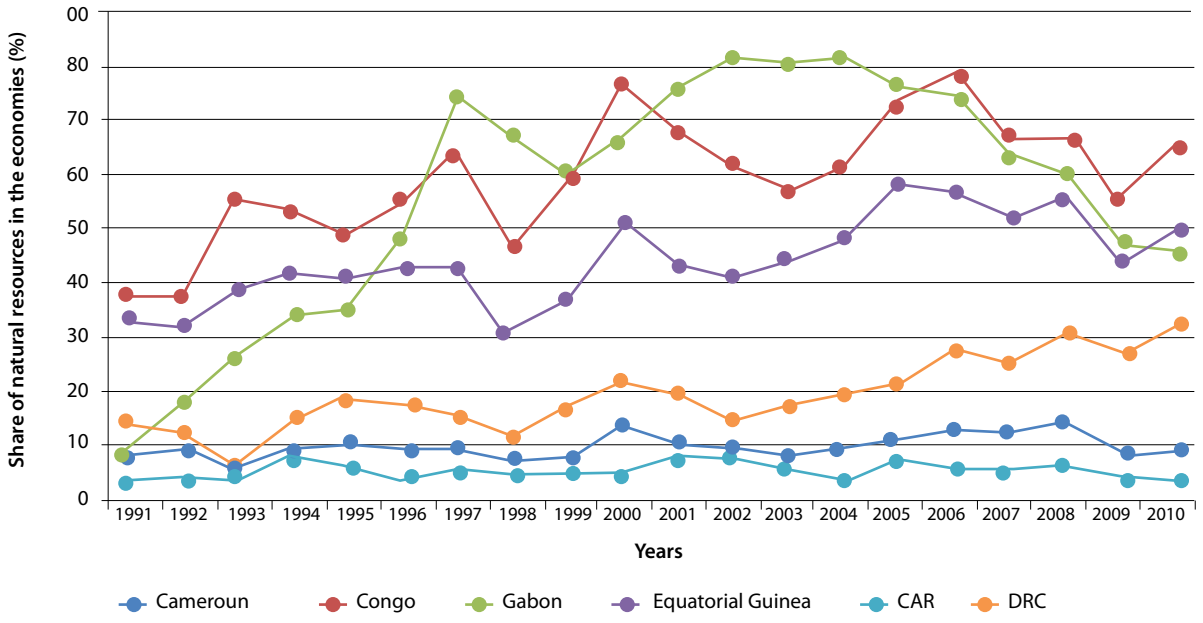

Figure 11. Evolution of the share of natural resources (including mining) in the economies of the study countries between 1991 and 2010.

CAR: Central Africa Republic; DRC: Democratic Republic of Congo

Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

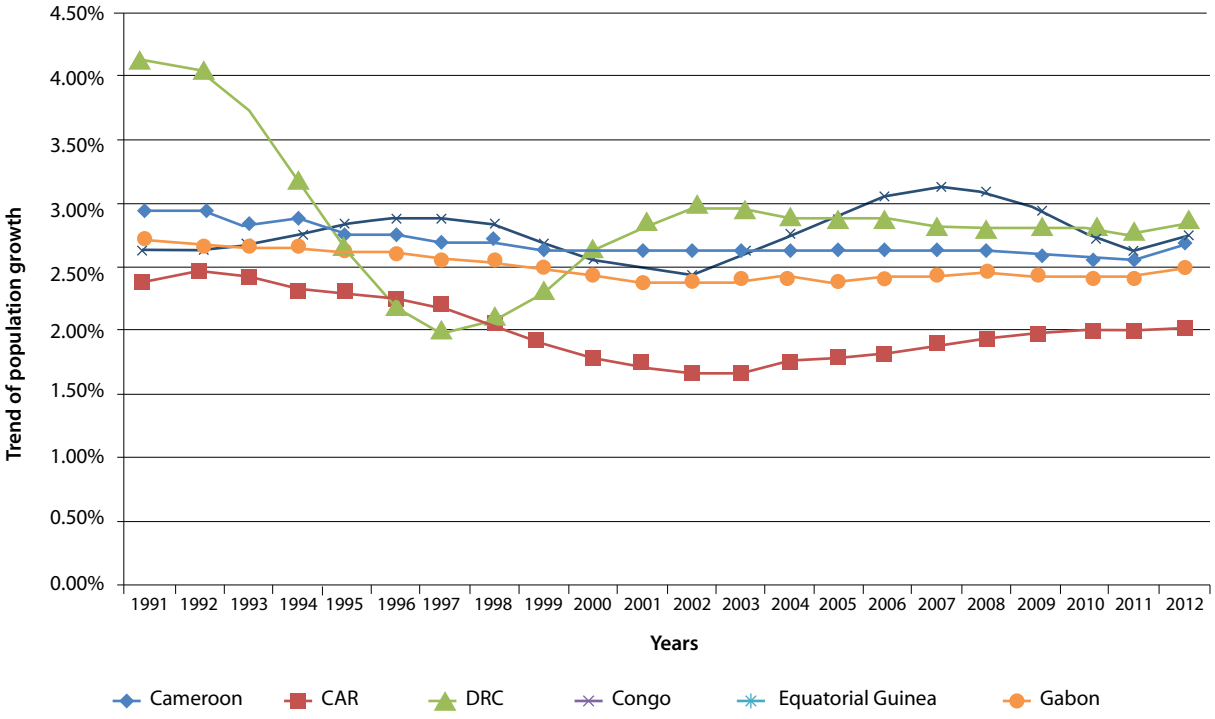

Figure 12. Trend of population growth of the countries of the Congo Basin.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

The displacement of refugees from wars is an indirect factor of deforestation and forest degradation in Congo, particularly in the north, in the Likouala region, and to the south. These two regions accommodated thousands of refugees fleeing the civil war in DRC.

Figure 11 presents the evolution of the contribution of natural resources, including mining with the exception of oil, to the economies of the countries.

The contribution of natural resources to the economy of Cameroon and the CAR is constant, unlike other countries where there is a rising trend between 1991 and 2010, the highest being recorded in Equatorial Guinea, following the oil boom. As a matter of fact, from 8% in 1991, the share of natural resources in the economy of Equatorial Guinea reached 80% between 2001 and 2002, before dropping to a little less than 50% in 2010.

3.2 Underlying causes

The underlying causes are the factors that do not act directly on the forest cover, but whose development could lead to the emergence of immediate factors, such as demographic and economic factors.

3.2.1 Demographic factors

These factors include the evolution of the population, its structure and even its density. The information relating to variations in the rate of population growth and densities in the six countries are summarized in Figures 12 and 13.

Figure 12 shows that the populations of the six study countries increase constantly over the entire period of the study. The rate of population growth varies between 2% and 4%. The highest rates are registered in DRC and in Equatorial Guinea.

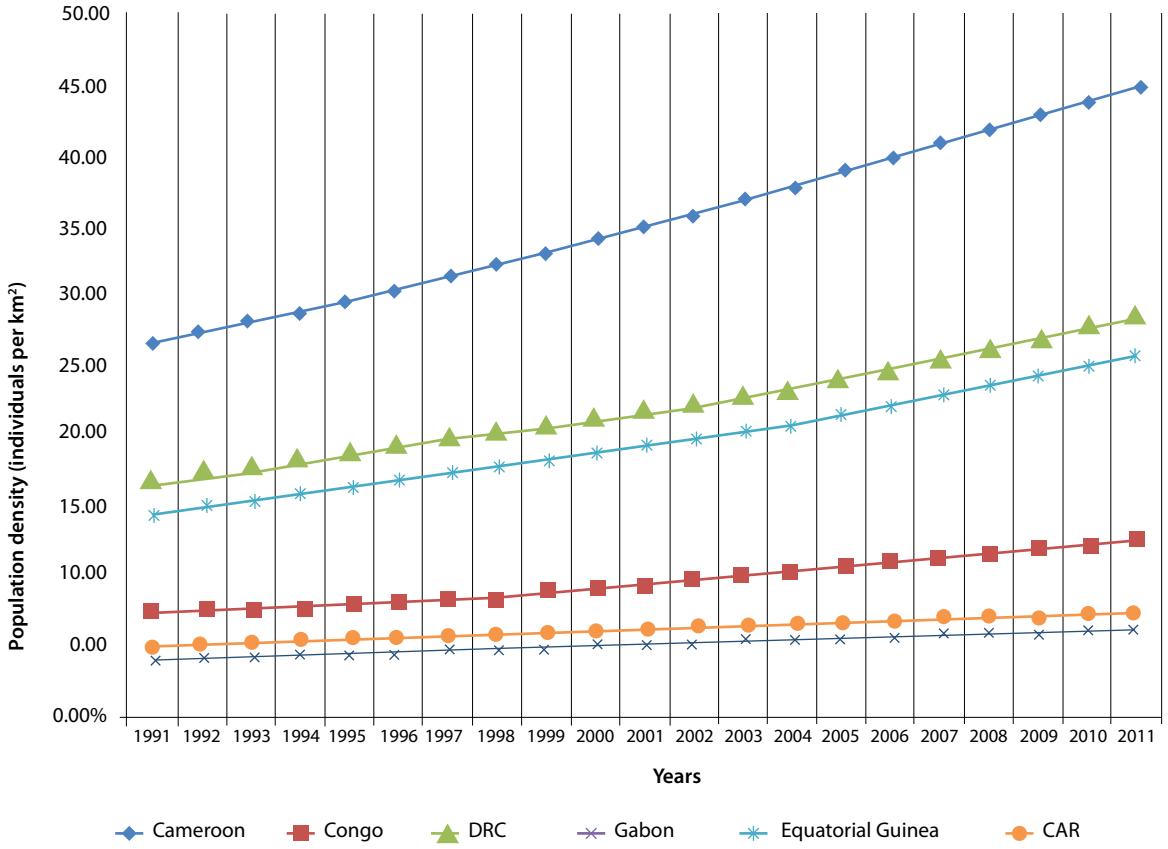

Figure 13. Evolution of the density of the population in the study countries between 1991 and 2009.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Source: Compilation from the World Bank database, retrieved in 2013 (http://donnees.banquemondiale.org/).

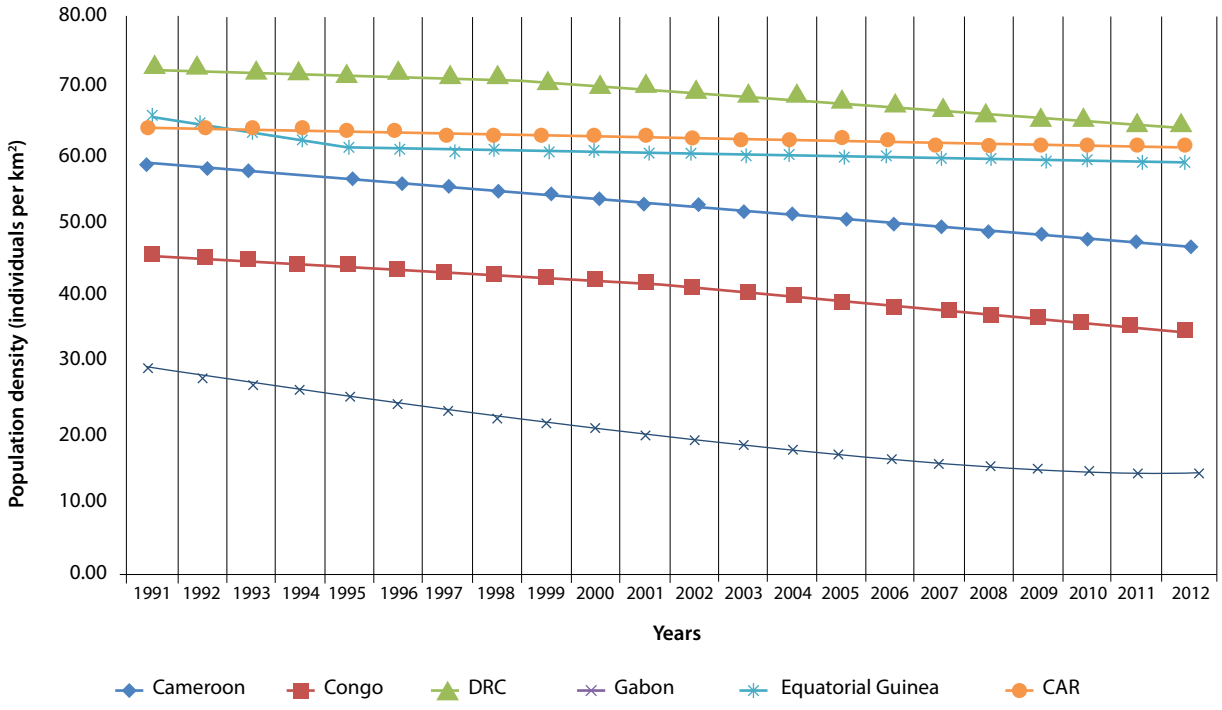

Figure 14. Trend of the rural population growth of the study countries.
CAR: Central Africa Republic; DRC: Democratic Republic of Congo
Sources: Compiled from World Bank database, consulted in 2013.

As expected, the density of the populations of the study countries increases constantly, but it is still low compared with other parts of the planet. Cameroon and DRC are the two most densely populated countries, with 45 inhabitants/km^2 and 27 inhabitants/km^2, respectively. However, the populations are unevenly distributed between the cities and the countryside. Figure 14 shows the evolution of the distribution of the rural population.

In the six countries, rural exodus is a reality and results in a steady decline in the rural population. Gabon is the country where the great majority of the population is concentrated in urban areas, while less than 15% live in rural areas. The DRC has the highest rate of rurality, reaching more than 65% of the total population.

3.2.2 Economic factors

In his study published in 1998, Awung says that before 1986, the economy of Cameroon experienced a growth of 8% per year to reach an income per capita of about 800 US dollars. This growth was sustained by oil, cocoa, coffee, timber and rubber exports. With the economic crisis of the 1980s accompanied by the decline of more than 30% of exports, Cameroon has had to tighten its finances.

More than half (60%) of households in the Congo live below the poverty line. They practice traditional subsistence agriculture on small plots of land. This practice leads to the clearing of forests (AfDB 2011).

In addition, the weakness of the forest governance, exacerbated by the absence of application texts of certain laws, a lack of enforcement of the law and of regulations and a proximity to areas of consumption and export (especially in the Southern Congo) are likely to encourage illegal forest exploitation, trafficking of fuelwood and charcoal, allocation of plots or building permits in protected areas, etc.

In Gabon, the percentage of the population living below the poverty line in 1990 was 27%. In 2000, this rate dropped slightly to 25%, reflecting a slight decline in the poverty index. But in 2005, Gabonese Investigation on the Evaluation and Monitoring of Poverty (EGEP) put the poverty rate at 33%.

In Equatorial Guinea, by contrast, a study by Kiari Liman Tinguiri (2010) estimated that between 1994 and 2004, despite the oil boom in the country, more than 70% of the population lived below the poverty line and 67% lived in extreme poverty, earning less than a dollar per day. This proportion was 70% in rural areas as against 60% in the city.

In CAR, 65% of the population lives below the poverty line, while 20% of the richest households will share 72% of the total income while 40% of the poorest share only 5%. This poverty has important consequences for the use of natural resources and leads to poaching and illegal exploitation of the wood around the cities (Central Africa Republic 2010).

3.3 Impact of each factor on deforestation and forest degradation

3.3.1 Method of evaluation of the impact on forest cover of factors related to deforestation

The objective of this section is to estimate the impact of potential factors of deforestation and forest degradation on the forest cover of the six countries of the Congo Basin. The available data include two dimensions:

- a chronological dimension (evolution in time)
- a spatial dimension (the six countries considered).

This type of data is usually called 'panel data' and helps answer some questions that would have been otherwise impossible to elucidate with the single chronological sample or a 'cross section' sample. In fact, panel data allow extrapolations to be made over the years and for the various countries.

Principle of the panel data method adopted

In general, if **Yit** corresponds to forest cover of country i in year t and **Xit** is the matrix of variables responsible for deforestation, the model can be specified in the following manner:

$$Yit = Xit\beta + Zi\alpha + \varepsilon$$

where β is the vector of coefficients of different factors of deforestation, α is a vector of coefficients that express the effects of unobservable variables and ε is the error of the model relative to the individual i and the date t.

Three major types of models can be estimated, namely:

- model of ordinary least squares (OLS)
- fixed-effects model, also known as Least Squares Dummy Variables (LSDV)
- random effects model , also called an error-components model.

The OLS model is the simplest: it is based on the assumption that all the individuals who make up the sample are strictly homogeneous, i.e. that they do not stand out from each other by any specific characteristic. Therefore, there is only one component to the vector Zi: a constant, common to all individuals.

Considering that this assumption is not verified, the choice is between the last two models. This choice is based on the Hausman test where the null hypothesis is that the preferred model has random effects compared with the alternative hypothesis which favors the fixed-effects model (Greene 2008). The alternative hypothesis tests mainly if the unique errors (ui) are correlated with the explanatory variables, while the null hypothesis is that the unique errors are not correlated with the explanatory variables.

The approach of the test is to run a fixed-effects model and save the estimates and then run a random model and save the estimates, before finally performing the test. If the p-value is significant (p-value > 0.05 = 5%), the null hypothesis is accepted and therefore a random effects model is adopted; otherwise, the fixed-effects model is adopted.

3.3.2 Model specification

The model has the objective of explaining the decline of forest cover caused by the potential factors of deforestation, from the diagram of Geist and Lambin (2001). Thus, the explanatory or dependent variable of this model is forest cover. In this regard, two criteria guided their choice:

- the fact that the theory presents the variable in question as a potential factor of deforestation
- the existence of data on this variable for the countries considered and estimation periods; when data were not available, a variable was replaced by a proxy, i.e. another variable strongly correlated to the latter and whose data are available.

On the basis of these two criteria, the following variables were selected as explanatory variables of the model.

- Agricultural value added per employee: the theory presented agriculture as one of the main factors of deforestation. The assumption underlying the integration of this variable among the explanatory variables assumes that a greater individual productivity could lead to less deforestation.
- Exploitation of logs: Geist and Lambin (2001) present the extraction of wood as one of the immediate factors that cause deforestation. Data are only available for the exploitation of logs, and thus only timber extraction is taken into account in the model.
- Cultivated area: as mentioned earlier, agriculture is one of the main factors that causes deforestation. To measure its impact on forest cover, the cultivated areas have been retained as an explanatory variable.
- Effect of the natural resources and mining on GDP: the theory shows that the exploitation of natural resources in general, and of mining in particular, has an impact on the forest cover. As a matter of fact, mining leads to direct deforestation. The best variable to describe this reality would have been the evolution of areas of mining concessions. Unfortunately, these data are not available.
- Effect of the forest sector on the GDP.
- Rural population: demographics is presented as one of the factors of deforestation in the literature. Many authors have evaluated the impact of rural populations on the evolution of forest cover.

The equation of the model is written thus:

$$COUVERTit = VAAit\beta 1 + SUPCULTit\beta 2 + PRNit\beta 3 + POIFORit\beta 4 + POPRURALit\beta 5 + Zi\alpha + \varepsilon$$

Table 9. Results of the model estimates.

Variables	Coefficients	Std. Error	Pr(> |t|)
Agricultural value added per employee	0.98558	0.16819	7.69E−08 ***
Cultivated area	−19.07630	6.98764	0.0076338 **
Effect of natural resources on GDP	−3.51810	1.43358	0.0160498 *
Effect of the forest sector on the GDP	25.63007	6.85088	0.0003239 ***
Rural population	−33.07159	0.90233	< 2.2E−1 ***

Meaning of codes: '***': 0.001; '**': 0.01; '*': 0.05; '-': 0.1

where COUVERTit = the forest cover of country i in year t, VAAitβ1 = the added value by labor from the agricultural sector of country i in year t, SUPCULTitβ2 = the cultivated area of country i in year t, PRNitβ3 = the effect of natural resources other than forest products of country i in year t, POIFORitβ4 = the effect of the forest sector on the economy of country i in year t and POPRURALitβ5 = the rural population of country i in year t.

The results of the Hausman test helped us select a fixed-effects model for the estimation of the model.

3.3.3 Analysis of the results of the estimates

The results of the model estimates are reported in Table 9 taking into account various factors.

It can be seen from Table 9 that the agricultural added value per worker has a positive impact on forest cover. That means that by improving the productivity of each agricultural worker, forest can be preserved. Improved policy that favors the modernization of agriculture, increased use of improved seeds and other strategies that can improve the agricultural yield all contribute to the preservation of the forest. Therefore, by improving the performance of agriculture, more can be produced in smaller areas and thus the forest cover can be preserved.

The importance of cultivated areas in light of agricultural practices has also had negative consequences for the forest cover. As a matter of fact, the more that cultivated areas are increased, the more the forest is destroyed. This result confirms what has been stated above. Improving agricultural yields could reduce the extent of cultivated areas by increasing production to meet the increasing demand and so preserve the forest.

The effects of the natural resources on the GDP and the rural population are also factors whose impact on the forest cover is harmful. As far as the share of natural resources in the GDP is concerned, it is worth mentioning that these are mainly oil resources and mining. This result confirms the theory that mining is one of the main factors that lead to deforestation.

As for the rural population, it has been recognized that population size might cause more pressure on the forest. The result of the econometric estimates confirms this assertion. Rural populations in general, and those living in forest areas in particular, depend mainly on forest resources. The forest is therefore one of the main sources providing livelihoods to these populations. If the population is large, forests will likely suffer more pressure, leading to deforestation and forest degradation.

The share of the forest sector in the GDP also has a positive impact on forest cover. This result can be explained by the fact that in transforming the forest resources, more added value is created, which contributes significantly to the GDP without prejudice to the forest.

The objective of this section was to identify current causes of deforestation and forest degradation in the Congo Basin. Based on the classification of Geist and Lambin (2001), agriculture and the development of infrastructure were identified as

the main direct causes of deforestation in this region. Population growth, urbanization, economic development and the war (especially in DRC) were the main underlying causes of deforestation. In terms of forest degradation, the extraction of timber was the main cause of forest degradation.

In view of the extensive programs of emergence developed by the countries of the region, emerging and pressing challenges such as increasing demand for lumber and NTFPs and climate change may amplify existing factors of deforestation and forest degradation in the Congo Basin.

4 Prospective analysis of the causes of deforestation and forest degradation of the Congo basin

This section attempts to make projections on different factors of deforestation and forest degradation in the future and the way in which each of the factors could act on forest cover in the next few years. In order to achieve this, several planning documents have been consulted in order to understand the sectoral policy of each country for the years to come. These documents include:

- documents of vision (Cameroon 2035; Gabon 2025; Equatorial Guinea 2020)
- Document on Strategy for Growth and Employment (DSCE) in Cameroon; Document on Strategy for Growth and Poverty Reduction (DSCRP) in DRC)
- sectoral strategies (natural sector, infrastructure sector)
- Report of the National Coordination REDD+ in DRC.

These documents give an idea about what each country wants to undertake in terms of economic development and poverty reduction. These are documents of reference in terms of government action. Their analysis can help understand how each factor of deforestation would evolve in the countries considered.

The aim here is to analyze the expected impacts of these development strategies on the forest cover. However, it is worth mentioning that the impacts will be underestimated because only factors that have direct impacts on forest cover are taken into account. With the current state of the data, it is impossible to estimate the induced effects of such strategies on forest cover. For instance, if one takes the example of the opening of a road, the estimated impact on the forest cover will be limited to just the loss of forest area created by the opening of the road. Deforestation caused by giving access to populations to previously inaccessible parts of the forest will not be estimated in this report.

4.1 Vision of the States and programs for development emergence

Each country of the Congo Basin has a vision document and programs for development emergence (or Emergence) over various timeframes. This section analyzes the documents produced by five countries of the region: Cameroon, Congo, Gabon, Equatorial Guinea and DRC.

4.1.1 Cameroon, emerging country in 2035

Cameroon has developed two documents that serve as reference documents for government action on economic development. These documents are the vision document and the Document on Strategy for Growth and Employment (DSCE), through which Cameroon has set the direction of the emergence in 2035. The vision document titled 'The Cameroon: an emerging country, democratic and united in its diversity' offers decennial strategic axes, which set out the national priorities. In terms of economic and social development, the strategy is based on five pillars:

- development of infrastructure
- modernization of the production apparatus
- human development
- regional integration and trade diversification
- financing the economy.

As regards infrastructural development, Cameroon does not intend to open new roads, but only to improve the quality of the existing road network and to asphalt the priority roads network. It also intends to construct a railway 3000 km long, to provide access to essential

parts of the country and to allow the flow of mine products toward the deep-water port of Kribi.

The following are also foreseen:

- construction of numerous hydroelectric dams, primarily in the forest areas
- modernization of the production apparatus through (i) the transition to second-generation agriculture (mechanization of agriculture, increase in the area cultivated, etc.); (ii) the modernization of the mining sector; (iii) the sustainable management of natural resources; and (iv) the development of industries and services
- human development by (i) the improvement of the health status of populations; (ii) the training of human capital; and (iii) promotion of gender equality
- regional integration and diversification of trade by (i) the strengthening of regional integration and (ii) the diversification of trading partners.

In the area of employment, Cameroon has developed several strategic axes, but unfortunately these are not dealt with in this report.

4.1.2 Emerging Gabon: Vision 2025

Gabon has set the direction of its emergence in 2025, 10 years earlier than that of its neighbor Cameroon. The vision for the emergence of Gabon rests on four foundations (sustainable development; good governance; human capital; infrastructure) and three pillars (Green Gabon; Industry Gabon; Services Gabon).

We emphasize that the Gabonese Government has centered its emergence on sustainable development; that is to say, an economic development that incorporates the priorities of the environment and the interests of future generations. However, the achievement of this goal is through the development of infrastructure and industry, which will have a definite impact on forest cover.

In terms of infrastructure, the Gabonese Government plans to: (i) develop the country and modernize the transport infrastructure; (ii) develop and maintain a sustainable and diversified supply of electricity that is accessible to all; and (iii) build digital infrastructure of global ranking. However, the opening up of the country will certainly lead to the opening of new roads and therefore the destruction of parts of the Gabonese forest. With regard to the development of the electricity supply, Gabon wants to improve the share of hydroelectric power by the construction of new dams.

In the area of industrial development, Gabon has ambitions of: (i) stimulating the production of petroleum and hydrocarbons; (ii) developing the mining potential of the country; and (iii) developing an innovative and diversified industry. These are programs that will put Gabonese forests in danger. Fortunately, the country has placed at the center of its emergence sustainable green development and the lack of deforestation as a gauge of the success of its emergence.

4.1.3 Equatorial Guinea 2020

Equatorial Guinea has set its emergence as 2020, i.e. a little earlier than two of its neighbors (Cameroon and Gabon). The vision of Equatorial Guinea is based on four pillars: (i) construction of international-class infrastructure; (ii) massive strengthening of human capital; (iii) construction of a diversified economy based on the private sector; (iv) establishment of quality governance at the service of its citizens; and (v) establishment of an institutional framework adapted to this vision.

The national strategy for the development of infrastructures is based on: (i) the improvement of the supply of energy through the construction of new dams; (ii) the establishment of modern transport infrastructure; and (iii) the modernization of communication infrastructure and of information and communication technologies (ICT).

In terms of human development, Equatorial Guinea intends: (i) to develop human capacity; (ii) to accelerate the development of infrastructure and social services; and (iii) to build a new system of social protection.

The construction of a diversified economy will rely on the private sector. Equatorial Guinea wants to build an institutional and regulatory environment favorable to the development of the private sector, to better exploit the oil resources and to make energy a key lever of competitiveness for

the national economy. Its government has also decided to promote the sector of maritime fishing, while modernizing agriculture and tourism.

It thus appears that Equatorial Guinea has planned that its emergence in 2020 will be based on activities with a high potential for deforestation, without providing for a strategic axis concerning the sustainable development or the protection of the environment. It is therefore to be feared that this emergence will take place at the expense of the environment.

4.1.4 DRC, Vision 2035

The vision of development of DRC is based on four main pillars, namely: (i) the strengthening of governance and peace; (ii) the diversification of the economy, the acceleration of growth and the promotion of employment; (iii) the improvement of access to basic social services and the strengthening of human capital; and (iv) the protection of the environment and the fight against climate change.

The strengthening of governance and peace- involves a series of measures that were passed that aimed at strengthening the authority of the State, in order to accelerate the process of decentralization, to continue the reform of public finances, to improve the business environment, to promote the private sector, to strengthen the institutional and human capacities and to modernize the public administration, and to support the planning facility and the national system of statistics.

The diversification of the economy, the acceleration of growth and the promotion of employment involve the revival of agriculture, the development of infrastructure, the revitalization of production and external trade, the development of the territory and of the cities, the formalization of the informal sector and the promotion of spatial development.

The improvement of access to basic social services and the strengthening of human capital include the fight against HIV/AIDS, the reduction of inequalities and vulnerability, the improvement of the living environment of the populations as well as better access to services and the promotion of community dynamic.

The protection of the environment and the fight against climate change involve the management and the sustainable protection of the environment and renewable natural resources, including the adaptation to climate change and the commitment to combat the causes.

Like Gabon, DRC has planned a strategic axis centered on the protection of the environment and the fight against climate change, committing the country to limit the impact of the emergence on the environment in general and on the forests in particular.

In the final analysis, all the countries of the Congo Basin aspire to the emergence, but to different horizons – 2035 for Cameroon and the DRC, 2025 for Gabon and 2020 for Equatorial Guinea – depending on the rhythms and varying procedures.

4.1.5 Congo: Document on Strategy for Growth and Poverty Reduction (DSCERP) 2012–2016

The vision for development of the Congo as articulated in the Document on Strategy for Growth, Employment and Poverty Reduction (DSCERP) rests on five main pillars, namely: (i) governance; (ii) growth and diversification; (iii) development of economic and social infrastructures; (iv) social development and inclusion; and (v) 'balanced' development, that is sustainable and long term.

Strengthening governance in all its aspects – political, judicial, administrative, security, economic and financial, which helps strengthen participatory and inclusive democracy – promotes good governance and social peace. Congo is also set to improve the quality and effectiveness of its interventions in order to achieve prosperity.

Promotion of economic growth and diversification is a question of densifying economic activities, in order to accelerate the growth and to promote jobs creation.

Development of the economic and social infrastructure involves programs of reforms and investment aimed at ensuring virtual or physical interconnection (ICT) of the economic space (internal, regional and global markets). These

strategies will reduce the costs of transactions and thus increase competitiveness. They also provide productive and essential social services to people (energy, transport, water), which will strengthen their capacity to participate in the growth and to share in the benefits.

Promotion of social development and inclusion aims to strengthen and develop human resources, as well as to strengthen the capacity of groups, including the most vulnerable, to contribute to the growth and to extract the benefits. This involves putting in place or strengthening existing programs that affect education, scientific research, health, social protection and inclusion of vulnerable groups (children, youth, older persons, indigenous peoples). These programs are designed to improve the productive capacity of the populations to reduce their vulnerability and to strengthen their solidarity and social security (Republic of Congo 2011b).

Achievement of a 'balanced' and sustainable development aims to better 'distribute' the development through different parts of the country and to preserve the natural resources of the country, while adding value in a sustainable way, for the long-term well-being of populations (Republic of Congo 2011b).

In the final analysis, in their strategy documents, Gabon and the Congo have given a prime place to environmental issues while Cameroon and Equatorial Guinea have simply ignored them. Considering ambitious development programs under implementation in the countries of the Congo Basin, it is important to analyze potential impacts of those projects on the forest cover. The following sections will deal with that.

4.2 Projected direct causes

As in the previous section, the analysis of the causes of future deforestation will be made on the basis of the schema of Geist and Lambin (2001) as we review and discuss the contentions of each country in terms of economic development and emergence.

4.2.1 The extension of the infrastructure

The development of infrastructure represents one of the key sectors that can accelerate economic growth and propel the country to accelerate the emergence to which they aspire. As a matter of fact, in the light of the different planning documents, the countries of the Congo Basin have all big ambitions in the area of infrastructural development, which will definitely have an impact on forest cover if nothing is done. The infrastructure considered here such as roads, railways, and electrical and water networks will have direct impacts on forest cover.

Development of the road infrastructure

In Cameroon, the Strategy Document for growth and employment (DSCE) provides several axes of intervention in the area of infrastructural development:

- rehabilitation and maintenance of the existing road network
- development of rural roads
- asphalting of new roads and motorways.

For the rehabilitation and maintenance of the existing network, the government provides for the asphalting of several sections and the improvement of the quality of the road network. Table 10 gives the projections in terms of the quality of roads and shows that Cameroon intends to improve the condition of the road network by increasing the proportion of roads in good condition from 12% of the network in 2010 to 55% in 2020.

The interventions for the management of rural roads will particularly aim at: (i) developing production; (ii) improving tourist sites; (iii) rehabilitating rural and peri-urban roads; (iv) ensuring access to the areas at risk; and (v) ensuring the presence of the State in the border areas. The Cameroonian Government plans to extend the distance of paved roads from 4918 km in 2007 to 6300 in 2015, and then to 8500 km in 2020,

Table 10. Projected trend of the state of the road network in Cameroon.

State/Year	2010	2015	2020
Good	12%	26%	55%
Medium	23%	32%	19%
Bad	65%	52%	26%

Source: Republic of Cameroon (2010).

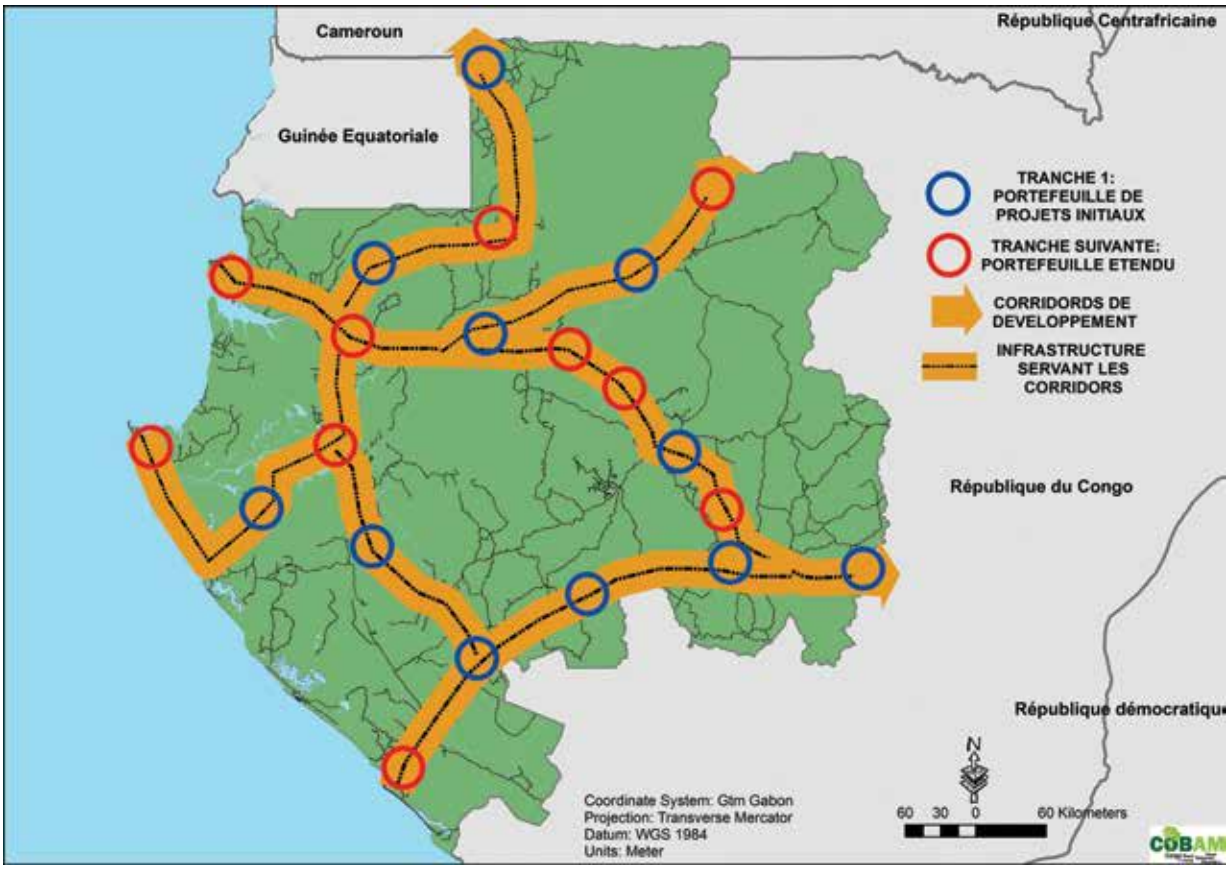

Figure 15. Road map of Gabon for 2025.
Source: Authors, adapted from: Strategic Plan for an Emerging Gabon (SPEG, 2025) (Republic of Gabon 2012).

almost double the initial network length (Republic of Cameroon 2010). Highway programs will be implemented, including for the loop Yaounde–Douala–Bafoussam–Yaounde, on the Yaounde–Nsimalen road and on the Douala–Limbe road. The fraction of bitumenized network will be 17% in 2020: an average of 350 km of highways is expected to be paved per year.

However it is noted that Cameroon has no intention of opening new roads until after 2035. The State wants to concentrate on the improvement of the existing roads. It will simply asphalt the unpaved roads, which will therefore not have a significant direct impact on the forest cover. The impacts on the forest will be mainly induced. In fact, with the opening up of previously inaccessible areas, the populations that practiced subsistence agriculture and who could not previously sell their products on the major markets, would then be able to increase the amount of arable land to the detriment of the forest. In addition, the movement of illegally harvested timber toward the major centers of consumption would be facilitated, thus paving the way for forest degradation.

In the Congo, the Government envisaged the asphalting of more than 1500 km of roads in the framework of the strategy document for growth and poverty reduction. It is, however, important to mention that no new road is on the agenda; it is simply a question of asphalting existing roads. This suggests that this program will not have a direct impact on forest cover, but rather will have indirect effects.

Gabon, through its Strategic Plan *Gabon emergence,* provides for a massive effort of development of infrastructure, which is available through three strategic objectives: (i) develop Gabon and modernize the transport infrastructure, (ii) develop a supply of sustainable diversified electricity that is accessible to all, and (iii) build digital infrastructure of global ranking (Republic of Gabon 2012).

As indicated in the road map of Gabon for 2015 (Figure 15), the Government of Gabon has the

intention to fully unlock the country through the construction of roads linking all the major cities.

However, the documents from Gabon remain silent about whether any new roads will be opened or not, which makes it difficult to estimate the projected loss of forest cover following the construction of any such roads. It is, however, possible to estimate that the ambitious road program of Gabon could cause deforestation of more than 4000 ha.

Equatorial Guinea has placed particular emphasis on transport infrastructure (roads, ports, airports). The policy of servicing and maintenance of the works is still however a major weakness. The documents also remain silent about road construction in the context of the emergence.

Parts of DRC remain poorly developed: only air transportation connects all the provincial capitals. The 152,400-km-long national road network, only 2% of which is paved, is in an advanced state of decay. The priority roads of general interest cover 30,786 km of which 25% are in good condition, 16% in average condition and 59% in poor condition. The network of agricultural roads extends over 86,821 km, of which only 11% are in good condition. The operation of road transport is still dominated by small informal businesses, which translates into generally very high costs for users. The government intends to develop the road infrastructure in order to ensure the stability of economic growth, to improve access to social services and to reduce the vulnerability of the poor.

Development of railways

Cameroon has established, through the National Master Plan of Railways (Republic of Cameroon 2012), an ambitious development program for the construction of railway lines. Table 11 presents the main railway lines to be built.

Table 11 shows that 3259 km of railway will be constructed in Cameroon by 2030. This program will open up areas where mining is important (iron in Mbalam, bauxite in Ngaoundal, etc.) to provide transport to different Cameroonian ports, particularly the deep-water ports of Kribi and Limbe.

If the already existing railway lines (Douala–Ngaoundere and Douala–Kumba, that is, a total of 928.8 km) are excluded from Table 11, it is expected that 2330.5 km of new lines will open, mainly in the forest regions of the country. Assuming that a 10-meter-wide strip spans all of these lines, the forest loss would be approximately 2330.5 ha.

Table 11. Railway lines to be built in Cameroon.

Sections	Linear (km)
Routes for the short term	
Edea–Lolabe	136.0
Mbalam–Lolabe	602.6
Douala–Limbe	73.5
Ngaoundere–Douala	907.5
Subtotal, short term	**1,719.6**
Itinerary for the medium term	
Douala–Wum	351.8
Mbanga–Kumba	21.3
Ngaoundere–Kousseri	683.7
Bertoua–Gamboula	182.9
Mora–Nigerian border	35.7
Bafoussam–Foumban	69.3
Bamenda–Jakiri	75.4
Mintom–Ngoyla	119.6
Subtotal, medium term	**1,539.7**
Overall total	**3,259.3**

Source: National Master Plan of Railways (Republic of Cameroon 2012).

In the Congo, the rail network is in a state of advanced decay and the level of service on the network does not allow people to be always transported safely and comfortably. Thus, there is permanent risk of derailment. Securing the railway network for the transport of persons thus remains an important challenge for the government in the next few years.

The national railway network of DRC covers 5033 km, of which 858 km are electrified. However, the whole network is in a very poor condition due to a total lack of systematic maintenance and improvements. The government intends to focus on the maintenance and improvement of existing lines. Thus, such works will have almost no impact on the forest cover. However, these projects could instead indirectly

favor deforestation through the expansion of agriculture and the informal exploitation of wood.

Electricity

In order to overcome recurrent energy shortages in Cameroon, the government is planning to build many hydroelectric dams, the most important of which are:

- The Lom Pangar dam will be built to regularize the flow of the Sanaga River and provide water for the hydroelectric plants of Song Loulou and Edea. It will include a power station of 25 MW to supply power to the electrical network in the East Region and a hydroelectric plant of 10 MW in Mekin.
- The hydroelectric plants of Nachtigal (330 MW), Song Mbenge (950 MW), Memve'ele (120–201 MW), Kikot (350–550 MW), Njock (270 MW), Ngodi (475 MW), Song Ndong (250–300 MW), Nyanzom (375 MW), Bayomen (470 MW), Mouila-Mogue (350 MW) and Bagangte (90 MW) will be built on the interconnected network of the South (*Réseau Interconnecté du Sud (RIS)*).
- On the interconnected network North, the hydroelectric power station of Warak (50 MW) on the Bini is envisaged, as well as the power plants of Colomines (Gbazoumbe 12 MW) and Ndokayo for the network of the East (Republic of Cameroon 2010).

The Cameroonian Government intends also to export electrical energy to neighboring countries (Chad, CAR, Nigeria). To do this, facilities will be built at Cholet (400 MW) on the Adi River, Grand Eweng (386 MW) and Small Eweng (230 MW) on the Sanaga River, Noun-Wouri (1,200 MW) on the Noun River, Mandourou (67 MW) and Mbinjal (66 MW) on the Faro River, Lancrenon (34 MW) and Vogzom (33 MW) on the Vina River, Munaya (200 MW) on the Cross River, Kpaf (300 MW) on the Katsina River and Mentchum (15–35 MW) on the Mentchum River (Republic of Cameroon 2010).

However, the construction of a hydroelectric dam is generally accompanied by deforestation. By way of illustration, the dam at Lom Pangar will cause a forest loss of 3220 ha. In fact, the preliminary conclusions of the Electricity Development Corporation (EDC) predict a clear cut of about 2470 ha, almost exactly in the same area initially identified by *Office national des forêts International* (ONFI), with additional areas of 750 ha in Ouami, 370 ha in Lom Pangar and 380 ha in Tourake (Electricity Development Corporation 2013). However, the share of the production of hydroelectricity that is consumed in the city reduces the demand for wood energy and therefore reduces deforestation. The impact of the development of electrical infrastructure on forest cover could therefore be positive.

For the Mem Mvele'e dam, the area concerned is of approximately 1900 ha; in addition, 110 km of road will open to give access to the site. If one considers a 10-meter-wide strip for the road, deforestation would comprise 110 ha. Therefore, the construction of this dam will entail the destruction of 2010 ha of forest. Taking this into consideration, it can therefore be projected that 42,000 ha of forest will be destroyed during the construction of other dams.

Apart from dam building, the construction of hydroelectric power lines will also cause deforestation. For instance, the Mem Mvele'e dam will require more than 285 km of hydroelectric power lines to be constructed to Yaounde and 40 km to Equatorial Guinea; that is, a total of 325 km of transmission lines, which could cause deforestation of 325 ha.

In the Congo, the main challenges of the subsector are: (i) the continuation of the rehabilitation of the distribution networks of Brazzaville and Pointe-Noire; (ii) the continuation of the construction of the power line, before linking the south to the north and the surrounding countries; (iii) the connection to the national network of all the cities located in the vicinity of the power line; (iv) the construction of new dams (Sounda, Kouembali, Chollet, Liouesso) in order to satisfy the increasing demand; (v) the improvement rural areas with the introduction of appropriate energy systems (solar, wind, pico and micro-hydro); and (vi) the optimization of the energy subsector by providing quality services and managerial support adapted to the context. This ambitious energy policy will have a definite impact on forest cover, because the construction of dams and the interconnection of cities will result in the destruction of forests by the construction of power transmission lines.

In Gabon, the government is considering the construction of a number of different types of infrastructure for the production of electrical energy, the most important of which are: (i) the hydroelectric

development of Grand Poubara (160 MW put into service in 2013), which will help to counter the energy deficit of Gabon; (ii) the hydroelectric development of Fe II (55 MW put into service in 2013); (iii) the hydroelectric development of the Empress Eugenie Falls (46 MW put into service in 2014), which will strengthen the national network of transport of electricity, along with the hydroelectric development of the Ngoulmendjim power plant (50 MW), put into service in 2015; (iv) the gas plant of Alinakieri (70 MW) built in order to reduce the energy deficit of Libreville and to supply electricity (35 MW) to the special economic zone of Nkok; (v) the gas plant of Port-Gentil (52.2 MW ×2).

Gabon wants to raise the share of hydroelectric energy from 55% in 2010 to 80% in 2020. This can only be done with the construction of numerous hydroelectric dams, which will no doubt be a significant factor of deforestation and forest degradation. As we mentioned earlier, the development of the electric power network could serve to reduce sharply the demand for wood energy, and thus to limit deforestation.

Equatorial Guinea has built and has started operating a gas liquefaction plant and installed gas turbines with a total power of 90 MW for the city of Malabo. It will also, in the years to come, build a hydroelectric power station of 120 MW in Djibloho equivalent to the whole of the current electrical power of the country. The latter will be export oriented, with interconnection lines being foreseen between Equatorial Guinea and Cameroon as well as Gabon ((Equatorial Guinea 2020), Republic of Equatorial Guinea 2007).

The electrical power installed in DRC represents only 2.5% of its huge hydroelectric potential, estimated at more than 100,000 MW and of which nearly half is out of service, because of a lack of maintenance and renovation. The policy of the government is designed to cover the national energy needs through the development of electrical production, to improve the access of populations to electricity, to increase the export of electricity to the region and to develop renewable energy (green energy) for the protection of the environment (Democratic Republic of Congo 2011).

The government intends to initiate the projects of the four hydroelectric plants of Kakobola, Grand Katende, Zongo II and Ivugha. It also planned to implement the megaprojects in Inga III and Grand Inga, as well as other development projects among the 213 other hydroelectric sites already identified (Democratic Republic of Congo 2011).

As was seen for Cameroon, the ambitious projects of extension of the electrical energy by the construction of numerous hydroelectric dams will lead to huge losses of forest cover in the countries of the Congo Basin.

4.2.2 The expansion of agriculture

Cameroon intends to increase yields and the amount of cultivated areas by the order of 30% compared with the 2005 level in order to ensure food security and enhance growth and employment in this sector.

This objective will be achieved particularly through: (i) promotion of medium and large farms by facilitating access to the land; (ii) provision of incentives to consolidate and synergize family businesses in the form of cooperatives or groups of common interest (GICs); (iii) provision of support aimed at attracting young people to rural areas; (iv) implementation of programs for the development and regeneration of production forests, exploitation of forest resources and wildlife; and (v) development of related subsectors.

This increase of 30% of the cultivated area will have a definite impact on the forest cover. Table 12 gives estimates of the agricultural areas in 2005 and in 2020. It evaluates the additional agricultural area that has encroached on the forest and the overall forest cover loss.

Cameroon will probably increase its agricultural area of more than 2.7 million hectares, from 2005 to 2020. This increase cannot occur without putting pressure on the forest. The impact of this measure on the forest cover is estimated at 1025 million hectares by 2005.

In Congo, the government sees the expansion of industrial agriculture through numerous concessions being approved for multinationals such as the Malaysian ATAMA Plantations, for

Table 12. Agricultural area projected by Cameroon in 2020.

Year	2005 (Across the country)	2005 (Forest regions)	Forest loss (30% of the area cultivated in forest areas)
Agricultural area (1,000 ha)	9,163	3,416	1,025

Sources: FAOSTAT (2014), Republic of Cameroon (2010) and our calculations.

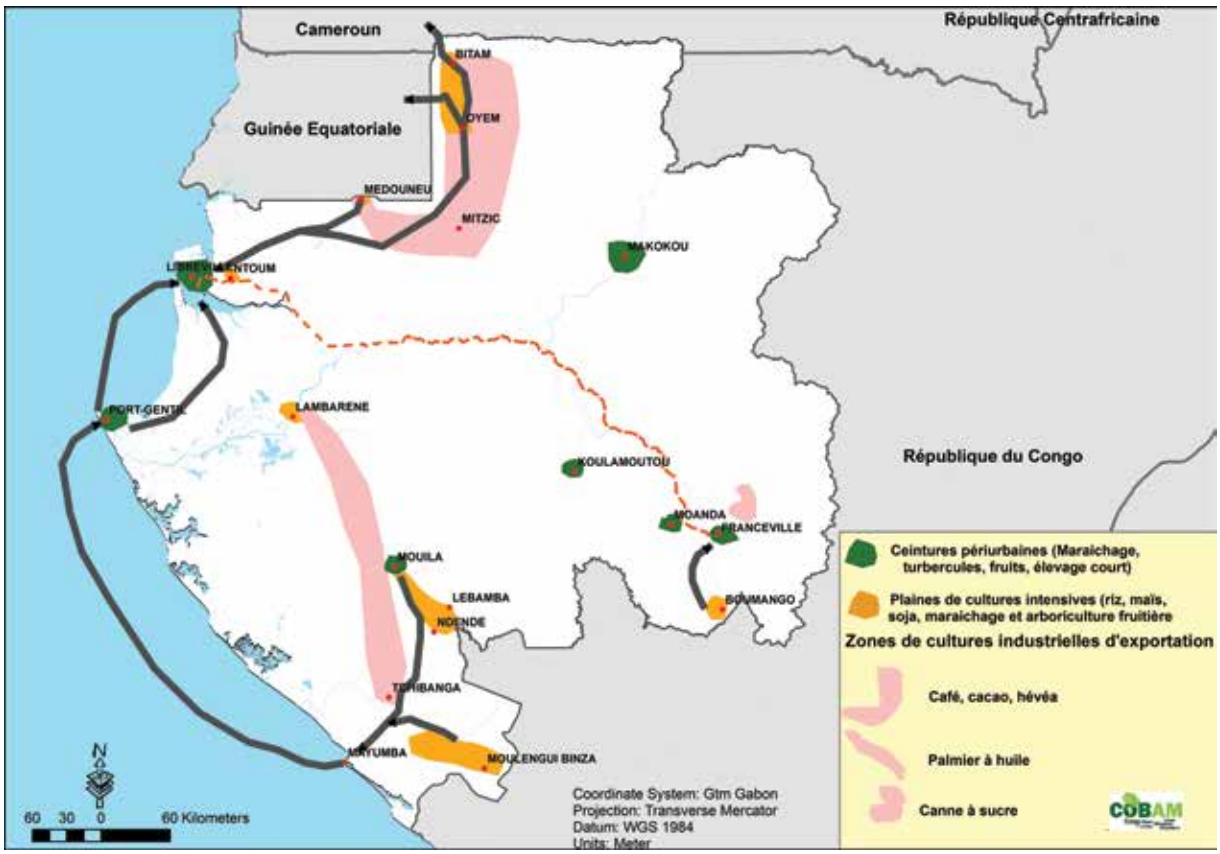

Figure 16. Map of agricultural areas and produce envisaged by Gabon in 2025.
Sources: Authors, adapted from: Plan stratégique Gabon émergent (Republic of Gabon 2012).

the production of oil palm on a large scale. A surface area of 170,000 ha has been granted to this company whose production will be used in the manufacture of biofuels. Similarly, the government has granted a concession of land to a Brazilian as well as to a South African company, for the production of cassava and maize, respectively, with a view to their processing and export.

In animal husbandry, Congolese national production is estimated at 12,000 head of cattle, 40,000 head of sheep, 47,000 goats, 85,000 pigs and 600,000 poultry. This is not sufficient to cover the national needs. In order to cover the deficit, the government has promoted the installation of a South African company to exploit an area of 80,000 ha. In addition to the cattle industry, this company will develop food crops and fruit (Republic of Congo 2011a).

In Gabon, agricultural production will be specialized in three major groups: (i) peri-urban food crops; (ii) intensive crops for food; and (iii) development of agro-industries aimed mainly at export.

Table 13. Projected evolution of agricultural production of Gabon between 2008 and 2016.

Products	Production in 2008 (tons)	Projected production 2016 (tons)	Difference (tons)
Rice	-	15,000	15,000
Maize	6,900	15,000	8,100
Soybeans	-	10,000	10,000
Cassava	227,000	260,000	33,000
Other tubers	59,000	90,000	31,000
Banana/plantain	175,000	250,000	75,000
Vegetable	3,613	8,000	4,387
Fruit	-	5,000	5,000
Peanut	17,000	20,000	3,000
Chicken meat	-	25,000	25,000
Small meat chain	-	4,000	4,000
Crude palm oil	8,800	280,000	271,200
Coffee/cocoa	300	5,000	4,700
Dry rubber	46,283	60,000	13,717
Sugar cane	25,800	27,000	1,200

Sources: Strategic Plan of an Emerging Gabon (Republic of Gabon 2012) and our calculations.

Gabon's plan by 2025 (Figure 16) is to develop extensive and intensive agriculture as well as industrial agriculture destined for export.

Table 13 refers to the developments expected for agricultural production of Gabon between 2008 and 2016.

It is clear from Table 13 that the Gabonese Government intends to significantly increase its agricultural production. The perennial crops seem to be experiencing the largest increases, with a production of oil palm that the government wants to multiply by 31.8 and coffee and cocoa by 16.6. To do this, Gabon aims to develop approximately 6000 ha of irrigated land and swamps (Republic of Gabon 2012, Strategic Plan for an Emerging Gabon).

4.2.3 The extraction of timber

In terms of the extraction of timber, the strategies of different countries cover three axes, namely:

- industrial timber exploitation
- artisanal exploitation or small-scale timber exploitation
- wood energy.

Industrial timber exploitation

In terms of industrial timber exploitation, all the countries considered have undertaken significant efforts to attain the sustainable exploitation of forests. That is one of the reasons why the rate of degradation of forests of the Congo Basin is among the lowest in the world. However, another step that would reduce forest degradation is to process timber locally. As already discussed, the share of the forest sector in GDP has a positive impact on forest cover. This means that the greater is the contribution of the forest sector to GDP, the more the forest is preserved. In addition, the more logs that are transformed locally, the more value is added to the forest sector, and as a consequence, the more the forest is protected.

To date, Gabon is the first country to have taken this step, even if the decisions taken with regard to the processing of wood on site have not yet been applied. As a matter of fact, the Gabonese authorities require that logs be transformed locally before any export. However, the application of this statutory measure is still being awaited.

Cameroon has planned for the stabilization of the exploitation of timber to 2 million m^3. Cameroon's plan is also to require the local processing of all logs prior to export, but the relevant legislation is still in preparation.

Artisanal logging or small-scale timber exploitation

In all the study countries, small-scale timber exploitation is not well organized. It is therefore not possible to make relevant projections for the next few years, nor to assess the impact on the forest cover. Data on small-scale exploitation are limited to background knowledge from production to consumption. As such, any future projections on this activity are difficult.

Wood energy

This sector represents one of the priorities of the governments for the study countries. For example, in Cameroon, the energy action plan for poverty reduction has elaborated on the problems associated with wood energy. Thus, to reduce the consumption of wood as a source of energy, the government intends to facilitate the access of households to other sources of energy, such as domestic gas and renewable energies, through the promotion of cooking appliances that use solar energy, or even improved stoves that consume less wood than those used by the majority of Cameroonian households.

DRC also intends to better organize the subsector of wood energy in order to reduce its impact on the deforestation and degradation of forests.

Equatorial Guinea made no reference to the wood energy sector in its vision document *Equatorial Guinea 2025.*

Other factors

An analysis regarding the future of mining operations in the various study countries helps provide an overview of this activity and future projections. Cameroon intends to promote the exploitation and processing of its mineral deposits of: cobalt, nickel and manganese near Lomié, estimated at 54 million tons; the iron deposits of Mbalam estimated at 2.5 billion tons and an estimated 350 million tons in Kribi; the deposits of bauxite in Ngaoundal and Mini-Martap, which represent more than a billion tons; the deposits of rutile in Akonolinga with geological reserves of 300 million tons; and the deposits of diamonds at Mobilong, likely to produce more than 700 million carats. This expansion of the mining will have a definite impact on the forest cover. A study conducted by Schwartz et al. (2012) for WWF has shown that mining permits issued in Cameroon will have a negative impact on the forest land. It is predicted that mining could be accompanied by the destruction of more than 943,725 ha of forest.

In Congo, the government envisages making considerable investments to revive the mining sector. Major private projects include: (i) the development of the iron production in the Zanaga by PDM, in Avima by Korea Mining, in Nabemba by Congo Iron, in Mayoko by DMC; (ii) the development of potash in Mengo by MPC, in Sintoukola by Sintoukola Potash; (iii) the development of poly metal in Boko Songho/ Yangabanza by SOREMI and in Mindouli-Mpassa by Lulu. These major projects will certainly have damaging consequences for the forest cover.

4.3 Projected underlying causes

4.3.1 Demographic factors

Different documents from the study countries have no strategy about population growth. This suggests that the population will continue to grow in the same way as today.

Considering the rate of population growth in the Congo Basin, Table 14 shows a projection of the population for each country by 2035.

According to Table 14, the population of the region will double by 2035 if population growth follows the same curve as for the last 20 years. The fact that the population of each country will be doubled by 2035 assumes that each country will have to produce twice as much food, either by increasing the area under cultivation or the agricultural yields. In addition, new spaces will

Table 14. Population projections for the study countries until 2035.

Country/Year	2010	2020	2035
Cameroon	20,624,343	26,830,773	39,945,906
Congo	4,111,715	5,393,728	8,117,854
Gabon	1,556,222	1,988,727	2,879,175
Equatorial Guinea	696,167	941,291	1,491,876
CAR[a]	4,349,921	5,306,217	7,152,115
DRC[b]	62,191,161	82,419,170	126,061,651

a Central Africa Republic; b Democratic Republic of Congo.
Sources: Projection using data from the World Bank (2014).

be needed for this extra population, which will undoubtedly have an impact on the forest.

4.3.2 Economic factors

In the field of economic development, most of the study countries aspire to development at different timelines. This emergence will entail important infrastructural, industrial and commercial development. If not accompanied by a coherent policy of forest conservation, the emergence of the countries of the Congo Basin could lead to economic development that is accompanied by high rates of deforestation.

4.3.3 Political and institutional factors

At the institutional level, each country of the region has a department in charge of forests and the environment. However, the development strategies are not always consistent with the concerns of forest conservation.

In Equatorial Guinea, for example, major strategies have been put in place for the expansion and modernization of the infrastructure, the strengthening of human capital, the improvement of the living environment, the construction of a diversified economy based on the private sector and the establishment of a governance of quality. However, it is worth mentioning that the preservation of forest and environment does not figure among the priorities of the government. As such, without a real policy for forest protection, development will occur at the expense of forests.

The situation of Cameroon is slightly different from that of Equatorial Guinea, but the result will likely be the same. Cameroon has a departmental strategy for the forest and wildlife sector. However, the development of forests and wildlife is mentioned only in one paragraph of the DSCE, without saying how the objectives for the other axes of development could be achieved while at the same time preserving the forests in particular and the environment in general. This document highlights the development of infrastructure, the expansion of agriculture and agro-industry, mining and the development of an industrial fabric to accelerate economic growth. In the absence of consistency in the sectoral strategies, it is likely that different sectors' development will be carried out to the detriment of the forests.

Only Gabon and DRC have given priority to forests and the environment in their strategy or vision document. The Gabonese government has placed the environment at the center of economic development and the improvement of the living conditions of the populations. It is clearly stated in the Emerging Gabon Strategic Document that all actions will be undertaken in a framework of respect for the environment and protection of the forest. If this plan is implemented as announced, Gabon will be at the forefront of the protection of its forests and may bring its net rate of deforestation, which is currently zero, to a negative figure.

DRC has announced in its Strategy Document for Growth and Poverty Reduction strategies for the protection of the environment and to fight against climate change. If properly implemented, DRC could reduce its net rate of deforestation, which is currently the highest in the region.

4.4 Impact of the projected emergence on the forest cover: The case of Cameroon

We propose here a quantitative estimation of forest loss that could arise from the implementation of the development strategies, taking for example the case of Cameroon. The aim of the exercise is to draw the attention of policy makers to the risks of non-concerted sectoral policies on the sustainability and the balance of natural systems.

Table 15 summarizes the projected forest loss in Cameroon by 2035.

Therefore, Emergence 2035 will cost Cameroon at least 2.02 million hectares of forest or 8% of the current national forest cover. However, it is worth mentioning that this rate is underestimated: first, we did not have all the necessary information to enable us to estimate the loss of forest cover due to the potential factors of deforestation; in addition, the induced effects of development programs could not be evaluated. However, as a minimum, more than 2 million hectares of forest will disappear due to Cameroon's development programs for Emergence 2035.

Table 15. Forest loss due to the emergence aimed for by Cameroon in 2035.

Factors	Loss of forest area (ha)
Agriculture	1,025,000.00
Dam at Lom Pangar	3,220.00
Dam at Mem Mvele'e	2,010.00
Other dams	42,000.00
Railways	2,330.50
Roads	-
Exploitation of timber	-
Mining	943,725.20
Total	**2,018,285.70**

Source: Our calculations.

5 Conclusions

This report has attempted to present the current state of forests of the Congo Basin, to analyze the main current factors of deforestation and forest degradation and to make projections in the light of the vision of the emergence of the various countries concerned.

With a net rate of 0.09% between 1990 and 2000 and 0.17% between 2000 and 2005, deforestation appears low in the Congo Basin compared with other regions of the world. Slash-and-burn agriculture practiced by the rural populations for subsistence, commercial agriculture and the development of infrastructure constitute the main causes of deforestation. Other factors include urban expansion due to the rural exodus and population growth.

Forest exploitation and the extraction of wood energy represent the main causes of forest degradation.

All the countries of the Congo Basin aspire to the emergence along various timelines: 2035 for Cameroon and DRC, 2025 for Gabon and 2020 for Equatorial Guinea. Primarily, these countries aim to promote economic development and to reduce poverty. Their programs of emergence are mainly based on infrastructure and industrial development. If not properly implemented, these development programs will be responsible for massive destruction of the forest.

The analysis of the case of Cameroon has shown that the development of infrastructure, by itself, is likely to destroy more than 47,230 ha of forest because of the construction of hydroelectric dams, 2330 ha for railway construction, 1.025 million hectares for agricultural expansion and 943,725 ha for mining. All together more than 2.018 million hectares of forest will be lost directly.

It is clear from the various studies that industrial forest exploitation, illegal timber exploitation, the collection of wood and slash-and-burn agriculture are the main causes of wood extraction in the forests of the Congo Basin. This is not the major issue for some countries such as Congo, Gabon or Equatorial Guinea where oil alone represents between 85% and 95% of the State revenue.

The visions of the emergence developed by the different countries, although very ambitious, have not always put environmental sustainability at the center of their development, which constitutes a considerable risk for the future of the forests of the Congo Basin. It is important for each country to put in place programs for mitigation of the impacts of development policies on forest cover. Initiatives could be taken at the regional level, i.e. at the level of the Central Africa Forest Commission (COMIFAC) to limit the consequences of strategies of emergence on the forest. From this perspective, additional studies, for example, on how to reconcile economic development and environmental concerns would be very useful.

6 References

Atyi RE, Lescuyer G, Poufoun JN and Fouda TM. 2013. *Étude de l'importance économique et sociale du secteur forestier et faunique dans les États d'Afrique Centrale: Cas du Cameroun*. Yaoundé: Ministère des forêts et de la faune/ Center for International Forestry Research (CIFOR).

Atyi RE, Devers D, de Wasseige C and Maisels F. 2009. État des forêts d'Afrique centrale: synthèse sous-régionale, *in* de Wasseige C, Devers D, de Marcken P, Eba'a Atyi R, Nasi R and Mayaux P, eds. *Les forêts du Bassin du Congo – État des forêts 2008*. Luxembourg: Office des publications de l'Union européenne. 17–44. ISBN 978-92-79-132 11-7. doi: 10.2788 /32456

Auzel P, Bekah S and Robert ML. 2001. *Estimation des coûts de production du bois des forêts communautaires à partir des résultats du sciage d'un bossé clair et d'un kossipo dans la forêt communautaire de Kompia*. Réseau de foresterie pour le développement rural. Yaoundé, Cameroun.

Awung WJ. 1998. Underlying Causes of Deforestation and Forest Degradation in Cameroon. Paper presented to the African Workshop on the Underlying Causes of Deforestation and Forest Degradation, Accra, October 1998.

[AfDB] Banque africaine de Développement. 2011. *République du Congo. Document de stratégie pays 2013–2017*. Brazzaville, Congo: Banque africaine de Développement.

[AfDB] Banque africaine de Développement. 2009. *République centrafricaine. Document de stratégie de partenariat pays conjointe (DSPPC) 2009-2012 du Groupe de la Banque africaine de développement et du Groupe de la Banque mondiale*. Tunis, Tunisia: Banque africaine de Développement.

[BEAC] Banque des Etats de l'Afrique Centrale. 2013. Accessed 2013. http://www.beac.int

[BEAC] Banque des Etats de l'Afrique Centrale. 2010. Accessed 24 May 2014. http://www.beac.int

[BUCREP] Bureau Central des Recensement et des Etudes de Population. 2010. Rapport de présentation des résultats du 3ième recensement général de la population. http://www.bucrep.cm/index.php/fr/recensements/3eme-rgph/20-3eme-rgph/presentation

Campion PY, Chalon B, Conte C and Coulongeat F. 2006, *La déforestation en Amazonie*. France: École nationale supérieure des Mines de Saint-Etienne. 33 p. http://www.emse.fr/site/publications/deforestation-amazonie.pdf

Central Africa Republic. 2010. *Proposition pour la préparation à la REDD+ (RPP).* Bangui: République centrafricaine.

Cerutti PO and Lescuyer G. 2011. *Le marché domestique du sciage artisanal au Cameroun. État des lieux, opportunités et défis*, Document occasionnel No. 59, 56 p. Bogor, Indonesia: CIFOR. http://webdoc.sub.gwdg.de/ebook/serien/yo/CIFOR_OP/59.pdf

Chomitz KM and Thomas TS. 2001. *Le massacre de l'Amazonie*. Document de travail. Amsterdam: Greenpeace.

[COMIFAC] Central Africa Forest Commission. 2010. Accessed 22 June 2015. http://www.comifac.org/

Debroux L, Hart T, Kaimowitz D, Karsenty A and Topa G, éds. 2007. *La forêt en République démocratique du Congo post-conflit: analyse d'un agenda prioritaire*. Rapport collectif par des équipes de la Banque mondiale, du Center for International Forestry Research (CIFOR), du Centre international de recherche agronomique pour le développement (CIRAD), d'African Wildlife Foundation (AWF), du Conseil national des ONG de développement du Congo (CNONGD), de Conservation International (CI), du Groupe de travail Forêts (GTF), de la Ligue nationale

des Pygmées du Congo (LINAPYCO), de l'Organisation néerlandaise de développement (SNV), du Réseau des partenaires pour l'environnement au Congo (REPEC), de Wildlife Conservation Society (WCS), du Woods Hole Research Center (WHRC), du World Agroforestry Centre (ICRAF) et du World Wide Fund for Nature (WWF). xxii, 82 p. ISBN 979-24-4683-4.

Demaze MT. 2007. *La déforestation en Amazonie brésilienne: une rupture apparente entre développement et environnement.* Le Mans, 23 p. http://hal.archives-ouvertes.fr/docs/00/30/89/73/PDF/Tsayem_deforestation_Amazonie.pdf

Democratic Republic of Congo. 2011. *Atlas interactif de la RDC*, République démocratique du Congo/World Resources Institute (WRI). Kinshasa, RDC.

Democratic Republic of Congo. 2011c. New Map Viewer Shows Development in the Forests of the Democratic Republic of Congo. Washington DC, USA: World Resources Institute. Accessed 10 September 2015. http://www.wri.org/blog/2011/04/new-map-viewer-shows-development-forests-democratic-republic-congo

Democratic Republic of Congo. 2010. *Plan national de développement sanitaire de la RDC 2011-2015*, Document de travail. République démocratique du Congo. Kinshasa, RDC.

de Wasseige C, de Marcken P, Bayol N, Hiol Hiol F, Mayaux Ph, Desclée B, Nasi R, Billand A, Defourny P and Eba'a Atyi R. 2012. *Les forêts du Bassin du Congo – État des forêts 2010*. Luxembourg: Office des publications de l'Union européenne, 276 p. ISBN: 978-92-79-22717-2. doi:10.2788/48830.

de Wasseige C, Devers D, de Marcken P, Eba'a Atyi R, Nasi R and Mayaux P. 2009. *Les forêts du Bassin du Congo – État des forêts 2008*. Luxembourg: Office des publications de l'Union européenne, 426 p. ISBN: 978-92-79-132 11-7, doi: 10.2788 /32456.

Dounias E. 2000. La diversité des agricultures itinérantes sur brûlis. *In* Bahuchet S, éd. *Les peuples des forêts tropicales aujourd'hui*, Bruxelles: Avenir des Peuples des Forêts Tropicales, Université Libre de Bruxelles. 65–106.

Electricity Development Corporation. 2013. *Rapport narratif semestriel d'activités du PHLP*, Rapport EDC. Yaoundé, Cameroun: EDC.

[FAO] Food and Agriculture Organization of the United Nations. 2011. *State of the World's Forest 2011*. FAO Report. Rome: FAO. ISBN 978-92-5-106750-5.

[FAO] Food and Agriculture Organization of the United Nations. 2010. *Global Forest Resources Assessment 2010*. Forestry Paper 163. Rome: FAO. ISBN 978-92-5-106654-6.

FAOSTAT. 2014. http://faostat.fao.org/

Friedlingstein P, Houghton RA, Marland G, Hackler J, Boden TA, Hackler J, Boden TA, Conway TJ, Canadell JG, Raupach MR, et al. 2010. Update on CO_2 emissions. *Nature Geoscience* 3(12):811–12.

Geist HJ and Lambin EF. 2001. What Drives Tropical Deforestation? A meta-analysis of proximate and underlying causes of deforestation based on subnational case study evidence. pp. xiii + 116 pp. LUCC Report Series No. 4.

Greene WH. 2008. *Econometric Analysis.* 6th ed. Upper Saddle River: Prentice Hall.

Greenpeace. 2009. *Le massacre de l'Amazonie, Résumé*, 12 p. Document électronique consulté le 30 août 2014. http://www.greenpeace.org/france/PageFiles/266591/massacre-amazonie-re.pdf

Hansen MC, Stehman SV, Potapov PV, Loveland TR, Townshend JRG, DeFries RS, Pittman KW, Arunarwati B, Stolle F, Steininger MK, et al. 2008. Humid tropical forest clearing from 2000 to 2005 quantified by using multitemporal and multiresolution remotely sensed data. *Proceedings of The National Academy of Sciences of the United States of America* 105(27):9439–44.

[IPCC] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report, United Nations Framework Convention on Climate Change (UNFCCC)*. Cambridge, England: Cambridge University Press.

[ITTO] International Tropical Timber Organization.2011. Annual review and assessment of the world timber production 2010. International Tropical Timber Organization (ITTO), Yokohama, Japan. http://www.itto.int (29 October 2011).

[ITTO] International Tropical Timber Organization. 2005. Critères et indicateurs révisés de l'OIBT pour l'aménagement durable des forêts tropicales Modèle de rapport sur les C&I inclus. Série OIBT: Politique forestière n° 15, Yokohama, OIBT

[ITTO] International Tropical Timber Organization. 2002. Directives OIBT pour la restauration, l'aménagement et la réhabilitation des forêts tropicales dégradées et secondaires. Série Développement de politiques OIBT No 13, Yokohama, OIBT.

Kanninen M, Murdiyarso D, Seymour F, Angelsen A, Wunder S and German L. 2007. *Do Trees Grow on Money? The Implications of Deforestation Research for Policies to Promote REDD*. Forest Perspectives No. 4. 61 p. Bogor, Indonesia: CIFOR,

Kissinger G, Herold M and De Sy V. 2012. *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*. Vancouver, Canada: Lexeme Consulting.

Lescuyer G, Cerutti PO, Tshimpanga P, Biloko F, Adebu-Abdala B, Tsanga R, Yembe-Yembe RI and Essiane-Mendoula E. 2014. *Le marché domestique du sciage artisanal en République démocratique du Congo. État des lieux, opportunités, défis*. Document occasionnel n° 110. Bogor, Indonésie: CIFOR.

Mahode J and Mvale N. 2002. *Évaluation des besoins en formation dans le secteur forestier en République centrafricaine. Rapport de consultation.* Food and Agriculture Organization (FAO), Réseau des Institutions de Formations Forestière et Environnementale de l'Afrique Centrale (RIFFEAC), International Union for Conservation of Nature (IUCN).

Megevand C. Mosnier A. Hourticq J. Sanders K. Doetinchem N and Streck C. 2012. Dynamiques de déforestation dans le bassin du Congo: Réconcilier la croissance économique et la protection de la forêt. Washington, DC: Banque Mondiale.

Nieuwenhuis M. 2000. *Terminologie de l'aménagement forestier en français*. IUFRO World Series Vol. 9 - fr. IUFRO 4.04.07 SilvaPlan and SilvaVoc.

Noss RF. 1999. *A Citizen's Guide to Ecosystem Management*. Boulder: Biodiversity Legal Foundation.

Peltier R, Bisiaux F, Dubiez E, Marien J-N, Muliele J-C, Proces P and Vermeulen C. 2010. De la culture itinérante sur brûlis aux jachères enrichies productrices de charbon de bois, en République démocratique du Congo. Actes du congrès ISDA, "Innovation & Sustainable Developpement in Agriculture and Food". Montpellier, France, 28–30 juin 2010.

Pison G. 2013. Tous les pays du monde, 2013. *Population & sociétés*, *503*, Paris: Institut national d'études démographiques (INED). 1–8.

Republic of Cameroon, 2012. National Master Plan of Railways. 2012. p. 54

Republic of Cameroon. 2010. *Document de stratégie pour la croissance et l'emploi*. Document de travail. Ministère de l'économie, de la planification et de l'aménagement du territoire. Yaoundé, Cameroun

Republic of Congo. 2011a. REDD+ Readiness Preparation Proposal (R-PP). 2011. Submitted to the World Bank FCPF in September 2011. Accessed May 2015. http://theredddesk.org/countries/republic-of-congo.

Republic of Congo. 2011b. *Document de stratégie pour la croissance et la réduction de la pauvreté*. Document de travail.

Republic of Congo. 2010a. *Proposition pour la préparation à la REDD+ (RPP*). République du Congo. Disponible sur le site http://www.forestcarbonpartnership.org/sites/forestcarbonpartnership.org/files/Documents/PDF/Apr2011/R%20PP%20de%20la%20Republique%20du%20Congo%20Version%20finale_10%20Mars%202011.pdf.

Republic of Congo. 2010b. *Congo. Plan national de développement*, Document de travail. Ministère de l'économie, du plan, de l'aménagement du territoire et de l'intégration. Brazzaville, Congo.

Republic of Gabon. 2012. *Plan stratégique Gabon émergent: Vision 2025 et orientations stratégiques 2011–2016*, Libreville, Gabon: République du Gabon.

Republic of Equatorial Guinea. 2007. *Guinée équatoriale 2020: Agenda pour une diversification des sources de la croissance*. Document de travail. Malabo, République de Guinée équatoriale.

Rossi G. 1999. Forêts tropicales entre mythes et réalités. *Natures, Sciences, Sociétés* [Paris] 7(3):22–37.

Rudel T and Roper J. 1996. Regional Patterns and Historical Trends in Tropical Deforestation, 1976–1990. A Qualitative Comparative Analysis. *Ambio* 25(3):160–66.

Schure J, Ingram V, Marien JN, Nasi R and Dubiez E. 2011. *Le bois énergie pour les centres urbains en République démocratique du Congo: le principal produit forestier et énergétique remis*

à l'ordre du jour de l'agenda politique. Brief no. 8. Bogor, Indonesia: CIFOR.
Schwartz B, Hoyle D and Nguiffo S. 2012. *Tendances émergentes dans les conflits liés à l'utilisation des terres au Cameroun: Chevauchements des permis des ressources naturelles et menaces sur les aires protégées et les investissements directs étrangers*. Document de travail. World Wildlife Fund for Nature (WWF). Yaoundé, Cameroun
Simula M. 2009. *Vers une définition de la dégradation des forêts: analyse comparative des définitions existantes*. Document de travail no. 154. Rome: Food and Agriculture Organization of the United Nations (FAO).
Tinguiri Kiari Liman. 2010. Guinée équatoriale: une croissance sans développement? *Stateco* 105:61–72.
Tsayem DM and Fotsing JM. 2004. La déforestation tropicale dans le contexte de mondialisation des risques climatiques et écologiques: outils d'évaluation et de suivi. *In* David G, éd. *Espaces tropicaux et risques. Du local au global*. Orléans et Paris: Presses universitaires d'Orléans et IRD éditions.
[UNFCCC] United Nations Framework Convention on Climate Change. 2007. Rapport du deuxième atelier sur la réduction des émissions dues à la déforestation dans les pays en développement. Framework Convention on Climate Change/ Subsidiary Body for Scientific And Technological Advice (FCCC/SBSTA/2007/3).
World Bank. 2014. http://donnees.banquemondiale.org/
World Bank. 2012. Accessed 2013. http://donnees.banquemondiale.org/

Other sources

Loi n° 94/01 du 20 janvier 1994 portant Régime des forêts, de la faune et de la pêche, Ministère de l'Environnement et des Forêts, République du Cameroun.
Accord de Cancun: http://unfccc.int/resource/docs/2010/cop16/fre/07a01f.pdf
http://www.diplomatie.gouv.fr/fr/dossiers-pays/republique-democratique-du-congo/presentation-de-la-republique-1274/#
http://www.lepotentielonline.com/index.php?option=com_content&view=article&id=6178:en-rdc-la-contribution-du-secteur-minier-au-budget-de-l-État-projetee-a-25-en-2016&catid=90:online-depeches&Itemid=472

ISBN 978-602-387-021-9
DOI: 10.17528/cifor/005894

CIFOR Occasional Papers contain research results that are significant to tropical forest issues.
This content has been peer reviewed internally and externally.

The Congo Basin comprises Cameroon, Central African Republic, the Democratic Republic of Congo, the Republic of Congo, Equatorial Guinea and Gabon. It covers close to 70% of the forestlands of Africa. Of the 530 million hectares in the Congo Basin, 300 million are composed of forests: 99% of these are primary or naturally regenerated forests, as opposed to plantations.

This study is mainly a bibliography to be used in identifying the present and future causes of deforestation in the six countries of the Congo Basin, step one in overcoming the challenges facing REDD+.

With a net deforestation rate of 0.09% between 1990 and 2000 and a 0.17% rate between 2000 and 2005, deforestation in this region seems small compared to other regions of the world. Slash-and-burn agriculture, commercial farming and the development of infrastructure to open up the forest zones together with the construction of secondary agricultural roads are the main causes of deforestation. Other reasons include urban expansion due to the rural exodus and population growth. Forestry operations and the harvesting of fuelwood are the main causes of forest degradation. But some countries do not depend on forestry (e.g. Congo, Gabon and Equatorial Guinea where oil revenue accounts for some 85–95% of State revenue).

All the Basin countries are hoping for emergence, but their timelines are different: 2035 for DRC and Cameroon, 2025 for Gabon and 2020 for Equatorial Guinea. Their emergence programmes are largely dependent on the development of infrastructure and industry and may entail massive destruction of forestlands. There is a need for directives at the regional level to contain the effects of the emergence strategies on the forestlands. With this in mind, in-depth studies that are complementary to the traditional environmental and social impact studies would be very useful in reconciling economic development with environmental preoccupations.

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

This research was carried out by CIFOR as part of the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA). This collaborative program aims to enhance the management and use of forests, agroforestry and tree genetic resources across the landscape from forests to farms. CIFOR leads CRP-FTA in partnership with Bioversity International, CATIE, CIRAD, the International Center for Tropical Agriculture and the World Agroforestry Centre.

cifor.org

blog.cifor.org

CGIAR Fund

PACEBCo

Center for International Forestry Research (CIFOR)
CIFOR advances human well-being, environmental conservation and equity by conducting research to help shape policies and practices that affect forests in developing countries. CIFOR is a member of the CGIAR Consortium. Our headquarters are in Bogor, Indonesia, with offices in Asia, Africa and Latin America.